

**U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

**CENTRAL SERVICE AREA
TERMINAL ENGINEERING SERVICES
FORT WORTH, TEXAS**



PROJECT SPECIFICATIONS

**LBB Replace Reseal ATCT and Base Building.
CSA-2927**

**LUBBOCK PRESTON SMITH INTERNATIONAL AIRPORT
(LBB-ATCT)
LUBBOCK, TEXAS**

JANUARY 06, 2023

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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 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.
- F. On the drawings, calculated or figured dimensions govern over scaled dimensions.
- G. Generally the electrical drawings and any drawings relating to piping are schematic only and dimensions shall be followed without regard to scale. Drawings show the general arrangement and the extent of the work. Exact location and equipment arrangement shall be determined by the physical dimensions of the equipment actually furnished, by shop drawings, detailed dimensioned drawings. Submit all necessary shop drawings mentioned in drawings or specifications.
- 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 is responsible to provide a certification to FAA that all materials used on this project are free of lead and asbestos
- J. The Contractor must not take advantage of any apparent error, omission, discrepancy, or

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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 these to the Contracting Officer (CO) prior to beginning work on affected task(s), for interpretation and decision, and such decision must be final.

- K. 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.
- L. 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 and per the requirements of Section 01 25 00 without additional cost to the government.
- M. 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.
- N. 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. When a particular manufacturer's product is used, the Basis of Design and Section 01 25

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00 shall be follow and be in conformance.

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 COR.
- B. 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 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.

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- 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.

1.7 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.

1.8 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

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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.

1.9 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.

1.10 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.

1.11 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.

1.12 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.

1.13 UTILITY CONTRACTOR LICENSING REQUIREMENTS

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

1.14 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.

1.15 SAFETY DATA SHEETS (SDS):

- A. The Contractor must submit to the COR Safety Data Sheets (SDS) 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 SDS submitted are utilized. Copies of all SDS must be turned over to the local FAA office for their records.

1.16 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 | CONSTRUCTION SCHEDULE |
| 3. | Section 01 33 00 | SUBMITTAL PROCEDURES |
| 4. | Section 01 40 00 | CONTRACTOR QUALITY CONTROL |
| 5. | Section 01 50 10 | FAA FIELD REPRESENTATIVE'S OFFICE |
| 6. | Section 07 12 00 | ELASTOMERIC WALL COATING |
| 7. | Section 07 56 00 | FLUID APPLIED ROOFING |
| 8. | Section 09 96 60 | HIGH PERFORMANCE COATINGS |

PART 2 - PRODUCTS

NOT USED

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PART 3 - EXECUTION

NOT USED

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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. Use of premises.
 6. FAA's occupancy requirements.
 7. Work restrictions.
 8. Specification formats and conventions.
 9. Permits and Fees
 10. Security Requirements
 11. 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.

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

1.3 WORK COVERED BY CONTRACT DOCUMENTS

- A. Project Identification: LBB Replace Reseal ATCT and Base Building.
Preston Smith International Airport
- B. FAA's Lead Project Engineer: Jelani Jones (AJW-2C11C) FAA Central Service Area
- C. CO (Contracting Officer): TBD
- D. The Work consists of the construction of the following:
 - Replace the joint sealant associated with the concrete panels on the ATCT and Base Bld
 - Seal the exterior surfaces of the ATCT and Base Bld
 - Replace all exterior doors and hardware on Base Bld
 - Reseal all windows including tower cab windows
 - Replace tower cab roof
 - Repair Base Bld roof at drains
 - Replace Cab roof fall protection system – move to parapet
 - Replace rusting hardware on Base Bld roof guard rail
 - Replace front doors (storefront)
 - Add accessibility function to front doors
 - Reseal metal panels above the cab windows
 - Grab bar for ladder to cab roof
 - Floor access door to catwalk

1.1 TYPE OF CONTRACT

- A. Refer to Contracting Officer

1.2 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 construction site.
- B. Before commencing Work, submit a schedule showing the sequence, commencement, and completion dates for all of the Work.

1.3 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.

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- B. Experience: Refer to Contracting Officer

1.4 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.

1.5 FAA'S OCCUPANCY REQUIREMENTS

- A. Full FAA Occupancy: FAA will occupy Project site and existing building(s) during entire construction period. Cooperate with FAA during construction operations to minimize conflicts and facilitate FAA usage. Perform the Work so as not to interfere with FAA's day-to-day operations. Maintain existing exits unless otherwise indicated.
1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from FAA and approval of authorities having jurisdiction.
 2. Notify FAA not less than 14 days in advance of activities that will affect FAA's operations.

1.6 WORK RESTRICTIONS

- A. Normal working hours are 0700 to 1700, 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. Night work shall be expected for the following tasks (10:00pm – 5:00am)

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1. As indicated on drawings
- 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 inside the buildings or within 25 feet of the building entrances, operable windows or openings, outdoor air intakes throughout the duration of the construction.
- E. Limits on Operations: The FAA has established moratorium dates for construction activity at critical facilities. 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:

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.

1.7 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:

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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.

1.8 PERMITS AND FEES

- A. 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.
 1. Air Space– All permanent and temporary work, including cranes, must comply with FAA Obstruction Evaluation / Airport Airspace Analysis (OE/AAA) requirements. Contractor shall file a Request for Construction for permanent structures on Airport. The Request should be submitted online. The website for more information and to obtain the appropriate forms is <https://oeaaa.faa.gov/oeaaa/external/puntal.jsp>. Erection of the crane will not be permitted without approval of the form. No claim for delay will be allowed for failure to submit the form in a timely manner. Allow a minimum of sixty (60) days for processing. Contractor is responsible for follow up with the issuing office after submittal.
 2. The contractor will be responsible for any additional fees, payments or applications required for the site utilities that have not been identified above.

1.9 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.

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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".

1.10 SECURITY REQUIREMENTS

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- 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: If contractor needs access to active facility, 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



Federal Aviation Administration

Request For Information No. 000

Title: _____

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

Question (Include Potential Impacts):

Response:

By: _____, FAA

Date:

097 DCR-23-R-0023

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. NOT APPROVED †	REVISE AND RESUBMIT
				AS SUBMITTED	AS NOTED*		
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
				<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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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SECTION 01 10 12 - CONSTRUCTION ADMINISTRATION FORMS

PART 1 – GENERAL

1.1 INDEX OF CONSTRUCTION ADMINISTRATION FORMS:

RFI Standard Form
Transmittals for Contractor's Materials or Shop Drawings
Resident Engineer EOSH Checklist (FAA 3900-19)
Pre-Construction and Maintenance Project Safety and Health Checklist (FAA 3900-18)

SEE DIVISION 2 FOR ADDITIONAL FORMS ASSOCIATED WITH REMOVAL AND DISPOSAL OF HAZMAT

Contractor shall submit a copy of Airspace Form 7460.1 to COR
Contractor shall be responsible to follow up with airport division within 2 weeks of submission to verify receipt and ensure timely processing of the form.

PART 2 - 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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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.

C. Basis of Design: Well-defined requirements consist of a set of statements that could form the basis of inspection and test acceptance criteria.

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 re-approval 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

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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 (COR).
 - 2. Submit 2 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. An itemized comparison of the proposed product to the specified product.
 - 5. Net amount of change to the contract sum.
 - 6. List of maintenance services and replacement materials available.
 - 7. Statement of the effect of the substitution on the construction schedule.
 - 8. Description of changes that will be required in other work or products if the substitute product is approved.
- G. The COR or project engineer 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

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END OF SECTION 01 25 00

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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.

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- ___ 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*)

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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:

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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 meetings.

1.2 DEFINITIONS

- A. RFI: Request for Information 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.
 - 4. Per Section 01 31 00 – 1.5, provide a qualified fulltime on-site Superintendent to coordinate project requirements and interface with the COR.
- B. Coordination Drawings, General: Prepare coordination drawings in accordance with Section 01 40 10 and requirements in individual Sections.
- 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

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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. Coordination Meetings: The contractor shall host regular weekly (or more frequent) coordination meetings in accordance with Section 01 31 00 – 1.8.F. Attendance is mandatory by all Team members to maintain the coordination and construction schedules.
- F. Supplemental Meetings: The contractor shall attend all additional meetings that are scheduled to address RFIs, submittals, safety concerns, or other project related matters. The contractor shall be responsible for recording and distributing the meetings minutes to all parties involved.
- G. 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.
- H. 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.

1.4 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 and in temporary field office. Keep list current at all times.

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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 five (5) 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 five (5) 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 6 or more months.
- D. Quality Control (QC) Manager with a minimum of five (5) years of experience as a superintendent, inspector, QC manager, project manager, project engineer or construction manager on similar size and type construction contracts that include the major trades that are part of this requirement. The QC Manager is required to be on site at all times and his duties can be combined with those of the Superintendent. The QC manager must be employed by the prime Contractor. The QC manager will be responsible for implementing the QC plan.

1.6 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

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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.
 - 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.

1.7 PROJECT MEETINGS

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- 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 the government and the contractor, 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; project manager, project superintendent; project scheduler; 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.

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- bb. Progress cleaning.

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- 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.

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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. 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 monthly 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.

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- 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. Weekly 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 pre-installation 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.

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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. Coordination Schedule: Contractor shall provide a 3-week look-ahead schedule. Schedule should include all items that require coordination with the facility or COR. This includes, but not limited to:
 - 1) Electrical cutovers
 - 2) HVAC cutovers
 - 3) Disabling fire alarm
 - 4) Additional work days
 - b. Schedule Updating: Revise 3-week 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.
 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.
- G. Coordination Meetings: Conduct project coordination meetings as needed to discuss project RFIs, submittals, issues, concerns, or other project coordination. The meetings shall be held at the discretion of the COR or when requested by the Contractor. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings, weekly coordination meetings, and pre-installation conferences.
1. Attendees: In addition to COR, each contractor, subcontractor, supplier, and other entity 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. 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 (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

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SECTION 01 32 00- CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Submittals Schedule.
 - 2. CPM Reports
 - 3. Daily construction reports.
 - 4. Material reports
 - 5. Field condition reports.
 - 6. Special reports.

1.2 SUBMITTALS

- A. Submittals Schedule: Arrange the following in tabular format
 - 1. Scheduled date for all submittals
 - 2. Specification Section number and title
 - 3. Submittal category (action or informational)
 - 4. Name of subcontractor
 - 5. Description of the work covered
 - 6. Scheduled date for COR's final release or approval
- B. CPM Reports: Concurrent with CPM schedule, submit each of the following computer-generated reports. Format for each activity in reports shall contain activity description, cost, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.
 - 1. Activity Report: List of all activities sorted by activity number and then early start date, or actual start date if known.
 - 2. Logic Report: List of preceding and succeeding activities for all activities, sorted in ascending order by activity number and then early start date, or actual start date if known
 - 3. Total Float Report: List of all activities sorted in ascending order of total float
- C. Daily Construction Reports: Submit all reports at monthly intervals
- D. Field Condition Reports: Submit at time of discovery of differing condition
- E. Special Reports: Submit at time of unusual event

PART 2 – PRODUCTS [NOT USED]

PART 3 - EXECUTION

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3.1 REPORTS

- A. CPM Report: Submit the following items for the Initial Schedule, and every Periodic Schedule Update throughout the life of the project:

1. Data Files

- a. Provide the COR and project engineer data files containing the current project schedule, previously submitted schedule in the format of the scheduling software (e.g. .xer) and a pdf file, the Narrative Report, and the required Schedule Reports. Include in the name of each file the type of schedule (Preliminary, Initial, Update), full contract number, data date, and file name. Each schedule shall have a unique file name and use project-specific settings.

2. Narrative Report

- a. Provide a Narrative Report with each schedule submission. The Narrative Report is expected to communicate to the Government the thorough analysis of the schedule output and the plans to compensate for problems, either current or potential, which are revealed through that analysis. At a minimum:
- 1) Identify and discuss the work scheduled to start in the next update period.
 - 2) Describe activities along the 2 most critical paths where the total float is less than or equal to 20 work days.
 - 3) Describe current and anticipated problem areas, delaying factors, their impact, and an explanation of corrective actions taken or required to be taken.
 - 4) Identify and explain why activities based on their calculated late dates should have either started or finished during the update period but did not.
 - 5) Identify and discuss the schedule changes by activity name, including what specifically was changed and why the change was needed. At a minimum, include new and deleted activities, logic changes, duration changes, calendar changes, lag changes, resource changes, and actual start and finish date changes.
 - 6) Identify and discuss out-of-sequence work.

3. Schedule Reports

- a. Formatting, filtering, organizing, and sorting each schedule report shall be as directed by the Contracting Officer. Typically, reports shall contain Activity Description, Original Duration, Remaining Duration, Early Start Date, Early Finish Date, Late Start Date, Late Finish Date, Total Float, Actual Start Date, Actual Finish Date, and Percent Complete. Provide the reports electronically in .pdf format. Typical reports that will be requested include:
- 1) Activity Report
 - a) List of the activities sorted according to activity number.
 - b) Do not change existing activity numbers
 - c) New activities shall be given new activity numbers that have not be used
 - 2) Logic Report
 - a) List of detailed predecessor and successor activities for every activity in ascending order by activity number.

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- 3) Total Float Report
 - a) A list of the incomplete activities sorted in ascending order of total float. List activities which have the same amount of total float in ascending order of Early Start Dates. Do not show completed activities on this report.
 - b) Any day past the contract completion date is behind schedule and must be indicated with negative float
 - 4) Network Diagram
 - a) The Network Diagram is required for the Initial, and Periodic Updates. Depict and display the order and interdependence of activities and the sequence in which the work shall be accomplished. The Contracting Officer will use, but is not limited to, the following conditions to review compliance with this paragraph:
 - i. Continuous Flow
 - a. Show a continuous flow from left to right with no arrows from right to left. Show the description, duration, and estimated earned value on the diagram.
 - ii. Project Milestone Dates
 - a. Show dates on the diagram for start of project, Contract-required interim completion dates, and Contract completion dates.
 - iii. Critical Path
 - a. Show all activities on the critical path. The critical path is defined as the longest path.
- B. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:
1. List of subcontractors at project site
 2. Approximate count of personnel at project site
 3. Equipment at project site
 4. Material Deliveries
 5. High and low temperatures and general weather conditions
 6. Accidents
 7. Meetings and significant decisions
 8. Unusual events (refer to special reports)
 9. Stoppages, delays, shortages, and losses
 10. Change orders received and implemented
 11. Change directives received and implemented
 12. Services connected and disconnected
 13. Equipment or system tests and startups
- C. Material Location Reports: Submit with each pay application, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site.
- D. Field Condition Reports: Immediately on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit an RFI. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents

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- E. Special Reports: Submit special reports directly to FAA within one day of an occurrence. Distribute copies of report to parties affected by the occurrence
 - 1. Unusual Events: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, response by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise FAA in advance when these events are known or predictable

END OF SECTION 01 32 00

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SECTION 01 32 01 - PROJECT SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
 - 1. Preconstruction project schedule.
 - 2. Baseline project schedule.
 - 3. Periodic schedule updates
 - 4. Weekly progress meetings
 - 5. Time extensions

1.2 DEFINITIONS

- A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.
 - 1. Critical activities are activities on the critical path. They must start and finish on the planned early start and finish times.
 - 2. Predecessor Activity: An activity that precedes another activity in the network.
 - 3. Successor Activity: An activity that follows another activity in the network.
- B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by COTR.
- C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.
- D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.
- E. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail
- F. Float: The measure of leeway in starting and completing an activity
 - 1. Float time is not for the exclusive use or benefit of either FAA or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date
 - 2. Activity float is the number of work days that an activity can be delayed without causing a delay to the "End Project" finish milestone.
 - 3. Project float is the number of work days between the projected early finish and the Contract completion date milestone

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- G. Major Area: A story of construction, a separate building, or a similar significant construction element
- H. Milestone: A key or critical point in time for reference or measurement

1.3 SUBMITTALS

- A. Qualification Data: For scheduling consultant or in-house scheduler
- B. Preconstruction Project Schedule: See section 3.1 for requirements
- C. Baseline Project Schedule: See section 3.2 for requirements
- D. Periodic Schedule Updates: See section 3.3 for requirements
- E. Weekly Meetings: See section 3.5 for requirements

1.4 QUALITY ASSURANCE

- A. Scheduling Consultant Qualifications: Authorize a representative to prepare the schedule and update and produce reports. The authorized representative shall have experience scheduling construction projects similar in size and nature to this project. Representative shall have a comprehensive knowledge of CPM scheduling principles and application, with capability of producing CPM reports and diagrams within 24 hours of COR's request.
- B. In-House Option: FAA may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications

PART 2 – PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 PRECONSTRUCTION SCHEDULE REQUIREMENTS

- A. General
 - 1. Prepare a detailed Preconstruction Project Schedule for the duration of the project and include all milestone activities
 - 2. Submit the Preconstruction Project Schedule to the Contracting Officer (CO) within 14 calendar days after contract award.
 - 3. The Preconstruction Project Schedule shall consist of a diagram or a bar chart showing the start and the finish 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
 - a. 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.
 - b. Diagram activities shall include, in addition to construction activities, the submittal, review and approval of samples of materials and shop drawings, the procurement of

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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.

4. The Preconstruction Project Schedule shall consist of a minimum of 20 activities. The selection of activities shall be subject to the Contracting officer's approval. Scheduling software may be used to produce this schedule

3.2 BASELINE PROJECT SCHEDULE REQUIREMENTS

A. General

1. Prepare for approval a Project Schedule, as specified herein, pursuant to AMS Clause 3.2.2.3-56, SCHEDULES FOR CONSTRUCTION CONTRACTS.
2. Must be generated using **Critical Path Method (CPM)**
3. Provide in original software format and pdf format
4. The initial project schedule must be submitted and approved prior to NTP.
5. Schedule must contain all contractual work and be broken down into sufficient detail to allow all interested parties insight into the project plan. Treat each floor or separate area as a separate numbered activity for each main element of the work.
6. Contractor management personnel shall actively participate in its development. Subcontractors and suppliers' designers, subcontractors, and suppliers working on the project shall also contribute in developing and maintaining an accurate project schedule.
7. Provide the schedule data to the COR and project engineer. This data is considered to be additional supporting data in a form and detail required by the Contracting Officer pursuant to AMS 3.3.1-2 "Payments under Fixed-Price Construction Contracts". The receipt of a proper payment requests pursuant to AMS 3.3.1-19 "Prompt Payment for Construction Contracts" is contingent upon the Government receiving both acceptable and approvable hard copies and matching electronic files of the application for progress payment.
8. The Contracting Officer will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail.

B. Activity Duration

1. Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods. No activities shall have Original Durations (OD) greater than 20 work days or 30 calendar days.
2. Activity Original Durations shall be reasonable to perform the work item. Duration changes are prohibited unless justification is provided to and approved by the Contracting Officer.
3. When resubmittals are required, a new activity must be added to the schedule which reflects a new review time
4. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time

C. Mandatory Activities

1. Include the following activities in the initial project schedule and all updates.
 - a. Submission, review and acceptance of all submittals and be broken down into four (4) categories

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- 1) Date of Submittal
- 2) Submittal Review
- 3) Procurement
- 4) Delivery
- b. Mobilization
- c. Mock-ups
- d. Performance Verification testing for electrical and mechanical units.
- e. Other systems testing, if required.
- f. Contractor's pre-final inspection.
- g. Correction of punch list from Contractor's pre-final inspection.
- h. Government's inspection for Substantial Completion (Contractor Acceptance Inspection).
- i. Correction of punch list from Government's inspection for Substantial Completion (Contractor Acceptance Inspection).
- j. Submission and approval of O & M manuals.
- k. Submission and approval of as-built drawings.
- l. Final Cleaning.
- m. Substantial Completion.
- n. Demobilization

D. Contract Milestones and Constraints

1. Milestone activities shall be used for significant project events including, but not limited to, project phasing, project start and end activities, and interim completion dates. The use of artificial float constraints such as "zero free float" or "zero total float" are prohibited.
2. Mandatory constraints that ignore or affect network logic are prohibited. No constrained dates are allowed in the schedule other than those specified herein. Submit additional constraints to the Contracting Officer for approval on a case-by-case basis.
3. Include, as a minimum the following milestones in the schedule.
 - a. Notice of Award
 - b. NTP
 - c. Temporary facilities and Field trailer operational
 - d. Beginning of ASDE interruption
 - e. Ending of ASDE interruption
 - f. Completion of Eng Report on embed plates
 - g. Completion of roof drain piping inspection
 - h. 25% completion of ground level reseals
 - i. 75% completion of ground level reseals
 - j. 25% completion of tower reseal
 - k. 75% completion of tower reseal
 - l. 25% completion of tower roofing
 - m. 75% completion of tower roofing
 - n. 25% completion of cab defogger system
 - o. 75% completion of cab defogger system
 - p. 25% completion of storefront
 - q. 75% completion of storefront
 - r. CAI Complete
 - s. CAI Punch List Complete

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- t. End Project
- 4. Project Start Date Milestone and Constraint
 - a. The first activity in the project schedule shall be a start milestone titled "NTP," which shall have a "Start On" constraint date equal to the agreed upon NTP date between the FAA and contractor.
- 5. End Project Finish Milestone and Constraint
 - a. The last activity in the schedule shall be a finish milestone titled "End Project".
 - b. The project schedule shall be constrained to the Contract Completion Date in such a way that if the schedule calculates an early finish, then the float calculation for "End Project" milestone reflects positive float on the longest path. If the project schedule calculates a late finish, then the "End Project" milestone float calculation reflects negative float on the longest path. The Government is under no obligation to accelerate Government activities to support a Contractor's early completion.
- E. Open Ended Logic
 - 1. Only two (2) open ended activities are allowed: the first activity "NTP" shall have no predecessor logic, and the last activity "End Project" shall have no successor logic.
 - 2. Predecessor open-ended logic may be allowed in a time impact analysis upon the Contracting Officer's approval.
- F. Out-of-Sequence Progress
 - 1. Activities that have progressed before the preceding logic has been satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case basis, subject to Government approval. Propose logic corrections to eliminate Out-of-Sequence Progress or justify not changing the sequencing for approval prior to submitting an updated project schedule. Address Out-of-Sequence Progress and logic changes in the Narrative Report and in the periodic schedule update meetings.
- G. Added and Deleted Activities
 - 1. Do not delete activities from the project schedule or add new activities to the schedule without approval from the Contracting Officer.
- H. Leads, Lags, and Start to Finish Relationships
 - 1. Lags shall be reasonable as determined by the Government and not used in place of realistic original durations, shall not be in place to artificially absorb float, or to replace proper schedule logic. Leads (negative lags) and Start to Finish (SF) relationships are prohibited.
- I. Percent Complete
 - 1. Update the percent complete for each activity started, based on the realistic assessment of physical completion. Activities which are complete but for remaining minor punch list work and which do not restrain the initiation of successor activities may be declared

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100 percent complete to allow for proper schedule management.

J. Early Completion Schedule and the Right to Finish Early

1. An Early Completion Schedule is a Baseline Project Schedule that indicates the scope of the required contract work will be completed before the contractually required completion date.
 - a. No baseline schedule indicating an Early Completion will be accepted. The time, in calendar days, between the schedule 'NTP' start milestone and its 'End Project' finish milestone shall match the contract's Period of Performance. The 'End Project' finish date, as a consequence, shall be the same as the contractually required completion date.
 - b. The Government is under no obligation to accelerate its own work items if early completion occurs, nor is it responsible to modify incremental funding (if applicable) for the project to meet the Contractor's accelerated work.

K. Failure to achieve progress

1. If the progress falls behind the approved project schedule for reasons other than those that are excusable within the terms of the Contract, the Contracting Officer may require submittal of a written recovery plan for approval. The plan shall detail how progress shall be recovered, including which activities will be accelerated by adding additional crews, longer work hours, extra work days, etc.
 - a. Artificially Improving Progress
 - 1) Artificially improving progress by means such as, but not limited to, revising the schedule logic, modifying or adding constraints, shortening activity durations, or changing calendars in the project schedule is prohibited. Indicate assumptions made and the basis for logic, constraint, duration, and calendar changes used in the creation of the recovery plan. Additional resources, manpower, and daily and weekly work hour changes proposed shall be evident at the work site and documented in the daily report along with the Schedule Narrative Report.
 - b. Failure to Perform
 - 1) Failure to perform work and maintain progress in accordance with the supplemental recovery plan may result in an interim and final unsatisfactory performance rating and/or may result in corrective action directed by the Contracting Officer pursuant to AMS 3.2.2.3-56 "Schedules for Construction Contracts", AMS 3.10.6-6 "Default (Fixed-Price Construction)", and other Contract provisions

L. Basis for payment and cost loading

1. The schedule is the basis for determining contract earnings during each update period and therefore the amount of each progress payment.
 - a. Activity Cost Loading;
 - 1) Activity cost loading shall be reasonable and without front-end loading. Provide additional documentation to demonstrate reasonableness if requested by the Contracting Officer.
 - 2) Cost loading should equal the total contract value
 - b. Withholdings / Payment Rejection
 - 1) Failure to meet the requirements of this Section may result in the disapproval of

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the schedules or updates and subsequent rejection of payment requests until requirements are met.

- c. If the Contracting Officer directs schedule revisions and those revisions have not been included in subsequent Project Schedule revisions or updates, the Contracting Officer may withhold 10 percent of pay request amount for each payment period until such revisions to the project schedule have been made

3.3 PERIODIC SCHEDULE UPDATE

A. Periodic Schedule Updates

1. Update the Project Schedule on a regular basis. An updated schedule is required with each pay application, and more frequently if requested by the Contracting Officer. Provide a draft Periodic Schedule Update for review at the schedule update meetings as prescribed in Paragraph PERIODIC SCHEDULE UPDATE MEETINGS, below. These updates will enable the Government to assess Contractor's progress
 - a. Update information, including Actual Start Dates (AS), Actual Finish Dates (AF), Remaining Durations (RD), and Percent Complete, is subject to the approval of the Government at the meeting
 - b. AS and AF data shall match the dates reported on the Contractor's Daily Construction Reports for an activity start or finish

B. Periodic Schedule Update Meetings

1. Conduct periodic schedule update meetings, to review the proposed Periodic Schedule Update, Narrative Report, Schedule Reports, and progress payment. Conduct meetings at least monthly. The Contractor's authorized scheduler shall organize, group, sort, filter, perform schedule revisions as needed and review functions as requested by the Contractor and/or Government. Provide a draft of the proposed narrative report and schedule PDF to the Government at least 2 workdays in advance of the meeting. The Contractor's Project Manager and scheduler shall attend the meeting with the authorized representative of the Contracting Officer. Superintendents, foremen, and major subcontractors shall attend the meeting as required to discuss the project schedule and work. Following the periodic schedule update meeting, make corrections to the draft submission. Include only those changes approved by the Government in the submission and invoice for payment.
2. Update Submission Following Progress Meeting
 - a. Submit the complete Periodic Schedule Update, containing the approved progress, revisions, and adjustments, not later than 4 work days after the periodic schedule update meeting.
 - b. Submit final periodic update schedule in the original software format and pdf snapshot
 - c. Submission of Contractor Periodic Schedule Update shall be required for periodic progress payments

3.4 WEEKLY PROGRESS MEETINGS

- A. Conduct a weekly meeting with the Government, separate from the Periodic Schedule Update Meetings, for the purpose of jointly reviewing the actual progress of the project as compared to the planned progress and to review planned activities for the upcoming 3 weeks. Provide a 3-week look ahead schedule prior to the weekly meeting. Submit the 3-week look ahead a minimum of 2 days before the weekly meeting. At the weekly progress meeting, address the status of RFIs, RFPs, and

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Submittals.

- B. Contractor must take the meeting minutes of these meetings and distribute the minutes to attendees for comments. Submit minutes not later than 2 work days after the weekly meeting

3.5 TIME EXTENSIONS

- A. Provide a justification of delay to the Contracting Officer, in accordance with the Contract provisions and clauses, for approval within 10 days of a delay occurring. Also prepare a time impact analysis for each Government request for proposal (RFP) to justify time extensions.

1. Justification of Delay

- a. Provide a description of the event(s) that caused the delay and/or impact to the work. As part of the description, identify the schedule activities impacted. Show that the event that caused the delay/impact was the responsibility of the Government. Provide a time impact analysis that demonstrates the effects of the delay or impact on the project completion date or interim completion dates. Multiple impacts shall be evaluated chronologically; each with its own justification of delay. With multiple impacts, consider concurrency of delay. A time extension and the schedule fragnet becomes part of the project schedule and future schedule updates upon approval by the Contracting Officer.

2. Time Impact Analysis (Prospective Analysis)

- a. Prepare a time impact analysis for Government approval based on industry standard AACE 52R-06. Use a copy of the last approved schedule prior to the first day of the impact or delay for the time impact analysis. If the Government determines the time frame between the last approved schedule and the first day of impact is too great, prepare an interim updated schedule to perform the time impact analysis. Unless approved by the Contracting Officer, no other changes will be incorporated into the schedule being used to justify the time impact.

3. Fragmentary Network (Fragnet)

- a. Prepare a proposed fragnet for time impact analysis. The proposed fragnet shall sequence new activities into the project schedule to demonstrate the influence of the delay or impact to the project's contractual dates. Clearly show how the proposed fragnet shall be tied into the project schedule, including the predecessors and successors to the fragnet activities. Obtain Government approval of the proposed fragnet before incorporating it into the project schedule.

4. Time Extension

- a. Time extensions will not be granted until after the Government has approved the Justification of Delay, including the time impact analysis. No time extension will be granted unless the delay consumes the available Project Float and extends the projected finish date ("End Project" milestone) beyond the Contract Completion Date. The time extension will be in calendar days.
- b. Actual delays that the Government determines are caused by the Contractor's own actions and result in a calculated schedule delay will not be a cause for an extension to the performance period, completion date, or interim milestone date.

5. Impact to Early Completion Schedule

- a. No extended overhead will be paid for delay prior to the original Contract Completion

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Date for an Early Completion Baseline Schedule.

END OF SECTION 01 32 01

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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 SUBMITTALS

- A. Contractor must provide submittal schedule before NTP

1.4 SUBMITTAL PROCEDURES

- A. 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.
- B. Submittals Schedule: Comply with requirements in Section 01 32 10 "Construction Progress Documentation" for list of submittals and time requirements for scheduled performance of related construction activities.
- C. Processing Time: Submittals for work in the critical path shall 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 calendar 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.

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2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
 3. Resubmittal Review: Allow 14 calendar 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 calendar days for initial review of each submittal.
- D. 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.
- E. Deviations: Encircle or otherwise specifically identify deviations from the Contract Documents on submittals. Indication must be reproducible when copied on black and white copier.
- F. 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.
- G. 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: See Section 01 10 12 – Construction Administration Forms
 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.

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- H. 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.
- I. 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.
- J. Use for Construction: Use only final submittals with mark indicating that no exceptions are taken by COR.

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 to the CO, COR, and Project Engineer
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment. Comply with Section 01 40 10 for incorporating approved product data as Facility Data.
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.

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- 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
- 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.

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- 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. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation".
- F. Application for Payment: Comply with requirements.
- G. Schedule of Values: Comply with requirements.
- H. Submittals required prior to Notice-to-Proceed: The following submittals must be approved by the COR prior to the contractor being allowed to proceed with the initial construction phases. No work can be done until the following submittals have been approved.
 - 1. COR Trailer
 - 2. Submittal Schedule
 - 3. Staging Plan
- I. 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. 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 one copy of subcontractor list, unless otherwise indicated. COR will return marked up 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 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.

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- B. Coordination Drawings: Comply with requirements specified in Section 01 31 00, "PROJECT MANAGEMENT AND COORDINATION."
- C. Contractor's Construction Schedule: Comply with requirements specified in Section 01 32 00 "Construction Progress Documentation."
- 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. 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.
- F. 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.
- G. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
- H. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
- I. Schedule of Tests and Inspections: Comply with requirements.
- J. 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.
- K. 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."
- L. 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.
- M. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

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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.
- N. 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 review each submittal and return the review to appropriately indicate the action taken, as follows:
1. Approved as Submitted
 2. Approved as Noted

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3. Not Approved
4. Revise and Resubmit
5. For Information Only

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 information 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.

3.3 SCHEDULES

- A. All submittals, including samples, certificates and shop drawings shall be submitted in ample time for the Government to make a determination of compliance with specification before fabrication or before materials are delivered to the site. All submittals requiring prior Government approval shall be submitted in advance of first need an amount of time adequate to allow for FAA's review (30 calendar days maximum) from date of receipt with possible contractor's re-submittal (15 calendar days maximum) from date of receipt and FAA's subsequent re-submittal review (15 calendar days maximum) from date of receipt. An additional (15 calendar days maximum) shall be allowed and shown on the register for review and approval of submittals for HVAC control systems.
- B.
- C. After a submission has been approved, no substitutions will be permitted without prior written approval by the Contracting Officer.
- D.
- E. Contractor shall submit a copy of submittal schedule along with an estimated date when each submittal will be given to FAA. Identify any submittals for equipment having a long lead time on whose submittals is critical to the delivery of equipment to site. All submittals shall be furnished no later than sixty (60) days after NTP. THE CONTRACTOR IS RESPONSIBLE FOR TIMELY SUBMITTALS!

END OF SECTION 01 33 00

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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. Daily Logs

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

- A. 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

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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

B. Content of the CQC Plan

1. Plan shall be submitted no later than 15 days after Notice to Proceed (NTP). Reviewing procedures will be in accordance with Section 01 33 00, "Submittal Procedures"
2. 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:
 - a. A description of the quality control organization, including a chart showing lines of authority.
 - b. The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a CQC function.
 - c. 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".
 - d. 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.)
 - e. Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures must establish verification that identified deficiencies have been corrected.
 - f. Reporting procedures, including proposed reporting formats.
 - g. 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.
3. 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.
4. 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.

3.2 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

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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.

3.2 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 Contractor 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 contractor, 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 contractor. The Contractor must instruct applicable workers as to the acceptable level of workmanship required in order to meet contract specifications.

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- 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 Contractor. 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.

3.3 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

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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.

3.4 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.
4. Test and/or control activities performed with results and references to specifications/drawings requirements. The control phase must be identified (Preparatory, Initial, and 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.

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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 Contractor. The report from the Contractor must include copies of test reports and copies of reports prepared by all subordinate quality control personnel.

3.5 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

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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 weather tight; exterior walls are insulated and weather tight; 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.

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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. 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.
- D. 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.
- E. 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.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Install temporary service or connect to existing service.

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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. Water Service: Provide potable water to temporary facilities that require water for toilets, lavatories, or drinking fountains
- C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel and FAA. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- D. 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.
- E. 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.

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. 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.
- C. 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.
- D. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. All containers shall have a cover to prevent debris from being blown around. Comply with requirements of authorities having jurisdiction.
- E. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

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1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.4 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. 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 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.
 2. 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.
 3. Maintain temporary toilet facilities: Clean facilities and surrounding areas daily. Provide toilet paper, paper towels and soap in suitable dispensers.
- C. 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. Remove temporary toilet facilities when permanent facilities are available for use, but no later than Substantial Completion.
 3. 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

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SECTION 01 50 10 – FAA FIELD OFFICE

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Installation of the FAA Field Representatives' Office
- B. Removal.

1.2 PERMITS

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

1.3 LOCATION

- A. The location of the Field Representatives' Office must be approved by the Contracting Officer's Representative (COR).

1.4 SUBMITTALS

- A. Provide product data and equipment specifications in accordance with Section 01 33 00.

1.5 TIME OF USE

- A. The Field Representatives' 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 and approved by the COR.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.1 FAA's FIELD REPRESENTATIVES' OFFICE

- A. Separate space for sole use of FAA's Field Representatives with separate entrance door with new lock and three (3) keys.
- B. Area: Provide floor plan with two offices, a conference room, and restroom.
- C. Doors: A minimum of two doors, each at least 2 feet, 8 inches wide, shall be provided. Access steps with a minimum 6'x6' entrance platform and safety hand rail shall be provided for each

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door. The movable step usually furnished with most office trailers is not acceptable.

- D. Floor: Floor covering shall be vinyl tile.
- E. 120 volt duplex convenience outlets, with a minimum of one per wall in each room.
- F. Switch controlled fluorescent light fixtures
- G. Indoor Sanitary Facilities: toilet; wash basin; mirror; toilet paper, cup, soap and towel dispensers; electric water heater; and waste receptacle. Restroom shall be properly ventilated. Contractor shall provide 2 ply bath tissue and paper towels throughout the duration of the construction period for FAA Field Representative Office. Contractor shall provide bath tissue and paper towels in quantity required to satisfy the needs of the facility. Contractor shall provide bath tissue and paper towels at the request of the COR.
- H. 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.
- I. Water Tank: Contractor shall provide water tank to provide potable water to the office
- J. Sanitary Tank: Contractor shall provide a sanitary waste tank for the office.
- K. Furnishings (confirm furnishings with RE):
 - 1. Table to accommodate D size drawings
 - 2. Provide one waste basket per room.
 - 3. 2½ pound A:B:C: dry-chemical fire extinguisher, minimum 2 each

3.2 MAINTENANCE AND CLEANING

- A. Maintain approach walks free of mud and water.
- B. The Contractor assumes full responsibility for all costs associated with equipment and services provided for the Field Representative's office, Temporary Breakroom, and Temporary restroom (including costs for equipment and/or services which are provided by the Contractor, but which are not specifically required by this Article).
- C. The sanitary waste tank shall be emptied at regularly scheduled intervals, not to exceed 1 week. At the CORs discretion, the tank shall be emptied sooner based on usage
- D. The water tank shall be refilled at regularly scheduled intervals, not to exceed 1 weeks. At the CORs discretion, the tank shall be filled sooner based on the amount of water usage.

3.3 REMOVAL

- A. At final completion of work or earlier if agreed by FAA, remove buildings, foundations, utility services and debris. Restore area back to pre-construction conditions.

END OF SECTION 01 50 10

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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.
- C. Storm Protection Plan.

1.2 SUBMITTALS

- A. Contractor shall submit a Storm Protection Plan to the COR for approval within 15 calendar days after notice to proceed.
- B. Storm Protection Plan shall include, as a minimum, the following:
 - 1. Storm Plan objectives.
 - 2. Methods to attain protection objectives.
 - 3. Responsibility of key personnel for the Contractor.
 - 4. Time frame required to secure the site.
 - 5. Time frame required to lower and/or secure crane(s).
 - 6. Disaster and emergency programs.
 - 7. Lists of key personnel to be contacted in time of emergency.

PART 2 - PRODUCT

NOT USED

PART 3 – EXECUTION

3.1 SUBMITTALS

- A. 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
- B. 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

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3.2 STORM PROTECTION PLAN

- A. The Contractor shall take all precautions as necessary to prevent damage to the facility and shall be responsible for damage to the facility resulting from any act, omission, neglect, or misconduct in the execution of the approved Storm Protection Plan
- B. In the event of a severe storm warning or as directed by the COR, the Contractor shall:
 - a. Secure outside equipment and materials and place materials subject to possible damage in protected locations
 - b. Check surrounding area, including roof, for loose material, equipment, debris, and other objects that could be blown away or against existing facilities.
 - c. Secure cranes.
 - d. Ensure that temporary erosion controls are adequate.
 - e. After the storm, the Contractor may be directed by the COR to assist in the restoration of the existing facility. Any restoration shall take precedence over the construction contract. Any additional costs will be claimed under the “changes” clause of the contract.

END OF SECTION 01 71 33

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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. All combustible waste materials shall be removed from buildings at the end of each working day.
- E. Broom clean interior areas on a daily basis.
- F. Control cleaning operations so that dust and other particulates will not adhere to wet or newly-coated surfaces.
- G. 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 as needed or at the direction of the COR. Legally dispose of off-site in an authorized disposal area. All waste containers shall have a cover to prevent debris from being blown around.

3.3 CONTRACTOR'S FAILURE TO CLEAN

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- 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

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SECTION 01 74 19 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for the following:
 - 1. Recycling nonhazardous construction waste.
 - 2. Disposing of nonhazardous demolition and construction waste.

1.3 DEFINITIONS

- A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Site improvement materials resulting from clearing operations.
- C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Owner's property.
- D. Recycle: Recovery of construction waste for subsequent processing in preparation for reuse.
- E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
- F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition and construction waste becomes property of Contractor.

1.5 ACTION SUBMITTALS

- A. Waste Management Plan: Submit plan within 7 days of date established for the Notice to Proceed.

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1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with transportation and disposal regulations of authorities having jurisdiction.
- B. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
 - 1. Review and discuss waste management plan including responsibilities of each contractor.
 - 2. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
 - 3. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

- A. General: Develop a waste management plan according to requirements in this Section or adhere to the Construction Waste Management Plan. Plan shall consist of waste identification. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
- B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Use Form CWM-1 for construction waste or the Contractor's form designation for a combined waste. Include estimated quantities and assumptions for estimates.

PART 2 – PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

- A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
 - 1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."
- B. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.
 - 1. Distribute waste management plan to everyone concerned within three days of submittal return.
 - 2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
- C. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and

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used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged and recycled.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
 - a. Comply with requirements in Section 329300 "Plants" for use of clean sawdust as organic mulch.

3.3 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged or recycled, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Owner's property.

C. Burning: Do not burn waste materials.

END OF SECTION 017419

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SECTION 01 77 00 - CLOSEOUT PROCEDURES

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. Prepare and submit Coordination Drawings, Project Record Documents, Facility Data COB (ie spreadsheets, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information).
 4. Deliver tools, spare parts, extra materials, and similar items to location designated by FAA. Label with manufacturer's name and model number where applicable.
 5. Complete startup testing of systems.
 6. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 7. Submit changeover information related to FAA's occupancy, use, operation, and maintenance.
 8. 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.

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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 (punch list) of items to be completed or corrected, 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. Perform a final cleaning in accordance with Section 01 74 23 "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. Update Facility Data COB (ie spreadsheets with warranty information as specified in Section 01 40 10.)
- 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, 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

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- 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. Clean cabinet work removing stains, paint, dirt and dust.
 10. Remove spots, plaster, soil and paint from ceramic tile, marble, and other finished materials, and wash or wipe clean.
 11. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 12. Clean flooring materials thoroughly, including stripping, buffing and waxing. Comply with materials manufacturer's instructions and recommendations.
 13. Remove labels that are not permanent labels.
 14. 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.
 15. Clean food-service equipment to a sanitary condition, ready and acceptable for its intended use.
 16. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 17. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 18. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs and defective and noisy starters.
- C. Removal of Protection: Remove temporary protection and facilities installed during construction to protect previously completed installations during the remainder of the construction period.
- D. 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.

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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. 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.
- B. Final Submittal: Submit two bound copies of each manual and two electronic copies (PDFs) 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 two (2) bound copies and two (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 includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

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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.

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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 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.

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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.

2.4 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.

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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.
- F. 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.

2.5 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.

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- 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.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to operation, and maintenance manuals.
- B. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- C. 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.
- D. 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.
- E. 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.
- F. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

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END OF SECTION 01 78 23

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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.

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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.

1.6 QUANTITY

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

1.7 EXTENDED WARRANTY

- A. Provide as a part of this contract a full five (5) year parts and labor warranty for all new air handlers, fan coil units, pumps, and all components supplied and installed under this agreement. Such warranty period begins at system acceptance. During the warranty support period all manufacturer's regular system hardware, software and firmware upgrades shall be provided as part of this extended warranty.
- B. During warranty period, all calls for warranty shall be returned within thirty (30) minutes.
- C. During warranty period, events designated as emergency by the facility FAA personnel a service technician shall be on site within one (1) hour of initial call.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION 01 78 36

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SECTION 033053 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Sections:

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Action Submittal:
 - 1. Design Mixtures: For each concrete mixture.

1.4 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. Comply with the following sections of ACI 301, unless modified by requirements in the Contract Documents:
 - 1. "General Requirements."
 - 2. "Formwork and Formwork Accessories."
 - 3. "Reinforcement and Reinforcement Supports."
 - 4. "Concrete Mixtures."
 - 5. "Handling, Placing, and Constructing."
 - 6. "Lightweight Concrete."
- C. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

PART 2 - PRODUCTS

2.1 FORMWORK

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- A. Furnish formwork and formwork accessories according to ACI 301.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I.
- B. Normal-Weight Aggregate: ASTM C 33, graded, 1-1/2-inch nominal maximum aggregate size.
- C. Water: ASTM C 94/C 94M.

2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

2.5 RELATED MATERIALS

- A. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick; or plastic sheet, ASTM E 1745, Class C.
- B. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.
- B. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.7 CONCRETE MIXTURES

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- A. Comply with ACI 301 requirements for concrete mixtures.
- B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301 , as follows:
 - 1. Minimum Compressive Strength: 3000 psi at 28 days.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: 4 inches to 6 inches, plus or minus 1 inch.
 - 4. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and furnish batch ticket information.
 - 1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, construct, erect, brace, and maintain formwork.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR RETARDERS

- A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.
 - 1. Lap joints 6 inches and seal with manufacturer's recommended adhesive or joint tape.

3.4 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

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- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Locate and install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
- D. Isolation Joints: Install joint-filler strips at junctions with slabs-on-grade and vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint fillers full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.

3.6 CONCRETE PLACEMENT

- A. Comply with ACI 301 for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 30.
- C. Do not add water to concrete during delivery, at Project site, or during placement.
- D. Consolidate concrete with mechanical vibrating equipment.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding 1/2 inch .
 - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch .
 - 1. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.8 FINISHING UNFORMED SURFACES

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- A. General: Comply with ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.
 - 1. Do not further disturb surfaces before starting finishing operations.
- C. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- F. Nonslip Broom Finish: Apply a nonslip broom finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.9 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests: Perform according to ACI 301.
 - 1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 - 2. Testing Frequency: One composite sample shall be obtained for each 100 cu. yd. or fraction thereof of each concrete mix placed each day.

3.11 REPAIRS

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- A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION 033053

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SECTION 05 52 13
PIPE AND TUBE RAILING SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Under sheet metal (USM) guardrail - powder coated steel. (IBC 20 LB/FT)

1.2 RELATED SECTIONS

- A. Section 05 50 00 - Metal Fabrications.
- B. Section 07 50 00 - Membrane Roofing.
- C. Section 07 70 00 - Roof and Wall Specialties and Accessories.

1.3 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A36 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 3. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- B. Occupational Safety and Health Administration (OSHA):
 - 1. 29 CFR 1926.500 - Scope, Application and Definitions Applicable to this Subpart.
 - 2. 29 CFR 1926.501 - Duty to Have Fall Protection.
 - 3. 29 CFR 1926.502 - Fall Protection Systems Criteria and Practices.
 - 4. 29 CFR 1926.503 - Training Requirements.
- C. Federal Aviation Administration (FAA):
 - 1. JO 3900.63A – Air Traffic Organization Fall Protection Program

1.4 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets for products and assemblies specified.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Cleaning methods.
- C. Shop Drawings:
 - 1. Indicate profiles, sizes, connections, size and type of fasteners, accessories.
 - 2. Show location of rails and guardrails including plans, details of components and anchor details.
 - 3. Field Verified Measurements: Verify dimensions indicated on Drawings.
- D. Verification Samples: For each finish specified, two samples representing actual colors specified.

1.5 DELIVERY, STORAGE, AND HANDLING

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- A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and recommendations and industry standards.
- B. Store materials in manufacturer's original sealed, labeled packaging until ready for installation and in accordance with manufacturer's instructions. Protect finishes on rails and uprights from damage.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.
- B. Field Measurements: Where horizontal rails and uprights are indicated to fit to other construction, check actual dimensions or other construction by accurate field measurements prior to ordering and installation; show recorded measurements on final Shop Drawings.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate fabrication and delivery schedule of handrails with construction progress and sequence to avoid delay of railing installation.
 - 1. Where field measurements cannot be made without delaying the system fabrication and delivery, obtain guaranteed dimensions in writing by the Contractor and proceed with fabrication of products to not delay fabrication, delivery and installation.

1.8 WARRANTY

- A. Warranty: Provide manufacturer's standard one year warranty against defects in materials and manufacturing.

PART 2 PRODUCTS

2.1 Requirements. Major requirements are summarized below. The systems are listed in the order of preference for use. (FAA JO 3900.63A Appendix J)

- A. Guardrail Systems. These systems must meet the following criteria:
 - 1. Systems must be 42 inches, in height, with a maximum opening of 19 inches between any midrails associated with the railing system.
 - 2. Toeboards must be solid and a minimum of three and one half (3.5) inches high and not have more than 1/4" clearance above the walking-working surface with no openings greater than 1 inch in any dimension.
 - 3. The system must have a capability of withstanding 200 pounds of outward/downward force at the top rail, 150 pounds of outward/downward force at the midrail and 50 pounds of outward force at the toeboard.
 - 4. If a guardrail system is used, the ladderway or stairway opening must also be guarded or so offset that a person cannot walk directly into the opening.
 - 5. Openings at the work platform floor used for access from an internal ladder must be equipped with a hatch that can be fully closed after entry into the work platform, and the closed hatch must be capable of supporting 250 pounds or the maximum intended load, whichever is greater.
 - 6. When hatches are associated with elevated platforms or rooftops, they must be secured against accidental displacement.

2.2 MANUFACTURERS

- A. Acceptable Manufacturer: Leading Edge Safety, LLC, which is located at: 1345 Taney St.; North Kansas City, MO 64116; Toll Free Tel: 888-990-2990; Fax: 816-472-0822;

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Email: [request info \(sales@leadingedgesafety.net\)](mailto:request info (sales@leadingedgesafety.net);); Web: <https://leadingedgesafety.net>

- B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.3 UNDER SHEET METAL (USM) GUARDRAIL - POWDER COATED STEEL - IBC 20 LB/FT

- A. Product: USM Guardrail-Powder Coated Steel as manufactured by Leading Edge Safety.
1. System Design: USM Guardrail provides permanent full-perimeter fall protection, installing under standard roofing and sheet metal details including coping caps, drip edges, gravel stops and inside most commercial gutters. Powder coated steel colors available to match Kynar sheet metal or other building components in RAL colors. USM Guardrail meets and exceeds OSHA Standards and IBC requirements.
- B. Components:
1. Uprights: 1.66 inches x .140 inch schedule 40 pipe (ASTM A53) welded to 2 inches x 3 inches x 3.5 inches steel block (ASTM A36) and 3/16 inch steel plate (ASTM A36) bracket with pre-punched holes and slots for permanent structural attachment.
 2. Horizontal Rails: 1.625 inches x .065 inch and 1.375 inches x .065 inch (ASTM C1008/1010) steel tube adjustable slide rails.
 3. Finish: Powder coated steel.
 4. Colors: Numerous colors to match Kynar sheet metal, building components and RAL colors.
 5. **Hardware: 18-8 stainless steel.** (Consult LES for approved structural attachment fasteners).
 6. Labels: Applicable safety warnings and manufacturer's contact information.
 7. Sizes: Uprights custom designed per project to OSHA Standards and IBC requirements.
 8. Horizontal Rails: 8 feet-0 inch o.c.; 120 inches to 70 inches, 70 inches to 43 inches, 42 inches to 29 inches adjustable.
 9. Corners: 20.5 inches o.c. Outside Corner; 12.5 inches o.c. Inside Corner.
 10. Toe Boards and Brackets: 16 gauge steel (ASTM A1008 CS Type B)
 11. Fasteners for Structural Attachment: As recommended by Leading Edge Safety.
 - a. For Wood Attachment: RSS Structural Screws by GRK Fasteners
 - 1) T-Star Washer Head Powerlag by SPAX.
 - b. For Concrete Attachment: Caliburn PH Concrete Pan Head Screws by GRK Fasteners.
 - c. Others Fasteners as approved by Leading Edge Safety
 12. Weight: Uprights: 12 lbs +/-.
 13. Horizontal Rails: 1 lbs / lineal foot +/-.
 14. Corners: 2 lbs +/-.

2.4 WALL MOUNT GUARDRAIL

- A. Product: Wall Mount Guardrail-Powder Coated Steel as manufactured by Leading Edge Safety.
1. System Design: Wall Mount Guardrail provides permanent full-perimeter fall protection, allowing direct mounting to interior parapet walls using a dual plate mounting system that assures water-tight installation. Backup plates, target patches, and upright plates creates a compression attachment to prevent water infiltration around mounting studs. Powder coated steel colors available to match Kynar sheet metal or other building components in RAL colors. Wall Mount Guardrail meets and exceeds OSHA Standards and IBC requirements.
- B. Components:
1. Uprights: 1.25 inches schedule 40 steel pipe (ASTM A53) - 1.66 inches O.D. x .140

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- inch wall
2. Mounting Bracket: 3/16 inch steel plate (ASTM A36) bracket with pre-punched holes for mounting stud attachment.
3. Horizontal Rails: 1.625 inches x .065 inch and 1.375 inches x .065 inch (ASTM C1008/1010) steel tube adjustable slide rails.
4. Finish: Powder coated steel.
5. Colors: Numerous colors to match Kynar sheet metal, building components and RAL colors.
6. **Hardware: 18-8 stainless steel.** (Consult LES for approved structural attachment fasteners).
7. Labels: Applicable safety warnings and manufacturer's contact information.
8. Sizes: Uprights: Custom designed per project to OSHA Standards and IBC requirements.
9. Horizontal Rails: 8 feet-0 inches o.c.; 120 inches to 70 inches, 70 inches to 43 inches, 43 inches to 29 inches Adjustable.
10. Corners: 20.5 inches o.c. Outside Corner; 12.5 inches o.c. Inside Corner.
11. Weight: Uprights: 12 lbs +/-.
12. Horizontal Rails: 1 lbs/lf +/-.
13. Corners: 2 lbs +/-.
14. Standards: Meets and exceeds OSHA Standards and IBC requirements.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Inspect and prepare substrates and nailers using the methods recommended by the manufacturer for achieving best result for the substrates under project conditions. Verify that nailers and other structural components of the building are securely fastened and capable of withstanding loads applied by the guardrail system.
- B. Do not proceed with installation until substrates and nailers have been prepared using the methods recommended by the manufacturer and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.
- C. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions including the following.
- B. USM Guardrail shall be installed on roof edge perimeters without penetrating the roof membrane and mounted under the outside perimeter sheet metal as detailed.
- C. Wall Mount Guardrail shall provide water-tight installation through wall flashings on parapet walls with the use of backup plates, target patches and wall mount brackets. Target patches shall be field fabricated to fit around backup plate mounting studs and provide roof manufacturers recommended seam width around perimeter of target patch. Mounting studs shall be sealed behind target patch with non-curing butyl or manufacturers recommended sealant.

3.3 PROTECTION

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- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

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SECTION 06 10 00 - CARPENTRY WORK (For Roofing)

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Roof curbs and cants; concealed wood blocking, with hardware and attachment accessories.
- B. Preservative Treated Wood (PTW).
- C. Refer to schedule at end of Section.

1.02 REFERENCES

- A. American Lumber Standards Committee (ALSC): National Design Specification for Wood Construction.
- B. American Wood Preservers Association (AWPA): AWPA Book of Standards.
- C. Product Standard of NBS (PS):
 - 1. PS 1 - Construction and Industrial Plywood
 - 2. PS 20 - American Softwood Lumber Standard

1.03 QUALITY ASSURANCE

- A. Rough Carpentry Lumber: Visible grade stamp of agency certified by National Forest Products Association (NFPA).
- B. Preservative Treatment: Confirm to applicable requirements of AWPA.

1.04 SUBMITTALS

- A. Product List: Submit list of proposed Products and manufactures, including all items specified in Part 2 -- Products or otherwise required by the Work.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, finish, accessories, and locations to a minimum scale of 1- ½ inch to one foot.
- C. Manufacturer's Certifications: Submit certification that preservative wood treatment is in accordance with applicable requirements and that preservative formulation/treater warrants PTW material for intended use.

PART 2 - PRODUCTS

2.01 ROUGH CARPENTRY MATERIALS

- A. Timber, General: Hand select material at factory from lumber of species and grade indicated below for compliance with "Appearance" grade requirements of ALSC National Grading Rule; provide certificate of inspection from an accredited Agency for selected material.
 - 1. Provide seasoned lumber with 19 percent moisture content at time of dressing and shipment, for sizes 2-inches or less in thickness.
 - 2. Provide lumber with 15 percent moisture content at time of dressing and shipment for, sizes 2-inches or more in thickness.
- B. Dimensioned Lumber: Graded in accordance with established grading rules; grade and species as follows:

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1. Concealed Boards: WWP standard grade, any species, or SPIB No. 3 grade Southern Pine.
2. Lumber for Miscellaneous Uses: Standard grade unless otherwise indicated.
3. Plywood: PS 1; select sheathing grade or APA rated 5/8-inch minimum thickness, CD-X, or better in sheathing.

- C. Nails, Spikes, and Staples: Galvanized; size and type to suit application.
- D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Medium carbon steel, hot dipped galvanized; sized to suit application.
- E. Anchors: Toggle bot type for anchorage to hollow masonry. Expansion shield and lag bolt type for anchorage to solid masonry or concrete. Bolts or power activated type for anchorage to steel.

2.02 PRESERVATIVE TREATED WOOD (PTW)

- A. Shop Preservative (Pressure Treatment Type): AWWPA C2 and C9.
- B. Wood for Above-Ground Contact Use: AWPB LP-2.
- C. Shop pressure treat and provide identification on preservative treated materials, including all wood blocking, cants, and plywood.
- D. Dry all PTW after treatment to the following maximum moisture content:
 1. Plywood: 15 percent.
 2. Lumber: 19 percent.

2.03 SOURCE QUALITY CONTROL

- A. Factory marked each piece of lumber with type, grade, mill, and grading agency.
- B. Nominal sizes are indicated. Provide actual sizes as required by PS 20.
- C. Provide dressed lumber, sized four sides.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

- A. Verify that surfaces are ready to receive work and field measurements are as shown on shop drawings.
- B. Verify mechanical, electrical, and building items affecting work of this Section are placed and ready to receive this Work.
- C. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.02 INSTALLATION

- A. Discard units or material with defects that might impair quality of work and units that are too small to use in fabricating work with minimum joints.
- B. Set carpentry work accurately to required levels and lines, with members plumb and true and accurately cut and fitted.
- C. Securely attach carpentry work to substrate to anchoring and fastening as shown and as required by recognized standards. Use common wire nails, except as otherwise indicated. Select fasteners of size that

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will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners with splitting wood; pre-drill as required.

- D. Install components with fasteners suited to materials.
 - 1. Nailable Surfaces: Galvanized compatible nails, sized as follows:
 - a. $\frac{3}{4}$ and 1-inch materials: 8d nails.
 - b. 1-1/2 or 2-inch materials: 16d nails.
 - 2. Hollow Masonry Walls: Toggle Bolts.
 - 3. Solid Masonry: Rawl Zamac pin drive.
 - 4. Steel Members: Bolts or Power actuated Hilti pins.
 - 5. Maximum Spacing: 12-inches on center, unless noted otherwise.
 - 6. Top of Hollow Masonry Wall: Set 12-inch minimum J-bolts in fully set bed of concrete; minimum 18-inches on center.
- E. Remove all bent or deformed nails from finished work and dispose of.

3.03 CLEANING

- A. Pick up spilled carpentry products, unused nails, and fasteners daily.

3.04 PROTECTION

- A. Protective Walkways - Traffic Area Protection: Install full sheets of $\frac{3}{4}$ -inch exterior grade plywood and minimum $\frac{1}{2}$ -inch wood fiber insulation to those areas of new roof surface to be trafficked by personal and wheeled vehicles.

3.05 SITE TREATMENT OF CARPENTRY

- A. Treat site-saw cut ends. Allow preservative to cure prior to erecting materials.

3.06 SCHEDULE

- A. Rough Carpentry Work:
 - 1. Miscellaneous blocking and canting for single-ply roofing systems and related flashings and sheet metal.
 - 2. Blocking and canting for roof mounted mechanical items.

END OF SECTION

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SECTION 070150 - PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Roof tear-off.
 - 2. Removal of base flashings.
- B. Related Sections:
 - 1. Division 06 Section "Carpentry (for Roofing)" for wood nailers, cants, curbs, and blocking.
 - 2. Division 07 Section "Polyvinyl-Chloride (PVC) Roofing."
 - 3. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counter flashings.

1.3 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain Owner's property, demolished materials shall become Contractor's property and shall be removed from Project site.

1.4 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
- B. Existing Membrane Roofing System: PVC roofing membrane, roof insulation, surfacing, and components and accessories between deck and roofing membrane.
- C. Roof Tear-Off: Removal of existing membrane roofing system from deck.
- D. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and reinstalled.
- E. Existing to Remain: Existing items of construction that are not indicated to be removed.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Fastener pull-out test report.
- C. Landfill Records: Indicate receipt and acceptance of hazardous wastes, such as asbestos containing material, by a landfill facility licensed to accept hazardous wastes.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning membrane roofing removal. Comply with hauling and disposal regulations of authorities having jurisdiction.

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1.7 PROJECT CONDITIONS

- A. Owner will occupy portions of building immediately below reroofing area. Conduct reroofing so Owner's operations will not be disrupted. Provide Owner with not less than 72 hours' notice of activities that may affect Owner's operations.
- B. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.
- C. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.
- D. Contractor is responsible for conclusions derived from existing roofing conditions.
- E. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.
- F. Hazardous Materials: It is not expected that hazardous materials such as asbestos-containing materials will be encountered in the Work.
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

PART 2 – PRODUCTS - NOT USED

PART 3 – EXECUTION

3.1 PREPARATION

- A. Coordinate with Owner to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
- B. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.
- C. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof-drain plugs specifically designed for this purpose. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.
 - 1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing membrane roofing system components that are to remain.

3.2 ROOF TEAR-OFF

- A. General: Notify Owner each day of extent of roof tear-off proposed for that day.
- B. Roof Tear-Off: Remove existing roofing membrane and other membrane roofing system components down to the deck.

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3.3 DECK PREPARATION

- A. Inspect deck after tear-off of membrane roofing system.
- B. Verify that substrate is visibly dry and free of moisture.

3.4 EXISTING BASE FLASHINGS

- A. Remove existing base flashings around parapets, curbs, walls, and penetrations.
 - 1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.
- B. Remove existing parapet roofing flashing materials and replace with new CDX plywood sheathing, 5/8 inch thick. If parapet framing has deteriorated, immediately notify Owner Representative.
 - 1. Plywood parapet sheathing is specified in Division 06 Section "Miscellaneous Rough Carpentry."

3.5 DISPOSAL

- A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site.
 - 1. Storage or sale of demolished items or materials on-site is not permitted.
- B. Transport and legally dispose of demolished materials off Owner's property.

END OF SECTION 070150

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SECTION 071200
ELASTOMERIC WALL COATING

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies a surface applied elastomeric silicone wall coating.

1.2 RELATED WORK

- A. Weatherproofing Silicone Sealant: Section 07920.

1.3 TEST AREA

- A. Before start of general application, apply the elastomeric silicone coating as specified in a representative test area. The area shall be approximately 100 square feet. The area to be covered by the coating shall include all site conditions such as corners and projections through the coating. Location of test area shall be determined by the Resident Engineer, and after approval, shall serve as an example for the remaining work.

1.4 SUBMITTALS

- A. Comply with Submittals in Division 1 – Submittal Procedures.
- B. Manufacturers Literature and Data: Each material, indicating compliance with specification requirements.
- C. Samples: Each finish color on 4 by 8 inch substrate, layered to show each coat and finish.

1.5 GUARANTY

- A. Guarantee surfaces, where elastomeric silicone coating has been applied, against leaks and other failures, over and above normal wear and failure of substrate, subject to the terms of the "Guaranty" Article in Section 01740, GENERAL CONDITIONS; except that the guarantee period is ten (10) years.
- D. Application contractor must be a member of product manufacturer approved contractor list for ten (10) years guaranty:

1.6 DELIVERY AND STORAGE

- A. Deliver materials to the site in original sealed containers, clearly marked with manufacturer's name and brand, and type of material.
- B. Store materials in weathertight and dry storage facility. Protect from damage from handling, weather and construction operations before, during and after installation. Store materials at temperatures and under conditions recommended by the manufacturer.

1.7 ENVIRONMENTAL REQUIREMENTS

Do not proceed with application of materials when ambient temperature is less or greater than that recommended by the coating material manufacturer.

1.8 SAFETY REQUIREMENTS

Keep products away from heat, sparks and flame. Do not permit use of spark-producing equipment during application of flammable products or where explosive fumes are present.

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1.9 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society for Testing And Materials (ASTM):
- C794-01 Adhesion-in-Peel of Elastmeric Joint Sealants
- E96-00 Water Vapor Transmission of Materials

PART 2 - PRODUCTS

- 2.1 Elastomeric silicone wall coating shall be GE SilShield SEC3100 or meeting the following characteristics:

PERFORMANCE REQUIREMENTS OF CURED FILM		
PHYSICAL PROPERTIES	TEST METHOD	BASE COAT
Density, lbs/gallon	WPSTM P-14	10.45
ElongationSolids Content, % by volume	WPSTM C-19	66
Solid Content, % by weight	WPSTM C-19	80
Tack Free Time, hours	WPSTM E-86	2
Skin Over Time, minutes		30
Viscosity, centipoise	WPSTM C-560	9000
Volatile Organic Content, g/L	EPA Meth.24	263
Tensile Strength, psi	ASTM C-412	200
Elongation %	ASTM C-412	400
Peel Strength, lbs/inch	WPSTM C-628	27
Hardness, shore A	ASTM D-2240	32

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Surfaces to be coated shall be clean and dry, free of loose materials, dirt, dust, rust, oil, frost, and other contaminants. Smooth rough spots and tool marks.
- B. Fill holes, depressions and cracks with fillers compatible with the coating material and recommended by the coating manufacturer.
- C. Subsurface imperfections that telegraph through the finish coating surface will not be accepted.
- D. Vacuum to remove all loose particles and dust. Solvents shall not be used on concrete. Concrete must be free of release agents, or other adhesion inhibiting contaminants.
- E. All cracks greater than hairline width, approximately 1/ 16 inch, must be ground out and patched with an appropriate masonry patching compound. Structural cracks of any thickness must be repaired and stabilized to prevent movement.

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- F. Mockups shall be performed on surfaces on the job site which are representative of all the surfaces to be coated to validate the efficacy of the cleaning and application procedures. The product manufacture representative should be on hand to witness the adhesion testing. All surface preparation and application procedures intended for use on the project should be tested in the mockup under observation of the product manufacture representative.

3.2 WORK COORDINATION

To provide a watertight installation, coordinate this work with flashing and drains required to be installed before the coating work begins and be completed after the coating is in place.

3.3 APPLICATION

- A. Prime all surfaces to receive elastomeric silicone materials as recommended by the product manufacturer.
- B. Where horizontal surfaces intersect vertical surfaces provide a sealant type fillet as recommended by the manufacturers.
- C. Application of elastomeric silicones coating can be achieved with rollers, brushes or power sprayers. Dilution of the coating is not allowed. The coating should be stirred prior to use and occasionally during application. Rollers should be solvent resistant and have a heavy nap (approximately ½ inch) in order to achieve the recommended coverage.
- D. The coating shall be applied in two separate to total a finished dried coating of 0.010 inches thickness \pm 0.002 inches. A single wet application of 0.075 inches thickness is achieved on a smooth surface with an application rate of 200 ft.²/gallon. Wet coating thickness may be estimated by using a wet film thickness gauge. Dried thickness will average 0.005 inches.
- E. Re-coating is recommended when the first coat is tack free to the touch. A tack free condition will usually take at least 1 hour at 70-80 deg. F. cooler temperatures may require more time. Application at temperatures below 45 degree F should be done with caution due to the possibility of dew or frost on the surface and long drying time.
- F. Start and stop the coating application only at distinct delineations of the façade (i.e, building joints, sills, parapets, corners, etc....).
- G. Rolling patterns can have an effect on final appearance. Use a consistent stroke and pattern between workers for the duration of the project. Keep the roller fully loaded at all times and always maintain a wet edge throughout one area of application.
- H. The direction of the final pass with a roller should be consistent. A back roll is recommended.
- I. Different roller types/knap will likely produce differing results Rollers with ½ knap are recommended for vertical walls. Do not use lesser-quality rollers and rolling equipment that will contribute a factor in an uneven finish appearance.
- J. Successive thin coats may produce a more uniform final appearance than fewer thicker coats.
- K. Full curing will usually take 7-10 days and can be verified by absence of solvent odor.
- L. Adhesion can be verified following full cure by cutting a small X in the coating down to the substrate. Starting at the crossover point of the X lift an edge of the coating with a sharp blade

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until it can be held with finger tips. It should not be possible to peel the coating from the surface. Good adhesion will be evidenced by breaking of the coating film.

- M. Coating thickness may be verified by measuring the thickness of the cured coating piece with a micrometer.

3.4 CLEANING

Remove smears of elastomeric silicone material from other work.

3.5 PROTECTION

- A. All surfaces not intended for coating shall be protected by drop cloths or masking.
- B. Misapplied uncured or partially cured coating on non-porous surfaces shall be removed by wiping with dry cloths or cloths wet with mineral spirits followed by dry cloths. Cured coating may be removed from nonporous surfaces such as glass or metal by razor scraping. Removal from porous surfaces such as stone, concrete or wood should be attempted as described above for nonporous surfaces. It may be necessary to abrade, sandblast or sand the cleaned porous surface to remove all traces of stain. Plants and animal life should be removed from exposure or provided with positive protection from overspray or misapplication of coating.
- C. Removal of misapplied coatings is the responsibility of the applicator.
- D. After the coating is applied, the contractor shall remove all masking and other protection and clean up any remaining defacement caused by this work.

3.6 Handling and Safety-This product is solvent based product that requires proper safety precautions.

3.7 Samples -The contractor shall submit to RE for approval, samples of the coating which are to be used and upon request, shall submit certification that the coating used on the job is of the same quality and meet the same standards as the submitted samples. He shall also submit literature which is current at the time of installation of the coating provided by the product manufacture for each coating used.

END OF SECTION 07120

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SECTION 07 54 19 –THERMOPLASTIC MEMBRANE ROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Adhered PVC sheet roofing
 - 2. Cover Board
 - 3. Polyisocyanurate Insulation
 - 4. Thermal Barrier
 - 5. Vapor Barrier
 - 6. Walkway pads
- B. Scope of Work:
 - 1. The scope of work includes the minimizing of the intrusion of dust and debris, created by the process of the installation of the new Roofing System. The phased installation of the new roof system will be installed in such a manner as to maintain a watertight integrity on a daily basis. Over the cleaned and prepared substrate, the specified flat stock, and tapered polyisocyanurate insulation, cover board, and the roofing system manufacturer's membrane shall be installed to meet the project's roofing design guidelines.
 - 2. Refer to Spec Section 07 56 00 Fluid Applied Roofing.
- C. Related Sections include the following:
 - 1. Division 5, Section 05 52 13 – "Wall Mounted Guard Rail"
 - 2. Division 6, Section 06 10 00 – "Carpentry Work for Roofing"
 - 3. Division 7, Section 07 62 00 – "Sheet Metal Flashing and Trim"
 - 4. Division 7, Section 07 71 00 – "Roof Hatch"
 - 5. Division 7, Section 07 92 00 – "Joint Sealants"
 - 6. Division 15, Section 15 01 00 – "Mechanical - Basic Requirements"
 - 7. Division 15, Section 15 06 20 – "Non-Penetrating Rooftop Pipe and Equipment Supports"
 - 8. Division 16, Section 16 01 00 – "Basic Electrical Requirements"

1.03 DEFINITIONS

- A. PVC: Polyvinyl-Chloride.
- B. Installer: Roofing Contractor.
- C. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

1.04 REFERENCES

- A. American Society of Civil Engineers (ASCE): ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
- B. Single-Ply Roofing Institute (SPRI): Application Guidelines and Wind Design Guidelines for Various Single Ply

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Membranes

- C. National Installers Association (NRCA): Current Roofing and Waterproofing Manual
- D. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA): Current SMACNA Technical Manuals.
- E. Underwriters Laboratories (UL):
 - 1. Roof Materials and Systems Directory. 2018.
 - 2. UL 790: Tests for Fire Resistance of Roof Covering Materials: 1983.
- F. American Society for Testing and Materials (ASTM)
 - 1. ASTM D 570 – 1981 (R 1988) Water Absorption of Plastics
 - 2. ASTM D 638 – 1991 Tensile Properties of Plastics
 - 3. ASTM D 751 – 1989 Coated Fabrics
 - 4. ASTM D 882 – 1991 Tensile Properties of Thin Plastic Sheeting
 - 5. ASTM D 1004 – 1990 Initial Tear Resistance of Plastic Film and Sheeting
 - 6. ASTM D 1204 – 1984 Linear Dimensional Changes of Non-rigid PVC Sheeting or Film at Elevated Temperature
 - 7. ASTM D 2136 – 1984 (R 1989) Coated Fabrics – Low-Temperature Bend Test
 - 8. ASTM D 2565 – 1982 Operating Xenon Arc-Type Light Exposure Apparatus With and Without Water for Exposure of Plastics
 - 9. ASTM D 3045 – 1974 (1984) Heat Aging of Plastics Without Load
 - 10. ASTM D 4434 – 1987 Poly (Vinyl Chloride) Sheet Roofing
 - 11. ASTM E 108 – 1991 (Rev. A) Fire Tests of Roof Coatings
 - 12. ASTM G 21 – 1990 Determining Resistance of Synthetic Polymeric Materials to Fungi
 - 13. ASTM G 53 – 1991 Operating Light – and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

1.04 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.
- B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing system manufacturer based on testing and field experience.
- C. Roofing System Design: Design uplift pressures for the building shall be done in accordance with ASCE 7-05. The specified roof assembly shall have been successfully tested to the calculated pressures by a qualified testing firm following ANSI/FM 4474 testing.
 - 1. Refer to construction drawings for component and cladding design pressures.
 - 2. Any design pressures needed for roofing attachments not listed on the construction drawings shall be in accordance with ASCE 7-05.
- D. FM Approvals Listing: Provide membrane roofing, base flashings, and component materials that comply with FMG Approvals 4450 and FMG Approvals 4470 as part of a thermoplastic membrane roofing system, and that are listed in FMG Approvals "RoofNav" for Class 1 construction. The roofing assembly shall conform to:
 - 1. Fire/Windstorm Classification: Minimum Class 1A-90
 - 2. Hail Resistance Rating: SH
- E. Underwriters Laboratories Inc. (UL):
 - 1. UL RMSD – 2018 Roofing Materials and Systems Directory
 - 2. UL 790 – 2009 Fire Resistance of Roofing Coverings Materials

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3. Exterior Fire Exposure Classification: Class A, ASTM E 108, for application and slopes shown

1.05 ACTION SUBMITTALS

- A. Product Data: Submit latest edition of roofing system manufacturer's roofing and base flashing specifications including list of materials proposed for use, installation procedures, and roofing system manufacturer's Product Safety Data Sheets.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Base flashings and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Roof plan showing orientation of steel roof deck and orientation of membrane roofing.
 - 4. Cover Board fastening patterns for field-of-roof, perimeters, and corners of the roof.
 - 5. Insulation fastening patterns for field-of-roof, perimeters, and corners of the roof.
 - 6. Thermal Barrier Board fastening patterns field-of-roof, perimeters, and corners of the roof.
- C. Samples for Verification: For the following products:
 - 1. Sheet roofing, of color specified.
 - 2. Cover board.
 - 3. Roof insulation
 - 4. Vapor Barrier
 - 5. Thermal Barrier.
 - 6. Metal termination bars.
 - 7. Six insulation fasteners of each type, length, and finish.
 - 8. Six membrane fasteners of each type, length, and finish.
 - 9. Walkway

1.06 INFORMATION SUBMITTALS

- A. Qualification Data: For qualified Installer and roofing system manufacturer.
- B. Installer: Provide copy of roofing system manufacturer's training certificate for each roofing mechanic permit to use the hot air welding equipment.
- C. Roofing system manufacturer Certificates: Signed by roofing system manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of compliance with performance requirements.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by roofing system manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
- D. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.
- E. Single Ply Roofing Institute (SPRI) - Fasteners Withdrawal Resistance Testing:
 - 1. The Installer shall conduct fastener pullout tests in accordance with the August 11, 2011 revision of the ANSI/SPRI FX-1 - American National Standard – Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
 - 2. Prior to starting the project, provide a copy of the Fasteners Withdrawal Resistance Testing to roofing system manufacturer's technical department.
- G. Warranty:
 - 1. Provide sample copy of 30-year (NDL) Full System roofing system manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.
 - 2. Provide sample of copy 5-year Installer's workmanship warranty stating obligations, remedies, limitations, and exclusions of warranty.

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- F. Inspection Report: Copy of roofing system manufacturer's final inspection report of completed roofing installation.

1.07 CLOSE OUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

1.08 QUALITY ASSURANCE

- A. Roofing System Manufacturer Qualifications: A qualified roofing system manufacturer that is FM or UL listed for membrane roofing system identical to that used for this Project.
- B. Installer Qualifications:
 - 1. A qualified firm that is approved, authorized, or licensed by membrane roofing system manufacturer to install roofing system manufacturer's product and that is eligible to receive roofing system manufacturer's special warranty.
 - 2. Installer must have a status of "Elite" or "Alliance" with the roofing system manufacturer.
 - 3. Prior to submitting a roofing proposal, Installer must be approval by Owner's representative.
- C. Roofing system manufacturer's membrane shall meet the following characteristics:
 - 1. Protective membrane surface coating to resist accumulation of air borne contaminants such as dust and dirt.
 - 2. Membrane Thickness: Membrane roofing system manufacturer is to verify that the membrane thickness is of the membrane thickness specified (see 2.02, A, 2). ASTM D751 or D638 nominal thickness of +/- 10 percent will not be acceptable for measurement of membrane thickness.
- D. Source Limitations: Obtain components including roof insulation, fasteners, and accessories for membrane roofing system from same roofing system manufacturer as membrane roofing.
- E. Exterior Fire-Test Exposure: ASTM E 108, Class A; for application and roof slopes indicated, as determined by testing identical membrane roofing materials by a qualified testing agency. Materials shall be identified with appropriate markings of applicable testing agency.
- F. Pre-installation Conference: Before installing roofing system, conduct conference at Project site. Notify participants at least 10 working days before conference.
 - 1. Meet with Owner's Representative/General Contractor, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 - 2. Review methods and procedures related to roofing installation, including roofing system manufacturer's written instructions.
 - 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 - 5. Review structural loading limitations of roof deck during and after roofing.
 - 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - 7. Review governing regulations and requirements for insurance and certificates if applicable.
 - 8. Review temporary protection requirements for roofing system during and after installation.
 - 9. Review roof observation and repair procedures after roofing installation.
- G. At no cost to Federal Aviation Administration, roofing system manufacturer's technical representative shall perform:
 - 1. Manufacturer's Quality Control Inspection: The Manufacturer's Technical Representative shall review the on-

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going work on the first day of the roofing production and a minimum of one (1) in-progress inspection every 14 working days. The Technical Representative shall:

- a. Communicate with the Federal Aviation Administration USA project manager, i.e. before entering the "work area," contact the Federal Aviation Administration designated project manager upon arrival at the Federal Aviation Administration facility.
 - b. Note all defects noted non-compliance with the specifications or the recommendations of the thermoplastic manufacturer should be itemized in a punch list. Pictures of the punch list items and the roof area inspected shall accompany the inspection report. The punch list items must be corrected immediately by the contractor to the satisfaction of the Federal Aviation Administration USA representative.
 - c. Ensure the roofing contractor has received a copy of each In-Progress Inspection Report within two days of the inspection. The roofing contractor is to forward the Project On-site Representative a copy of the In-Progress Inspection Report.
2. Final Roof Inspection: Contractor is to arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion of the roofing project.
- a. All defects noted non-compliance with the specifications or the recommendations of the thermoplastic manufacturer should be itemized in a punch list. These items must be corrected immediately by the contractor to the satisfaction of the Federal Aviation Administration USA and Sika Sarnafil.
 - b. The roofing contractor is to forward a copy of Final Inspection Report to the Nestlé On-site Representative within two days after date inspection(s) is performed.
- H. Installer's Responsibility: Any failure by the Owner Representative or roofing system manufacturer's Representative to detect, pinpoint, or object to any defect or noncompliance of these specifications of work in progress or completed work shall not relieve the Installer, or reduce, or in any way limit, his responsibility of full performance of work required of the Installer under these specifications.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with roofing system manufacturer's name, product brand name, and type, date of manufacture, and directions for storing and mixing with other components. Deliver materials in sufficient quantity to allow work to proceed without interruption.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within temperature range required by roofing system manufacturer.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Store and protect materials, including roofing insulation from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store all materials in a dry location. Use pallets to support all materials from roof deck. Distribute the load to stay within live load limits of the roof construction. Remove unused materials from the roof at the end of each day's work. Comply with roofing system manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.10 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to roofing system manufacturer's written instructions and warranty requirements.
- B. The PVC adhered membrane shall not be installed under the following conditions without consulting manufacturer for precautionary steps:
 1. The roof assembly permits interior air to pressurize the membrane underside.
 2. Any exterior wall has 10% or more of the surface area comprised of opening doors or windows.
 3. The wall/deck intersection permits air entry into the wall flashing area.

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- C. Protective wear shall be worn when using solvents or adhesives or as required by job conditions.
- D. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to roofing system manufacturer's written instructions and warranty requirements.
- E. Protection:
 - 1. Provide special protection and avoid traffic on completed areas of membrane installation.
 - 2. Restore to original condition or replace work or materials damaged during handling of roof materials.
 - 3. Take precautions as required to protect adjacent work and structures.
- F. Emergency Equipment and Materials: Maintain onsite equipment and materials necessary to apply emergency temporary edge seal in event of sudden storms or inclement weather. If inclement weather occurs while a temporary water stop is in place, the Installer shall provide the labor necessary to monitor the situation to maintain a watertight condition.
- G. Protection:
 - 1. Arrange work sequence to avoid use of newly-constructed Roofing for storage, walking surface, and equipment movement. Where such access is absolutely required, the Installer shall provide all necessary protection and barriers to segregate the work area and to prevent damage to adjacent Roofing areas.
 - 2. The Installer shall provide a suitable temporary protective surface for all roofing areas which will receive construction traffic or construction of equipment during all phases of the roofing project.
 - 3. During installation of the membrane roofing systems, should there be any damage created by other construction trades to the new or to existing roofing membrane and/or roofing system, the Installer is to immediately notify the Owner's Representative and membrane roofing system manufacturer. All damages are to be repaired according to the membrane roofing system manufacturer's or Owner's representative's recommendations. The "party" responsible for the roofing damages shall bear the total cost for the repairs or for the replacement of existing or new roofing system.
- H. Restrictions:
 - 1. Comply with Owner's General and Safety Requirements on use of site.
 - 2. Smoking, Illegal Drugs, and Tobacco products are prohibited on all roof areas and on the campus grounds.
 - 3. No food products are allowed on the roof or on the facility grounds at any time.
 - 4. Provide and maintain sanitary facilities for employees.
 - 5. Maintain facility and all utility services in a functional condition.

1.11 WARRANTY

- A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights of the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Installer under requirements of the Contract Documents.
- B. Roofing System Manufacturer's Warranty: Submit a written warranty, without monetary limitation, with all available options, including flashing endorsement, roofing system manufacturer's roof insulation and roofing system manufacturer's accessories, signed by roofing system manufacturer's agreeing to promptly repair leaks resulting from defects in materials or workmanship for the following warranty period:
 - 1. Refer to Spec Section 07 56 00 Fluid Applied Roofing.
- C. Installer's Warranty: Submit roofing Installer's workmanship warranty, on a notarized written warranty form, signed by Installer, covering Work of this Section, including membrane roofing, sheet flashing, cover board, roof insulation, fasteners, adhesives, sealants, and associated sheet metal, for the following warranty period:
 - 1. Warranty Period: Five (5) years from date of Substantial Completion.

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PART 2 - PRODUCTS**2.01 ROOFING SYSTEM MANUFACTURER**

- A. The components of the roof system are to be products of a single roofing system manufacturer or approved by the Sika Sarnafil, whose products meet or exceed the project specifications, have manufactured and installed the roofing materials and systems of the type specified for a minimum of thirty (30) years, and who maintains a single source responsibility for the total roofing system.
- B. Roofing system manufacturers: The components of the roofing system are to be products of a single roofing system manufacturer as required to provide the specified system warranty. Subject to compliance with requirements, provide roofing products from:
 - 1. Sika – Roofing, Canton, MA.
 - 2. Federal Aviation Administration Approved Equal.

2.02 ROOF ASSEMBLIES

- A. Basis of Design: Sikalastic RoofPro with Insulation.
 - 1. Control Tower Cab Roof; Refer to Spec Section 07 56 00 Fluid Applied Roofing.

2.03 PVC MEMBRANE

- A. Not Used; Refer to Spec Section 07 56 00 Fluid Applied Roofing.

2.04 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by roofing system roofing system manufacturer for intended use and compatible with membrane roofing materials.
 - 1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdictions.
- B. Membrane flashing and Flashing Accessories: As recommended by the roofing system manufacturer's printed instructions for reinforced sheet flashing of same material, mil thickness and color as sheet membrane.
- C. Insulation Fasteners: Roofing system manufacturer approved corrosion resistant steel #12 screws of the appropriate size and type for roof membrane and insulation attachment. A #12 corrosion-resistant fastener is used with insulation plates to attach insulation boards to concrete decks. Fasteners for the insulation shall be supplied and installed as recommended by the roofing system manufacturer's printed instructions.
- D. Insulation Securement Plates: Roofing system manufacturer approved corrosion resistant steel, 3-inch round plates, of the appropriate size and type for the securement of the insulation to approved substrates. Securement plates for the insulation shall be supplied and installed as recommended by the roofing system manufacturer's printed instructions.
- E. Membrane Securement Plates: Roofing system manufacturer approved corrosion resistant steel, 2-inch round plates for the securement of the membrane to the steel roof decks. Securement plates for the membrane shall be supplied and installed as recommended by the roofing system manufacturer's printed instructions.
- F. Membrane Securement Screw: Roofing system manufacturer approved corrosion resistant steel #14 screws of the appropriate size and type for roof membrane securement. A #12, corrosion-resistant fastener used with membrane securement plates and bars to attach PVC roof membrane to concrete decks. Fasteners for the membrane shall be supplied and installed as recommended by the roofing system manufacturer's printed instructions.
- G. Membrane Bonding Adhesive: Roofing system manufacturer's approved contact adhesive used to attach membrane to the horizontal or near-horizontal substrate. Application rates are to be as recommended by roofing system

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manufacturer's printed instructions.

- H. Membrane Flashing Bonding Adhesive: Roofing system manufacturer's approved contact adhesive used to attach the flashing membrane to the substrate, either horizontally or vertically. Application rates are to be as recommended by roofing system manufacturer's printed instructions.
- I. Membrane Securement Bar: A 1-inch wide aluminum alloy bar used with #14 or #15 to clamp the PVC membrane to the roof deck along walls, curbs, and certain vertical to horizontal changes in the roofing system.
- J. Sealants: Owner approved sealant shall be used to seal penetrations through the membrane system and at miscellaneous sealant applications that are exposed to roof systems components.
- K. Sealing Tape: "Multi-Purpose Tape," a high-performance sealant tape with superior surface tack that remains elastic and is designed to bond the PVC membrane and a variety of metals. "Multi-Purpose" sealing tape strip is used to seal the metal roof edge of buildings reducing air infiltration into the roof assembly, behind the membrane flashing at termination details, and to seal the overlaps of the air/vapor retarder membrane.
- L. Pre-Fabricated Pipe Flashing: Prefabricated vent pipe flashing made from 0.060 inch (60 mil/1.5 mm) thick PVC membrane.
- M. Pre-Fabricated Corner Flashing: "Sarnacorners," prefabricated universals corners made of 0.060 inch (60 mil/1.5 mm) thick membrane that are heat-weldable to membrane or "Sarnaclad" base flashings.
- N. Membrane Coated Metal: A PVC-coated, heat-weldable sheet metal manufactured from a 24 gauge, G90 galvanized metal sheet with a 20 mil (0.5 mm) unsupported PVC membrane laminated on one side.
- O. Other miscellaneous materials shall be of the "best grade" available and to be approved in writing by the roofing system manufacturer for the specific application.

2.05 THERMAL BARRIER BOARD

- A. Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing materials.
 - 1. Type and Thickness: Gypsum core board with a thickness of 5/8-inch
 - 2. UL Class A (UL 790) and ULC S-102
 - 3. Product: Subject to compliance with requirements, provide product as manufactured by:
 - a. "Dens-Deck®" as manufactured by Georgia-Pacific Corporation.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate board to roof deck.

2.06 VAPOR RETARDER

- A. Self-Adhering-Sheet Vapor Retarder: A 31 mil (0.8 mm) thick self-adhesive vapor retarder/air barrier for use within a single ply membrane insulated roofing systems. Provide primer as recommended by vapor-retarder manufacturer.
 - 1. Product: Subject to compliance with requirements, provide product as manufactured or supplied by:
 - a. "Sarnavap SA 31" as supplied by Sika - Roofing.

2.06 INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by thermoplastic membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.

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- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 2, Grade 2, glass-fiber mat facer on both major surfaces.
- C. 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. Atlas Roofing Corporation.
 - 2. R-Max.
 - 3. Sika – Roofing.
- C. Tapered Insulation:
 - 1. Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches as indicated on roof plans.
 - 2. Provide 1/8 inch per foot tapered boards at primary roof drains to create 4 feet x 4 feet drain sump.
 - 3. Provide factory-tapered insulation boards fabricated to slope of 1/2 inch per 12 inches saddles, crickets, tapered edge strips, and other insulation shapes for sloping to drain.
 - 4. Provide 1/2 inch per 12 inches saddles on the “high side” of all equipment, measuring 18 inches and greater in width.

2.07 COVER BOARD

- A. Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing materials.
 - 1. Type and Thickness: Gypsum core board with a thickness of 5/8-inch
 - 2. UL Class A (UL 790) and ULC S-102
 - 3. Product: Subject to compliance with requirements, provide product as manufactured by:
 - a. “Dens-Deck Prime®” as manufactured by Georgia-Pacific Corporation.

2.08 INSULATION AND COVER BOARD ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by roofing manufacturer for intended use and compatible with membrane material.
- B. Fasteners: Factory-coated steel fasteners and metal plates meeting corrosion-resistance, designed for fastening roof cover board, insulation board, and thermal board to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
 - 2. As listed in FM RoofNav Assembly Approval #220223-00 or in FM RoofNav Assembly Approval #213454-0-0

2.07 SPARY IN PLACE FOAM SEALANT

- A. Spray in Place Foam Sealant: A two-component, quick-cure polyurethane foam that fills cavities, penetrations, cracks, and expansion joints.
- B. Applicable ASTM Standards:
 - 1. C203 – Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
 - 2. C273 – Standard Test Method for Shear Properties of Sandwich Core Materials
 - 3. C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
 - 4. D1621 – Standard Test Method for Compressive Properties of Rigid Cellular Plastics
 - 5. D1622 – Standard Test Method for Apparent Density of Rigid Cellular Plastics
 - 6. D1623 – Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics

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7. D2842 – Standard Test Method for Water Absorption of Rigid Cellular Plastics
8. E96 – Standard Test Methods for Water Vapor Transmission of Materials
9. E283 – Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
10. E2178 – Standard Test Method for Air Permeance of Building Materials

C. Approved Roofing system manufacturer and Product:

1. Dow Building Solutions, “FROTH-PAK™”

2.08 RELATED MATERILAS

- A. Timber, General: Hand select material at factory from lumber of species and grade indicated below for compliance with "Appearance" grade requirements of ALSC National Grading Rule; provide certificate of inspection from an accredited Agency for selected material.
1. Provide seasoned lumber with 19 percent moisture content at time of dressing and shipment, for sizes 2-inches or less in thickness.
 2. Provide lumber with 15 percent moisture content at time of dressing and shipment for, sizes 2-inches or more in thickness.
- B. Dimensioned Lumber: Graded in accordance with established grading rules; grade and species as follows:
1. Concealed Boards: WWPA standard grade, any species, or SPIB No. 3 grade Southern Pine.
 2. Lumber for Miscellaneous Uses: Standard grade unless otherwise indicated.
 3. Plywood: PS 1; select sheathing grade or APA rated 5/8-inch minimum thickness, CD-X, or better in sheathing.

2.09 MISCELLANEOUS FASTNERS AND ANCHORS

- A. General: All fasteners, anchors, nails, straps, bars, etc. shall be post-galvanized steel, aluminum, or stainless steel. Mixing metal types and methods of contact shall be assembled in such a manner as to avoid galvanic corrosion. Fasteners for attachment of metal to masonry shall be expansion type fasteners with stainless steel pins. All concrete fasteners and anchors shall have a minimum embedment of 1¼ inch (32 mm) and shall be approve for such use by the fastener roofing system manufacturer. All miscellaneous wood fasteners and anchors used for flashings shall have a minimum embedment of 1 inch (25 mm), stainless steel, and to be approved for such use by the fastener roofing system manufacturer.

2.10 WALKWAY PROTECTION

- A. Crossgrip XTR
1. Rolled-out walkway protection mat loose laid on top of completed roof assemblies consisting of 5/8” (16 mm) thick flexible PVC with cross-directional textured ribs. Available in white, gray, and yellow. Use gray unless approved otherwise.
 2. Provide heat-welded strips of membrane to attach Crossgrip walkway to base swatch. Install securement strips at 6’-0” o.c. max on each side of walkway material.
 3. Provide heat-welded base swatch of sacrificial pvc membrane to attach strip to roofing membrane. Install base swatches at 6’-0” o.c. max on each side of walkway material.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect entire roof area to be roofed for acceptability. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
1. Verify that roof openings and penetrations are in place, and curbs are set and braced, and that the roof drains and drain lines are properly clamped into position and are in a 100% functional condition.

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2. Do not permit voids greater than 1/4-inch-wide in the substrate.
 3. Substrates for roofing materials shall be dry and free of oil, dirt, grease, sharp edges, and debris. Inspect substrates, and correct defects before application of roofing system.
- B. The Installer shall conduct fastener pullout tests in accordance with the August 11, 2011 revision of the ANSI/SPRI FX-1 - American National Standard – Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
- C. Correct unsatisfactory conditions prior to commencing roof installation. Starting installation shall imply Installer's acceptance of surfaces and conditions of the roof area(s).
- D. Surface on which insulation or roofing membrane is applied shall be clean, smooth, dry, and free of projections or contaminations that would prevent proper application of or be incompatible with the new installation, such as fins, sharp edges, and foreign materials.
- E. Do not allow grease, fats, oils, and other contaminants to contact roofing membrane.

3.02 PREPARATION

- A. Clean substrate of dust, debris, and other substances detrimental to roofing installation according to roofing system roofing system manufacturer's written instructions. Remove all sharp projections.
- B. The Installer will be entirely responsible for the complete removal of all dirt, debris, moisture from the roof's substrate, i.e. steel decking, concrete decking, before the installation of the roofing system. The roof's substrate must be 100% completely dry before the installation of the specified roofing insulation.
- C. Mask off adjoining surfaces not receiving roofing membrane materials to prevent spillage or over spray affecting other construction.
- D. Fill all gaps and voids between substrate components that are wider than 1/4 inch. Fill all gaps with same materials as the substrate.
- E. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- F. Clear deck of debris, ice, water, and foreign material prior to installation of any roofing materials. Remove all debris from the bottom ribs of the steel decking.
- G. Proceed with roofing work only when weather conditions permit work to proceed in accordance with manufacturer's requirements and recommendations.
- H. Seal around pipes, conduits, and other penetrations for 2 inches minimum with the specified spray in place foam insulation.

3.03 WOOD NAILER INSTALLATION

- A. All Wood Nailers shall be anchored to resist a minimum force of 300 pounds per lineal foot (4,500 Newtons/lineal meter) in any direction. Individual nailer lengths shall not be less than 3 feet (0.9 meter) long. Nailer fastener spacing shall be at 12 inches (0.3 m) on center or 16 inches (0.4 m) on center if necessary to match the structural framing. Fasteners shall be staggered 1/3 the nailer width and installed within 6 inches (0.15 m) of each end. Two fasteners shall be installed at ends of nailer lengths. Wood nailer attachment shall meet the current Factory Mutual Loss Prevention Data Sheet 1-49. Refer to Division 06 10 00 for acceptable fasteners for wood product attachments.
- B. Wood Nailer thickness shall be as required to match the insulation and cover board height (thickness) to allow a

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smooth transition.

- C. Stainless steel, corrosion resistant, fasteners are required when mechanically attaching any thermoplastic product to wood nailers and wood products treated with ACQ (Alkaline copper Quaternary). When ACQ treated wood is used on steel roof decks or with metal edge detailing, a separation layer must be placed between the metal and ACQ treated wood.
- D. New wood nailers and/or plywood sheeting shall meet the performance criteria in Division 06 10 00.

3.04 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.05 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
 - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. Locate end joints over crests of steel roof deck.
 - 2. Tightly butt substrate boards together.
 - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Global RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

3.06 VAPOR-RETARDER INSTALLATION

- A. Self-Adhering-Sheet Vapor Retarder: Prime substrate as required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches and 6 inches, respectively.
- B. Use a minimum 100 lb. (45 kg) steel roller to press the Vapor Retarder onto the substrate including the laps. Use the roller to push out any air bubbles out to the edge of the membrane. Do not cut the membrane to remove a bubble. Coordinate installation of vapor retarder so it is not exposed to precipitation or left exposed at the end of the workday.
- C. Apply Sika's Mastic to seal around penetrations, T-joints, 90° angle transitions, fishmouths or other openings. Use a trowel to mound Sika's Mastic around the penetrations to seal the opening.
- D. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.07 INSULATION BOARD INSTALLATION

- A. General Criteria:
 - 1. Coordinate installing membrane roofing system components, so insulation is not exposed to precipitation or left exposed at the end of the workday.
 - 2. Fasten the specified insulation board according to requirements of the membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
 - 3. Wet, broken, warped, or bent insulation boards are not acceptable. Any damaged insulation boards are to be

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- replaced with new insulation boards.
4. The substrate surface must be free of debris, dirt, grease, oil, ice, snow, frost, standing water, and must be 100% completely dry prior to the installation of the specified roofing insulation or during the time of applying the dual component polyurethane adhesive and the spray- in-place foam.
 5. Roofing system manufacturer's technical representative must be on the jobsite during the first initial day of installation of the roofing system.
 6. On all roof areas, the insulation boards are to be sealed to the base of the walls, along the perimeter blocking, along the base of the equipment curbs, around all roof drains, and around all roof penetrations, i.e. conduits and piping with an approved spray-in-place foam insulation.
 - a. The base layer of insulation shall be spaced approximately 2 inches away from the base of the walls, equipment curbs, and all roof penetrations, i.e. curbs and piping. The spray in place foam shall be applied into the 2-inch space. Each additional or subsequent layers of insulation shall be also spaced 2 inches away from the base of the walls, the equipment curbs, roof drains, and all roof penetrations, i.e. curbs and piping. The spray in place foam adhesive shall be applied into the 2-inch space. The spray in place foam insulation is "forced down" and to be a continuous application into the 2-inch space.
 7. Install tapered insulation under area of roofing to conform to slopes indicated.
 8. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.5 inches or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
 9. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges, and ends between boards. Fill gaps exceeding 1/4 inch with spray in place foam insulation.
 10. Install four (4') feet x four (4') feet tapered insulation at each roof drain or supper. The tapered insulation shall be mitered at the corners to provide a smooth and tapered transition into the roof drains and scuppers.
- B. Installation of tapered and flat stock polyisocyanurate insulation:
1. The flat stock polyisocyanurate insulation panels shall be adhered to the prepared substrate with the dual component polyurethane adhesive.
 2. The tapered polyisocyanurate insulation panels shall be laid transverse to the proceeding layer of insulation, with joints staggered at least 1/3 of overall length from those of the proceeding layer.
 3. The flat stock and tapered polyisocyanurate insulation shall be adhered to the proceeding layer of insulation with the dual component polyurethane adhesive.
 4. Adhered insulation board to vapor retarder according to recommendations in FM Global RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
 5. After allowing dual component polyurethane adhesive to rise 3/4 inch to 1 inch, lay insulation board in to position and walk into place. After walking into place, the insulation board shall be pressed firmly into the adhesive layer with using an approved 100-pound weighted roller by frequent rolling in two or more directions.

3.08 COVER BOARD INSTALLATION

- A. General Criteria:
1. Fasten the specified cover board according to requirements of the roofing system manufacturer's written instructions.
 2. Wet, broken, warped, or bent insulation boards are not acceptable. Any damaged cover boards are to be replaced with new cover boards.
 3. Consult roofing system manufacturer on current acceptable substrates and rates for applying the low-rise urethane adhesives. The surface of substrate shall be inspected prior to installation of the cover board.
 4. The insulation substrate surface must be free of debris, dirt, grease, oil, ice, snow, frost, standing water, and must be 100% completely dry prior to the installation of the specified cover board or during the time of applying the dual component polyurethane adhesive and the spray- in-place foam.
 6. Install a single layer of cover board over the specified polyisocyanurate insulation.
 7. The cover board sheeting shall be laid transverse to the top layer of the insulation board, with joints staggered at least 1/3 of overall length from those of the insulation layer.

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8. The cover board shall be neatly cut to fit within 1/4 inch (6 mm) of nailers, penetrations, and projections.
9. Fill all gaps exceeding 1/4 inch (6 mm) with spray-in-place foam insulation.
10. Trim surface of cover board where necessary at roof drains so completed surface is flush and does not restrict flow of water.
11. Do not install more cover board than can be covered with the specified roofing system by the end of the day, or onset of inclement weather.

B. Attachment of Cover Board:

1. The cover board panels shall be laid transverse to the proceeding layer of insulation, with joints staggered at least 1/3 of overall length from those of the proceeding layer.
2. Adhered cover board to insulation according to recommendations in FM Global RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
3. After allowing dual component polyurethane adhesive to rise 3/4 inch to 1 inch, lay cover board in to position and walk into place. After walking into place, the cover board shall be pressed firmly into the adhesive layer with using an approved 100-pound weighted roller by frequent rolling in two or more directions.
4. The cover board shall be completely adhered to the top layer of the specified insulation board. There shall not be any elevation change or raise of the corners or sides of the cover board as compared to the sides of the adjacent cover board sides. The cover board shall lay flat or level as compared to the edges of the adjacent cover board.

3.09 PVC MEMBRANE INSTALLATION

- A. General: Install in strict accordance with roofing system manufacturer's latest published requirements, instructions, specifications, details, and approved shop drawings.
- B. Install PVC membrane per roofing system manufacturer's requirements to obtain roofing system manufacturer Thirty (30)-year Full System (NDL) warranty.
- C. Install in strict accordance with roofing system manufacturer's latest published instructions.
- D. Roofing system manufacturer's technical representative must be on the jobsite during the first initial day of installation of the roofing system.
- E. Coordinate with Owner representative to shut down air-intake equipment in the vicinity of the Work. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.
- F. The PVC membrane is to be adhered with roofing system manufacturer's approved adhesive. Membrane overlaps shall be shingled with the flow of water where possible. Tack welding of the PVC membrane side laps for purposes of temporary restraint during installation is not permitted.
- G. Installation of PVC membrane:
 1. The PVC membrane shall be adhered to the specified cover board substrate with PVC membrane contact adhesive.
 2. The adhesive is roller-applied, using a using solvent-resistant 3/4 inch (19 mm) nap paint rollers. Installer is to consult Roofing System Manufacturer's Technical Department for the proper application of the contact adhesive.
 3. The adhesive shall be applied in smooth, even coating with no gaps, globs, puddles or similar inconsistencies.
 4. After installing the PVC membrane, the PVC membrane shall be pressed firmly into the adhesive layer with using an approved weighted roller by frequent rolling in two or more directions.
 5. Installer is to ensure there are no wrinkles in the membrane. There shall not be any wrinkles or "fishmouths" in the membrane overlap seams.
- H. The means of application and the quantities of the membrane adhesive to be used shall be per the roofing system

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manufacturer's recommendations. Consult roofing system manufacturer on proper application rates for adhering the membrane to the acceptable substrates.

- I. **USE CAUTION TO ENSURE ADHESIVE FUMES ARE NOT DRAWN INTO THE BUILDING.**
- J. Mechanically fasten membrane securely at all vertical to horizontal transitions, at points of terminations, and at the perimeter of roof to meet Manufacturer's Technical Department's requirements for properly securing the specified roofing system.
- K. Spread sealant bed over deck drain flange at deck drains and securely seal roofing membrane in place with drain clamping ring.
- L. Field-seam according to Section 3.07, "Seam Installation."
- M. Securement Around Perimeter and Rooftop Penetrations
 - 1. Around all perimeters, at the base of walls, drains, curbs, vent pipes, or any other roof penetrations, roofing system manufacturer's fasteners and securement bar shall be installed. Fasteners and securement bar shall be installed accord to the roofing system manufacturer's instructions. Fasteners shall be installed using the fastener roofing system manufacturer's recommended fastening tools with depth locators.
 - 2. PVC membrane flashings shall extend a minimum of 3 inches past the securement bar or plates and shall be hot air welded to the PVC membrane.

3.10 SEAM INSTALLATION

- A. General:
 - 1. All seams shall be hot air welded. Seam overlaps should be 3 inches (75 mm) wide when automatic machine-welding and 4 inches (100 mm) wide when hand-welding, except for certain details.
 - 2. The Installer shall provide, and use approved Automatic Welding Equipment for machine welding the specified PVC membrane. All mechanics intending to use the automatic welding equipment shall have successfully completed a training course provided by a Roofing system manufacturer's Technical Representative prior to welding.
 - 3. All membrane to be welded shall be clean and dry.
- B. Hand-Welding:
 - 1. Hand-welded seams shall be completed in two stages. Hot-air welding equipment shall be allowed to warm up for at least one minute prior to welding.
 - 2. The back edge of the seam shall be welded with a narrow but continuous weld to prevent loss of hot air during the final welding.
 - 3. The nozzle shall be inserted into the seam at a 45-degree angle to the edge of the membrane. Once the proper welding temperature has been reached and the membrane begins to "flow," the hand roller is positioned perpendicular to the nozzle and pressed lightly. For straight seams, the 1½-inch (40-mm) wide nozzle is recommended for use. For corners and compound connections, the ¾ inch (20 mm) wide nozzle shall be used.
- C. Machine Welding:
 - 1. Machine welded seams are achieved by the use of PVC manufacturer's approved hot air welding machine. When using the hot air welding equipment, Installer shall follow manufacturer's instructions on proper operation of the hot air welding machine.
 - 2. All applicable building local codes for electric supply, grounding and over current protection shall be observed. A dedicated portable generator is recommended for machine welding. No other equipment shall be operated off the generator during the time of machine welding.
 - 3. Metal tracks may be used over the field membrane and under the machine welder to minimize or eliminate wrinkles along the seam.

3.11 MEMBRANE FLASHING INSTALLATION

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- A. General: All membrane flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and the roofing system manufacturer. Approval shall only be for specific locations on specific dates. Membrane flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces.
- B. Contact Adhesive for Membrane Flashings:
 - 1. Over the properly installed and prepared flashing substrate, the adhesive shall be applied according to instructions found on the Product Data Sheet. The adhesive shall be applied in smooth, even coats with no gaps, globs, or similar inconsistencies. Only an area that can be completely covered in the same day's operations shall be flashed. The bonded sheet shall be pressed firmly in place with a hand roller.
 - 2. No adhesive shall be applied in seam areas that are to be welded. All panels of membrane shall be applied in the same manner, overlapping the edges of the panels as required by welding techniques.
 - 3. All flashing membranes shall be consistently adhered to substrates. All interior and exterior corners and miters shall be cut, and hot-air welded into place. Where applicable, roofing system manufacturer's pre-fabricated corners shall be used.
 - 4. The membrane flashing shall be completely adhered to the substrate with no unadhered areas.
- C. All flashings shall extend a minimum of 8 inches (0.2 m) above roofing level unless otherwise accepted in writing by the Owner's Representative and roofing system manufacturer's technical department.
- D. All flashings that exceed 30 inches (0.75 m) in height shall receive additional securement. Consult roofing system manufacturer's technical department for securement methods.
- E. All membrane flashings shall be mechanically fastened along the counter-flashed top edge with securement bar; fastened 6-8 inches on center. Seal the top edge and backside of the membrane flashing with "Multi-Purpose Sealing Tape" and approved sealant. Complete termination per roofing system manufacturer's requirements. Provide a metal counterflashing to protect the sealant and multi-purpose sealant tape.
- F. Only an area, which can be completely covered in the same day's operations, shall be flashed.
- G. Daily test lap edges with probe to verify seam weld continuity of all membrane flashings.
- H. Complete all membrane flashing and metal details daily. No temporary flashings shall be allowed with the prior written approval of the Owner's Representative and roofing system manufacturer. If any water is allowed to enter under the completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the Installer's expense.
- I. Installer is to ensure there are no wrinkles and "fish-mouths" in the membrane flashing and in the overlap seams.

3.11 PVC COATED METAL BASE FLASHINGS

- A. General: All flashings shall be installed concurrently with the roofing membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and the roofing system manufacturer. Acceptance shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the Installer's expense.
- B. Adjacent sheets of PVC coated metal shall be spaced ¼ inch (6 mm) apart. The joint shall be covered with 2-inch (50-mm) wide aluminum tape. A 4-inch minimum wide strip of membrane flashing membrane shall be hot air welded over the joint. Check all coverstrip welds with a rounded screwdriver prior to installation of eight-inch coverstrip. Re-weld any inconsistencies before eight-inch coverstrip installation.
- C. An 8 inch minimum wide strip of the 60 mil membrane flashing shall be hot air welded to the 4 inch wide flange of the PVC coated metal and to the field membrane. Check all coverstrip welds with a rounded screwdriver. Re-

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weld any inconsistencies.

3.12 WALKWAY INSTALLATION

- A. Installer is to install walkway in the areas as indicated on roof plans. Installer is responsible for verification of the total linear footage of the required walkway installation. The minimum length of the walkway, installed at any one location, shall be four (4') feet.
- B. Install the walkway to roofing system manufacturer's written instructions.
 - 1. Clean all dirt and debris from the deck membrane in areas where the walkway will be installed.
 - 2. Important: Check all deck membrane welds with a rounded screwdriver prior to installation of walkway. Re-weld any inconsistencies before walkway installation.
 - 3. Install walkway in the indicated roof areas.
 - 4. Installer shall not hot air weld the walkway to the field membrane.

3.13 TEMPORARY ROOFING TERMINATIONS AND PROTECTION

- A. Prior to starting roofing project, the Installer shall inspect the facility existing roof area(s) associated with the contract roofing project for any defects which could cause water or moisture vapor entries into the building during the roofing application. Any defects or concerns shall be address in writing to the Owner's representative prior to starting the roofing project. Proceeding with the roofing project indicates the Installer's acceptance of the existing facility conditions.
- B. For existing roof areas where access is absolutely required for the installation of the new roofing system on another roof area, the Installer shall provide all necessary protection and barriers to segregate the work area and to prevent damage to adjacent roof areas. A suitable temporary protective surface shall be provided for all roof areas which receive traffic during construction of the new roofing system. During the roofing project, any damage which occurs to the new or existing roofing membrane and/or system shall be removed and replaced at the Installer's expense.
- C. The Installer shall provide the labor and materials required to maintain a watertight and impermeable condition always on the roof areas as referenced in the project's contract documents. All membrane and metal flashings shall be installed concurrently with the field membrane installation to maintain a 100% watertight and to prevent any air/water vapor infiltration into the completed roofing system each day.
- D. When an interruption or a postponement in the roofing work occurs during the installation of the roofing system, the Installer shall install temporary watertight and hermetic terminations across the installed Sika Sarnafil roofing system. The Sika Sarnafil roofing system shall be 100% impermeable to prevent water and air/water vapor infiltration into or under the new roofing system. When work resumes, any contaminated membrane shall be removed from the work area and disposed off-site. None of these materials shall be reused in the new work.
- E. During inclement weather or during a postponement in the roofing work occurs while a temporary water stops, or terminations are in place, the Installer shall provide the labor and materials to monitor and ensure the temporary water stops and terminations are 100% watertight and impermeable condition.
- F. If any weather-related moisture is allowed to enter into the newly-completed PVC Roofing System, the affected roof area(s) shall be removed and replaced at the Installer's expense.

3.14 FIELD QUALITY CONTROL

- A. The Roofing Contractor shall assign a qualified, full, non-working Quality Control Supervisor to be on Project site at all times during installation of Work. This QC supervisor is to have good communication skills and be able to communicate with the Owner Representative and with Contractor's Employees.
 - 1. At the end of the work day, the Quality Control Supervisor shall inspect all installed Work, particularly roofing tie-ins, membrane seams, and completed flashings to ensure water-tightness of the roofing system.
 - 2. The Quality Control Supervisor shall prepare a daily report which describes each major portion of Work or

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operation. The Quality Control Supervisor shall confirm all of the completed work has been thoroughly inspected to ensure the water-tightness of the roofing system. The daily report shall include pictures of Work completed "that" day.

3. The Quality Control Supervisor shall use a Roof Plan to indicate each day's completed Work, the sequence of Work, and with previous completed Work dates.
 4. All Quality Control Supervisor's daily electronic reports shall be submitted to the Owner's Representative at the end of the work week. Each daily report shall be properly dated.
 5. At the end of the work week, the Quality Control Supervisor shall submit a written electronic report / schedule or bar chart indicating where the "next week's" work will occur, and any information needed to be coordinate the Owner's representative, i.e. raising of equipment, required disconnects of equipment, and when applicable any supply deliveries.
- B. Quality Control of Welded Seams:
1. The Installer shall designate a Quality Control Supervisor to check all welded seams for continuity by using a rounded screwdriver.
 2. On-site evaluation of welded seams shall be made by the Installer at locations as directed by the Owner's Representative or roofing system manufacturer's technical representative.
 3. One inch (25-mm) wide cross-section samples of welded seams of the membrane and membrane flashing shall be taken at a minimum of three (3) times a day by the Installer.
 4. Installer shall label each seam test cut with the time, date, and location of the test cut. At the close of project, all seam test cuts are to be submitted to the Owner's representative for review.
 5. Retain test cuts for the roofing system manufacturer's technical representatives and Owner's representative's inspection and evaluation.
 6. Correct welds display failure from shearing of the membrane prior to separation of the weld.
 7. Repair cold welds, tears, voids, and wrinkles in the over lapped seams of the roofing membrane and membrane flashing which do not meet manufacturer's requirements for a quality seam weld.
 8. Each test cut shall be patched by the Installer at no extra cost to the Owner or to roofing systems manufacturer.
 9. All membrane seams, both field and flashings, shall be hot air welded and probed daily. NO EXCEPTIONS.
- C. Roofing system manufacturer's technical representative: Installer shall arrange to have the system manufacturer's technical representative on site of the first day of installation of the roofing system. The Technical Representative shall note:
1. Conduct a site inspection on the first day of production.
 2. After the first day of inspection, the roofing system manufacturer's technical representative shall perform a minimum of one (1) in-progress inspection every 14 working days for the duration of the project.
 3. At the completion of the project, the technical representative shall perform a final inspection of the completed work.
 4. A copy of each In-Progress Inspection Report shall be sent to the Owner's Representative within two days after date inspections are performed.
- D. Final Roof Inspection: Arrange for roofing system manufacturer's technical representative to inspect roofing installation on completion of the roofing project.
1. All defects noted non-compliance with the roofing specifications and details or the recommendations of roofing system manufacturer representative should be itemized in a punch list. These items must be corrected immediately by the Installer to the satisfaction of the Owner's Representative and roofing system manufacturer technical representative.
 2. A copy of Final Inspection Report shall be sent to the Owner's Representative within two days after date of the inspection has been performed.

3.15 MANDATORY TESTING

- A. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

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- a. Perform tests before overlying construction is placed.
- b. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
- c. Flood each area for 48 hours.
- d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
 - i. The Contractor is responsible for repairing any materials damaged as a result of flood testing.
 - ii. Cost of retesting is Contractor's responsibility.
- e. Testing agency shall prepare survey report indicating locations of initial leaks, if any, and final survey report.

3.16 PROTECTING AND CLEANING

- A. Protect sheet membrane roofing from dirt, grease, scuff marks, abrasions, adhesive spills, sealant spills, damage, and wear during the construction period. Installer is to inspect the completed roofing system for any damage, dirt, grease, scuff marks, abrasions, adhesive spills, and sealant spills. Any non-compliance item shall be removed and/or repaired to the satisfaction of the Owner's representative(s).
- B. Upon completion of the Work, dispose of, away from the Site, all debris, trash, containers, fasteners, roofing remnants and scraps.
- C. The completed "Roof" shall be washed with water and Owner's approved cleaner to remove all dirt, stains, adhesive and sealant spills, and any construction residue from roof membrane.

3.17 ACCEPTANCE

- A. Prior to demobilization from the site, the roofing system manufacturer's project manager, Owner's representative(s), roofing system manufacturer's designated field technical representative and Installer's project manager, production crew superintendent, and project's roofing foreman shall review the completed work. All defects noted noncompliance with the project's bid documents will be itemized in a punch list. These items must be corrected immediately by the Installer prior to demobilization to the satisfaction of the Owner's representative, and to roofing system manufacturer.
- B. Correct deficiencies, noted in the final acceptance itemized punch list, by repairing and / or by removing roofing membrane, roofing membrane flashing, associated metal copings, metal counter-flashings, any associated metal required for the roofing project, perimeter edge metal, associated roofing securement fasteners, cover board, and insulation that do not comply with project roofing requirements. The noted deficiencies shall be repaired or replaced to a condition free of damage and deterioration at the time of Substantial Completion, to Owner's representative's Acceptance of the Completed Project, according to project bid documents, and / or to according to the project warranty requirements.
- C. All warranties as required for the project of this specification shall be submitted for approval prior to final payment.

END OF SECTION

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SECTION 07 56 00 FLUID APPLIED ROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. This section specifies all labor, materials, transportation, equipment and services necessary to install a **Sikalastic® RoofPro (Decothane®)** waterproofing system, on structural concrete, plywood, metal, or other approved substrate by manufacturer and shown on the drawings and described herein.
- B. Sections Included
 - 1. Section 07 56 00 : Fluid-Applied Roofing
- C. Related Sections
 - 1. Section 03 00 00 : Concrete
 - 2. Section 07 62 00 : Flashing and Sheet Metal
 - 3. Section 07 54 19 : Thermoplastic Membrane Roofing

1.02 REFERENCES

- A. Factory Mutual (FM Global) - *Approval Guide*
- B. American Society for Testing and Materials (ASTM) - *Annual Book of ASTM Standards*
- C. National Roofing Contractors Association (NRCA)
- D. American Society of Civil Engineers (ASCE)

1.03 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D1079 and the glossary of the National Roofing Contractors Association (NRCA) *Roofing and Waterproofing Manual* for definitions of roofing terms related to this section.

1.04 PERFORMANCE REQUIREMENTS

- A. Provide an installed roofing membrane that does not permit the passage of water, and will withstand the design pressures calculated in accordance with ASCE 7-05.
- B. Manufacturer shall provide all primary waterproofing materials that are physically and chemically compatible when installed in accordance with manufacturers current application requirements.

1.05 SUBMITTALS

- A. Provide product data sheets for each type of product indicated in this section.
- B. Provide manufacturers standard details and approved shop drawings for the specified system.

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- C. Installer shall provide written documentation from the manufacturer of their authorization to install the system, and eligibility to obtain the warranty specified in this section.
- D. Certification showing full time quality control of production facilities and that each batch of material is tested to ensure conformance with the manufacturer's published physical properties.
- E. Certification that the waterproofing membrane meets FM Global Approval Standard 4470 for Class I roof covers, on non-combustible substrates, with a Class 1-990 wind uplift rating, a hail rating of SH and is ASTM E-108-00 Class A approved at a slope of 1 in 12.
- F. Manufacturer's certification that all waterproofing system products meet current Volatile Organic Compound (VOC) regulations as established by the State in which they are being installed; and stating total VOC content, in grams per litre, for all system components (i.e. primers, adhesives, coatings, etc.).
- G. **Additional Action Submittals and Information Submittals;**
 - 1. **Refer to Spec Section 07 54 19 Thermoplastic Membrane Roofing**

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer shall demonstrate qualifications to supply materials of this section by certifying the following:
 - 1. Membrane Manufacturer must show evidence that the specified membrane has been manufactured by the same organization or direct affiliate for fifteen (15) years.
 - 2. Membrane Manufacturer shall have available an in-house technical staff to assist the contractor, when necessary, in application of the products and final inspection of the assembly.
- B. Installer's Qualifications: The Contractor shall demonstrate qualifications to perform the work of this Section by submitting the following documentation:
 - 1. Certification or license by the waterproofing membrane manufacturer as an authorized applicator of the product the installer intends to use.
- C. Source Limitations: All components listed in this section shall be provided by a single manufacturer or approved by the primary waterproofing manufacturer.
- D. Final Inspection
 - 1. Manufacturers representative shall provide a comprehensive final inspection after completion of the waterproofing system. All application errors must be addressed and final punch list completed.

1.07 PRE-INSTALLATION CONFERENCE

- A. Prior to scheduled commencement of the waterproofing installation and associated work, conduct a meeting at the project site with the installer, architect, owner, manufacturer's representative and any other persons directly involved with the performance of the work. The installer shall record conference discussions to include decisions and agreements reached (or disagreements), and furnish copies of recorded discussions to each attending party. The main

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purpose of this meeting is to review foreseeable methods and procedures related to waterproofing work.

1.08 REGULATORY REQUIREMENTS

- A. All work shall be performed in a safe, professional manner, conforming to all federal, state and local codes.
- B. All waterproofing system components shall meet current VOC regulations as established by the State in which they are being installed; and stating total VOC content, in grams per litre, for all system components (i.e. primers, adhesives, coatings, etc.)

1.09 DELIVERY, STORAGE AND HANDLING

- A. Deliver all waterproofing materials to the site in original containers, with factory seals intact.
- B. Store all pail goods in their original undamaged containers in a clean, dry location within their specified temperature range.
- C. Do not expose materials to moisture in any form before, during, or after delivery to the site. Reject delivery of materials that show evidence of contact with moisture.
- D. Remove manufacturer supplied plastic covers from materials provided with such. Use "breathable" type covers such as canvas tarpaulins to allow venting and protection from weather and moisture. Cover and protect materials at the end of each work day. Do not remove any protective tarpaulins until immediately before the material will be installed.
- E. Materials shall be stored above 55°F (12.6°C) a minimum of 24 hours prior to application.

1.10 PROJECT CONDITIONS

- A. Weather
 - 1. Proceed with waterproofing only when existing and forecasted weather conditions permit.
 - 2. Membrane application can proceed when precipitation is imminent. **Sikalastic RoofPro (Decothane)** is capable of curing, in immersion, immediately after application. Physical damage, in the form of pock marks, may occur if uncured **Sikalastic RoofPro (Decothane)** is exposed to heavy rainfall, but is not considered a limiting factor in the performance of the roofing membrane.
 - 3. Ambient temperatures should be above 32°F (0°C) when applying the system.
- B. All surfaces to receive the membrane shall be free from visible water, dew, frost, snow and ice.
- C. Application of membrane should be conducted in well ventilated areas.
- D. Over its service life, do not expose membrane to a constant temperature below -140°F (-40°C) or in excess of 140°F (60°C) (i.e., hot pipes and vents or direct steam venting, etc.).
- E. **Sikalastic RoofPro (Decothane)** is non-flammable and VOC compliant. Consult container or packaging labels and Material Safety Data Sheets (MSDS) for specific safety information.

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- F. **Sikalastic RoofPro (Decothane)** is resistant to gasoline, paraffin, fuel oil, mineral spirits, and moderate solutions of acids and alkalis, acid rain and detergents. Some low molecular weight alcohols can soften. Any exposure to foreign materials or chemical discharges must be presented to membrane manufacturer for evaluation to determine any impact on the waterproof membrane assembly performance prior to warranty issuance.
- G. Contractor shall ensure adequate protection during installation of the waterproofing system. **Sikalastic RoofPro (Decothane)** may be applied to properly prepared concrete decks, at a wet film thickness of 15-20 mils, for use as a temporary waterproofing barrier. **Sikalastic RoofPro (Decothane)** applied as a temporary waterproofing membrane does not have to be removed prior to installation of the specified waterproofing system.

1.11 WARRANTY

- A. Each warranty varies in scope and terms. Contact Liquid Plastics for exact warranty terms and conditions to meet the specific project requirements.
- B. Warranties available from the manufacturer:
1. **Watertightness Warranties**; includes labor and material. Duration **20** Years.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Sika Coporation
201 Polito Avenue
Lyndhurst, NJ 07071
Phone: 800-933-7452
Fax: 201-922-6225
www.sikaconstruction.com
- B. Substitutions: As approved in writing prior to receipt of bid and membrane must meet or exceed the performance requirements set forth in 2.04C and ASTM D7311-07.

2.02 ROOF ASSEMBLIES

- A. Basis of Design: **Sikalastic RoofPro** with Insulation
1. Control Tower Cab Roof; Steel Decking: having the following components:
 - a. **Sikalastic RoofPro**, adhered to cover board.
 - b. 5/8-inch thick Dens Deck Prime, adhered to insulation.
 - c. Sika Joint Tape SA – reinforcement of joints between Dens Deck
 - d. Two layers Factory–Mutual tested insulation adhered, providing an R-value of 30.
 - e. One-ply self-adhering 31 mil modified bitumen membrane vapor barrier, adhered to thermal barrier.
 - f. 5/8-inch Thermal Barrier mechanically attached to steel decking.

2.03 CONCRETE REPAIR

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- A. A single component, polymer modified, fiber reinforced, Portland cement based repair compound, which exhibits unique hydraulic properties to produce a rapid curing mortar with enhanced polymeric properties, **SikaQuick® Fastfill**, or equal approved by membrane manufacturer.

2.04 SEALANTS and PRIMERS

- A. A fast-drying, two-component, water-based, adducted polyamide epoxy primer for concrete, masonry and previously coated surfaces, **Sika Bonding Primer**.
- B. A two-component, solvent free, epoxy primer and damp proof membrane, which is designed to be applied to damp or new concrete with high moisture drive prior to the application of Decothane systems, **Sikalastic DTE Primer**.
- C. A two-component, cyclo-aliphatic, amine cured material with a high level of corrosion resistance for metal, modified bitumen surfaces, and chemically treated wood, **Sikalastic Epoxy Primer**
- D. A single component, polyurethane based primer for the reactivation of existing Sikalastic RoofPro (Decothane) systems prior to overcoating, **Sika Reactivation Primer**.
- E. One part polyurethane sealant suitable for sealing reglet terminations, cracks and providing a suitable transition between the waterproofing system and roof penetrations prior to the installation of the membrane system. Meets or exceeds ASTM C-920-87, Type S, Grade NS, Class 25, **Sikaflex® 1a**, or equal as approved by membrane manufacturer.

2.05 FLUID APPLIED MEMBRANE MATERIALS

- A. A conformable, random woven fiberglass mat for total reinforcement of the roofing membrane system, which provides greater impact resistance and greater resistance to excessive thermal and structural movement while maintaining elasticity and membrane film integrity, **Sika Reemat**.
- B. A nylon mesh for local reinforcement of the roofing membrane at structural cracks, expansion joints, and transitions between dissimilar materials, **Sika Flexitape Heavy**.
- C. A single component, cold, fluid applied, moisture triggered, aliphatic, polyurethane meeting the following physical properties and ASTM D7311-07: Standard Specification for Liquid Applied, Single Component, Moisture-Triggered, Aliphatic Polyurethanes used in Roofing, **Sikalastic 601 BC and Sikalastic 621 TC (Decothane EC and Decothane SP)**.

LIQUID PROPERTY REQUIREMENTS

PHYSICAL PROPERTIES	ASTM	REQUIREMENTS
VISCOSITY	D2196	5 to 20 Pa.s (pascal.seconds)
VOLUME SOLIDS	D2697	76% minimum
WEIGHT SOLIDS	D1644	83% minimum
SAG RESISTANCE	D4400	No sag at 700 micrometers (0.028 in. / 28 mil)

FILM PHYSICAL PROPERTY REQUIREMENTS

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PHYSICAL PROPERTIES	ASTM	REQUIREMENTS
TENSILE STRENGTH (TENSION)	D412	MIN 1.86 MPa (270lb/in ²)
ELONGATION	D412	MIN 200%
ACCELERATED WEATHERING FL/UV – 5000 HOURS	G154	NO CRACKING OR CHECKING
WATER VAPOR TRANSMISSION PERMEABILITY / PERMEANCE	E96	MAXIMUM 8.5 gms/m ² / day (0.033 perm-inches)
FLEXIBILITY – MANDREL BEND	D522	PASS NO CRACKING OR FLAKING
TEAR RESISTANCE	D624	MINIMUM 5.8 kN/m (33 lbf/in)
INDENTATION HARDNESS	D2240	82 Durometer Units (+/- 5 units)
DYNAMIC PUNCTURE RESISTANCE	D5635	MINIMUM 15 joules (357 ft.poundals)
STATIC PUNCTURE RESISTANCE	D5602	MINIMUM 20.7 kg. (45.5 lbs.)

2.06 FLASHING MATERIALS

- A. The fluid-applied membrane system is seamless and self-flashing. No special flashings are required for system installation.

2.07 ADDITIONAL PART 2 PRODUCTS

- A. Refer to Spec Section 07 54 19 Thermoplastic Membrane Roofing

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify that the surfaces and site conditions are ready to receive work.
- B. Verify that the deck is supported and secured.
- C. Verify that the deck is clean and smooth, free of depressions, waves, or projections, and properly sloped to drains, valleys, eaves, scuppers or gutters.
- D. Verify that the deck surfaces are dry and free of ice or snow.
- E. Verify that all roof openings or penetrations through the roof are solidly set.

3.02 SUBSTRATE PREPARATION

- A. Structural Concrete Deck
1. Minimum deck thickness for structural concrete is 4" (10.2 cm).
 2. Only poured in place concrete decks that provide bottom side drying are acceptable. Decks that are installed over non-vented metal decks or pans that remain in place may trap moisture in the deck beneath the roof system and may not be acceptable. Contact manufacturer for approval.

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3. Structural Weight Concrete: Recommend 28 days, minimum 14 days cure, dependent upon substrate moisture (less than 28% WME on a protimeter is acceptable), prior to application of the membrane.
4. Lightweight Structural Concrete: Recommend 28 days, minimum 14 days dependent upon substrate moisture (less than 28% WME on a protimeter is acceptable), prior to application of membrane. Venting of the deck from the underside is recommended to facilitate drying.
5. The above minimum cure/dry times are recommended based upon basic concrete fundamentals and experience. **Sikalastic RoofPro (Decothane)** can be applied to any cementitious substrate with a moisture content of less than the maximum 28% wood moisture equivalent (WME) as measured by a protimeter. Contact manufacturer for specifics when less than the minimum drying time is desired.
6. Light broom finish equivalent.
7. Curing agents must be checked for compatibility with waterproofing materials.
8. Sumps for the roof drains should be provided in the casting of the deck.
9. In all retrofit roof applications, it is required that deck be inspected for defects.
10. Using most effective means, prepare structural concrete deck to minimum CSP 2-4 standards, as required by manufacturer based upon actual field conditions, as outlined in International Concrete Repair Institute (ICRI) Guideline No. 03732: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
11. Patch all unsound or defective concrete with repair mortar acceptable to membrane manufacturer.

3.03 INSTALLATION - GENERAL

- A. Install **Sikalastic RoofPro (Decothane)** waterproofing system according to all current application requirements in addition to those listed in this section.

3.04 FLUID APPLIED MEMBRANE APPLICATION

- A. Surface Preparation:

1. Concrete and Masonry
 - a) All previously prepared concrete and masonry surfaces to receive the fluid applied membrane should be low-pressure (5,000 psi or less) power-washed, in accordance with ICRI Guideline No. 03732: Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays to remove all dirt, debris, or surface contamination that would compromise bonding of the waterproofing membrane system. Remove oil or grease with solvent or detergent and water. Rinse surface clean of all cleaning agent remains.
 - b) All surfaces should be blown clean using an air compressor to remove any remaining loose debris, and to facilitate the drying process.
 - c) All cracks and voids >0.040" should be routed and caulked with a single component polyurethane sealant. Allow to cure per manufacturer's instructions prior to overcoating with the waterproofing system.

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- d) At all inside corners and any gaps or voids at the juncture of the roof deck and penetrations, apply a minimum ½" bead of a single component polyurethane sealant, and allow to cure per manufacturer's instructions prior to overcoating with the waterproofing system.
 - e) Membrane terminations should be finalized prior to project start-up and documented in shop drawings, but in general, terminations should occur in raked out mortar joints, saw cut terminations, and where feasible, under installed counter-flashing materials.
 - f) Tape lines should always be used to achieve a straight and professional looking edge detail.
2. Metal
- a) All exposed metal surfaces and drain bowls to be coated must be cleaned by power tool cleaning (SSPC SP-3) to remove all corrosion deposits back to a clean, bright metal, followed by a solvent wipe prior to application of specified primer.
 - b) Fill any gaps or voids at the juncture of the roof deck penetrations with a single component polyurethane sealant, and allow to cure per manufacturer's instructions prior to overcoating with the waterproofing system.

B. Priming

1. Concrete and Masonry
- a) Mix and apply **Sika Bonding Primer** to concrete/masonry/wood surfaces by brush, roller or airless spray at a rate not to exceed 320 sf/gallon (porous, rough or absorbent surfaces will decrease coverage rate). Allow to cure and dry in accordance with manufacturer's instructions.
- Or
- b) Mix & apply **Sikalastic DTE Primer** onto the prepared and exposed concrete/masonry substrate by brush or roller at a coverage rate not to exceed 269 ft²/gallon (porous or absorbent surfaces will decrease coverage). Allow to cure and dry in accordance with the technical data sheets.
2. Metal
- a) Apply **Sikalastic Metal Primer (Epoxy Primer)** to previously prepared metal and drain bowls by brush, roller or airless spray at a rate of 200-250 SF/gallon, to achieve an overall wet film thickness of 6-8 mils. High porosity and roughness of the substrate will decrease coverage rates.
 - b) Allow to cure and dry in accordance with manufacturer's instructions.
3. Previously Applied **Sikalastic RoofPro (Decothane)**

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- a) Apply **Sika Reactivation Primer** to all previously applied **Sikalastic RoofPro (Decothane)** that has been in place longer than fourteen (14) days, by roller at a maximum coverage rate of 250 SF/gallon. Allow to cure prior to applying subsequent layers of **Sikalastic RoofPro (Decothane)**.
4. All Other Surfaces
- a) Check with manufacturer for specific priming instructions.
- C. Local Reinforcement (Cracks, Plywood Board Joints, and Dissimilar Material Transitions)
1. Apply a minimum 1" bond break at repaired cracks in concrete decks, joints between plywood sheets, and transitions between dissimilar materials, prior to applying the specified membrane system. Bond break should be installed centered over each joint or crack.
 2. Follow by applying a local stripe coat of polyurethane resin at a width a minimum of 1" wider than the reinforcement, and while wet, insert nylon tape reinforcement into the wet membrane and backroll to fully embedment adding additional material as needed.
 3. Ensure that local reinforcing mesh is not in tension during embedment.
- D. Membrane Application

The following **Sikalastic RoofPro (Decothane)** system is specified for this project. Please note, these tables specify the warranted roofing system components and do not include additional optional anti-skid or decorative finishes which may be specified.

Sikalastic RoofPro 20	Film Thickness (wet mils)	*Est. Coverage Rate (sf/gal)
Sikalastic 621 TC (Decothane SP)	45	28-32
Sikalastic 621 TC (Decothane SP)	30	45-50
<i>*Note: Coverage rates <u>include</u> a reasonable amount of wastage. Rough and textured substrates can significantly affect coverage rates.</i>		

1. The base embedment coat shall be applied to all horizontal and vertical surfaces by $\frac{1}{2}$ " - $\frac{3}{4}$ " nap roller, brush or airless spray to achieve minimum wet film thicknesses as specified above.
2. While the base embedment coat is still wet, immediately lay precut lengths of conformable reinforcing scrim (**Sika Reemat**) into the wet base embedment coat, and using a short nap roller with the appropriate roller frame and handle, roll the scrim to force the wet coating up through the scrim to achieve full saturation and embedment. Add additional material, if necessary, to ensure that the mesh is fully saturated and fully conformed to the substrate without any visible pinholes.
3. Minimum overlap of the reinforcement mesh shall be 2" in all directions. Reinforcement shall turn up all adjacent wall surfaces, etc. until the termination point is accomplished according to the project details and specifications. Membrane terminations should be finalized prior to project start-up and documented in shop drawings, but in general, terminations should occur in raked out mortar joints, saw cut terminations, and where feasible, under installed counter-flashing materials. Tape lines should always be used to achieve a straight and professional looking edge detail.

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4. Allow the base embedment coat to cure and dry prior to the next application procedure.
5. Apply top coat by nap roller, brush or airless spray to achieve minimum wet film thicknesses, as specified in table above.
6. Allow the top coat to cure and dry prior to the next application procedure.

E. Anti-Skid/Decorative Finishes

1. Field Mockup: It is highly recommended that sample mockup(s) be installed using selected quartz size, textures, colors, etc. prior to installation for review and approval by the owner or owner's representative.
2. Silica Quartz **Broadcast**
 - (a) Apply **Sikalastic 621 TC (Decothane SP) or Sikalastic 624 AR (Decothane Balcons)** to the previously cured top coat of the waterproofing system at a wet film thickness (wft) of 15 mils (approximately 100 square feet per gallon) to all areas where an anti-skid finish is required;
 - (b) While the top coat is still wet; broadcast clean, clear silica quartz, until fully beached. Size and texture to be selected by the owner or owner's designated representative
 - (c) Once the top coat is cured, remove all loose/excess silica quartz
 - (d) Apply a "lock-down" coat of **Sikalastic 621 TC (Decothane SP) or Sikalastic 624 AR (Decothane Balcons)** to all areas at a wet film thickness (wft) of 15 mils (approximately 100 square feet per gallon), ensuring complete coverage of the broadcast quartz.

3.05 FLASHINGS

A. Parapet and Building Walls:

1. Terminate the **Sikalastic RoofPro** fluid applied membrane at a tape-line to ensure a clean edge.
2. Where possible, terminate the fluid applied membrane within a sawcut reglet and finish the reglet with **Sikaflex 1a**, single component polyurethane sealant.
3. Metal counterflashings are optional, but recommended.
4. Flash wall scuppers with a coated metal insert that is mechanically attached to the wall and integrated as part of the fluid applied membrane.

B. Roof Drains:

1. Remove the strainer basket and clamping ring from the drain bowl prior to membrane application.
2. Replace the drain bowl bolts prior to application
3. Extend the Decothane fluid applied waterproofing membrane directly into the throat of the prepared drain.
4. Remove drain bowl bolts, replace clamping ring and trainer, and resecure.

3.06 MANDATORY TESTING

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- A. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D 5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
 - a. Perform tests before overlying construction is placed.
 - b. Flood to an average depth of 2-1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.
 - c. Flood each area for 48 hours.
 - d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.
 - i. The Contractor is responsible for repairing any materials damaged as a result of flood testing.
 - ii. Cost of retesting is Contractor's responsibility.
 - e. Testing agency shall prepare survey report indicating locations of initial leaks, if any, and final survey report.

3.07 ROOF PROTECTION

- A. Protect all partially and fully completed waterproofing work from other trades until completion.
- B. Whenever possible, stage materials in such a manner that foot traffic is minimized over completed roof areas.
- C. When it is not possible to stage materials away from locations where partial or complete installation has taken place, temporary walkways and platforms shall be installed in order to protect all completed roof areas from traffic and point loading during the application process.
- D. Temporary tie-ins shall be installed at the end of each workday and removed prior to commencement of work the following day.

3.08 CLEAN-UP

- A. All work areas are to be kept clean, clear and free of debris at all times.
- B. Do not allow trash, waste, or debris to collect on the roof. These items shall be removed from the roof on a daily basis.
- C. All tools and unused materials must be collected at the end of each workday and stored properly off of the finished roof surface and protected from exposure to the elements.
- D. Dispose of or recycle all trash and excess material in a manner conforming to current EPA regulations and local laws.
- E. Properly clean the finished roof surface after completion, and make sure the drains and gutters are not clogged.
- F. Clean and restore all damaged surfaces to their original condition.

END OF SECTION

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SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Flashings and counterflashings, gutters and downspouts, metal coping, metal edge and fabricated sheet metal items.
 2. Sheet metal accessories

1.02 RELATED SECTIONS

- A. Related Sections include the following:
1. Division 5, Section 05 52 13 – “Wall Mounted Guard Rail”
 2. Division 6, Section 06 10 00 – “Carpentry Work for Roofing”
 3. Division 7, Section 07 54 19 – “Thermoplastic Membrane Roofing”
 4. Division 7, Section 07 71 00 – “Roof Hatch”
 5. Division 7, Section 07 92 00 – “Joint Sealants”
 6. Division 15, Section 15 01 00 – “Basic Mechanical Requirements”

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM):
1. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 2. A653 - Steel Sheet, Zinc Coated, (galvanized) by the Hot-Dip process, Structural (Physical) Quality Property.
 3. A924 - Steel Sheet, Zinc Coated, (galvanized) by the Hot-Dip process.
- B. Federal Specifications (FS):
1. FS TT-C-494 - Coating Compound, Bituminous, Solvent Type, Acid Resistant.
 2. Q-F-506 - Flux, Soldering, Paste and liquid.
 3. QQ0L-201F - Lead Sheet.
 4. QQ-S-571 - Solder, Tin Alloy
- C. National Roofing Contractors Association (NRCA): Roofing and Waterproofing Manual.
- D. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA): Architectural Sheet Metal Manual, current edition.

1.04 SYSTEM DESCRIPTION

- A. Work of this Section is to physically protect membrane roofing, base flashings, and expansion joints from damage that would permit leakage to building interior.

1.05 SUBMITTALS

- A. Section 01330 - Submittal Procedures: Procedures for submittals.
1. Product Data: Provide data on prefabricated components.
 2. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
 3. Samples: Provide full sized sample of metal flashing illustrating typical seam, external corner, internal corner, material, and finish.
 4. Submit color chart or physical samples for selection of prefinished metal color by the Owner.
 5. Assurance/Control Submittals:
 - a. Certificates: Manufacturer's certificate that Products meet or exceed specified requirements.

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- b. Qualification Documentation: Submit documentation of experience indicating compliance with specified qualification requirements.

1.06 QUALITY ASSURANCE

- A. Standards: Comply with latest edition of standards specified in this section and as referenced below:
1. ANSI/SPRI ES -1
 2. Architectural Sheet Metal Manual, Sheet Metal and Air Conditioning Contractors
 3. The NRCA Roofing and Waterproofing Manual, Latest Edition - National Roofing Contractors Association
 4. Published installation from manufacturer's of selected products.
 5. Annual Book of ASTM Standard, Latest Edition - ASTM International
- B. Qualifications:
1. Fabricator: Company specializing in manufacturing Products specified with minimum 3 years documented experience.
 2. Installer: Company specializing in performing the Work of this Section with minimum 3 years documented experience. Use adequate number of skilled workers who are thoroughly trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements and methods needed for proper performance of the work in this section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Product Requirements: Transport, handle, store, and protect Products
- B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- C. Prevent contact with materials during storage and installation that may cause discoloration, staining, or damage.

1.08 WARRANTY

- A. All new materials and workmanship provided under this section of the specifications shall be guaranteed in writing by the Contractor to maintain all sheet metal flashing in a watertight condition without cost to the Owner for a period of five years after date of substantial completion.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Aluminum Sheet: ASTM B209, 3004 alloy, 0.040 inch thick.
- B. Galvanized Steel: ASTM A 653, Grade A, G90, 24-gauge minimum core steel.
- C. Lead: FS QQ-L-201F, 4-lb/sq ft and 2-1/2-lb/sq ft.
- D. SarnaClad Galvanized Steel: ASTM A 653, 25-gauge minimum with 20-mil (1mm) unsupported Sarnafil membrane laminated on one side. The color of the Sarnaclad metal shall be white.
- E. Pre-Finished Galvanized Steel: ASTM A 653, Grade A, G90, 24-gauge minimum core steel, exposed face pre-finished with fluorocarbon type coating (Kynar⁷ 500), color as selected by Owner's Representative from manufacturer's standard color selections; unexposed face finished with manufacturer's standard primer; manufactured by Centria; PAC-CLAD; Berridge Manufacturing Company; or MBCI. Protect finish with factory applied plastic film.

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- F. Pre-Finished Edge Grip Fascia: A two-part assembly with a rigid terminator base plate and decorative snap on fascia cover. The fascia will be formed 24 ga. Kynar 500 coated galvanized steel and with concealed splices plates. Retainer base plate will be 20-gauge galvanized steel with 9/23" pre-punched holes for fasteners at 12" (304.8 mm) on center in 10' - 0" (304.8 mm) standard lengths. Color as selected by Owner's Representative from manufacturer's standard color selections.
- G. Copper: ASTM B 370, cold rolled temper, commercially pure alloy 110; minimum 16 ounces per foot.
- H. Stainless Steel: ASTM A 167, Type 302/304, soft temper, 24-gauge minimum, No. 2B finish.
- I. Where sheet metal is required, and material or gauge is indicated on the drawings, provide the highest quality and gauge commensurate with the referenced standards.
- J. Contractor shall use gauges or thickness listed in the referenced standards for specific girths.
- K. Continuous clip shall be fabricated with material one gauge heavier than connecting.

2.02 COMPONENTS

- A. Counter and Slip Flashings, Base and Cover Plates, End Caps, Joint Fasteners, and Gravel Stop: Profiled as indicated and to suit existing conditions.
- B. Downspouts: Rectangular profile; fabricated from Pre-Finished Galvanized Steel.
- C. Counter and Slip Flashings, Base and Cover Plates, End Caps, Joint Fasteners, and Gravel Stops, Scupper Sleeves and Boxes: Profiled as indicated and to suit existing conditions.
- D. End Caps, Downspout Outlets, Gutter and Downspout Support Brackets and Straps, Joint Fasteners, Gutters, Downspout Strainers, Downspout Header, and Scupper Boxes: Profiled to suit gutters and downspouts.
- E. Insulated wall panel end cap enclosure; fabricated from 18-gauge galvanized steel.

2.03 FASTENERS

- A. Manufacturers:
 - 1. Construction Fasteners, Inc.
 - 2. Hilti
 - 3. OMG
 - 4. Powers
 - 5. Simplex
- B. Fasteners and Anchorage Devices: Comply with SMACNA requirements, unless otherwise indicated.
 - 1. Appropriate for purpose intended, approved by Factory Mutual where required.
 - 2. Rust-resistant and compatible with materials to be joined.
 - a. Ferrous Metals: Stainless steel, finish of exposed fasteners same as flashing metal.
 - b. Rivets: Stainless steel (rivet and mandrel), Series 44.
 - 3. Length: As required for thickness of material to penetrate substrate 1/2-inch minimum.
 - 4. Exposed Fasteners: Provide metal-jacketed neoprene washers, jacket color to match pre-finished sheet metal.
- C. Mechanical Fasteners for Sheet Metal to Substrate Anchorage:
 - 1. Masonry: One-step, screw-type drive anchor (nailing); heat-treated, stress relieved, stainless steel pin; zinc jacketed; sized for intended application; minimum 1-1/4-inch length x 1/4-inch diameter; Hammer-Screw® manufactured by Powers Fasteners, Inc.

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2. Wood Blocking: Hexagonal head screws, stainless steel, with neoprene rubber washers with jacket color to match pre-finished sheet metal.
 3. Concrete: Same as masonry or other power actuated fasteners, suitable for application.
- D. Roofing Nails: Hot-dipped galvanized or non-ferrous type, with annular rings, size as required to suit application, minimum 11-gauge with 3/8-inch diameter head.
- E. Mechanical Fasteners for Sheet Metal to Metal Fabrications (Support Framing) Anchorage: Appropriate for purpose intended, size as required to suit application and achieve positive anchorage to substrate material.

2.04 ACCESSORIES

- A. Solder: FS QQ-S-571, 50/50 type.
- B. Flux: FS O-F-506.
- C. Metal Primer: Zinc-rich, or Zinc Chromate, compatible with metal and substrate material.
- D. Reglets/Receivers: Surface mounted or recessed pre-finished steel, face, and ends covered with plastic tape.
- E. Downspout Supports: Brackets; Pre-Finished Galvanized Steel.
- F. Sealant: As specified in Section 07900. Urethane.
 1. Metal Contact: Type I.
 2. Pitch Pan Filler: Type II.
- F. Vent Pipe, Piping, and Electrical Conduit Flashings: Preformed Sarnafil G membrane pipe flashings, minimum height above roof: 8 inches.
- G. Roof Drain Flashings: Sarnafil G membrane flashing extended minimum 36-inches beyond drain bowl in all directions.
- H. Aluminum Tape: Pressure sensitive aluminum tape, approved by membrane manufacturer.
- I. G410 or G459 Membrane: Fiberglass reinforced membrane manufactured by membrane manufacturer.
- J. Substitutions: Under provisions of Section 01600.

2.05 SHEET METAL FABRICATION

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architctural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.
 1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Form all sheet metal sections and components (except corners) in longest practical length up to 10-feet maximum, true to shape, accurate in size, square, and free from distortion or defects detrimental to appearance or performance.

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- C. Fabricate continuous cleats and starter strips of same material as sheet, interlocking with sheet.
- D. Form pieces in longest possible lengths.
- E. Hem exposed edges on underside ½-inch, miter, and seam corners.
- F. Form all sheet metal material to provide watertight joints. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
 - 1. Unprotected Horizontal Surface (expansion joint covers, etc.) Standing seam or drive cleat joints.
 - 2. Vertical Surfaces (copings, cap flashings, etc.): Cover and backer plate seams.
 - 3. Fabricate all components, i.e. coping cap, with horizontal (flat) surfaces with built-in slope for drainage toward roof unless indicated otherwise.
- F. Formed Sheet Perimeter Metal:
 - 1. Fabricate to size and profile to match existing conditions.
 - 2. Supply sections with minimum length of 8 feet, but not exceeding 10 feet.
 - 3. Fabricate metal corners to form one piece with minimum 18 inches and maximum 36-inch long legs.
 - 4. Fabricate joint plates of same sheet thickness as copings.
 - 5. Securement:
 - a. External Leg: Continuous cleats, no exposed fasteners.
 - b. Internal Leg: Color-matched fasteners in slotted holes.
 - 6. Miter corners, seal, and solder watertight.
 - 7. Joint Style:
 - a. ¼ inch Butt Joint with 6 inches wide, exposed cover plate.
- G. Fabricate corners on all sheet metal components (copings, cap flashings, etc.) to form one piece with minimum 18-inch and maximum 36-inch long legs.
- H. Prefabricate all sheet metal accessory components (pitch pans, utility sleeves, umbrellas, etc.) as much as practical.
- I. Gutter and Downspouts: Form in sections from minimum Pre-Finished 24-gage sheet metal with all required special pieces and accessories. Owner's Representative shall select gutter and downspout color from manufacturer's standard color. Gutter and downspouts shall be form to the profiles and sizes accord to SMACNA requirements.
- J. Fabricate downspout accessories; solder watertight.
- K. Miter all sheet metals corners and solder, weld, tape, or fasten and seal all joints watertight:
 - 1. SarnaClad: Cover joints with 2-inch wide aluminum tape and heat weld 4-inch wide G410 Membrane over aluminum tape.
 - 2. Pre-finished Galvanized Steel: Apply minimum ¼-inch bead of sealant between connecting metal flanges and drill and fasten with rivets at 2-inches on center.
 - 3. Unfinished Galvanized Steel: Solder joints watertight.
 - a. After soldering, remove flux. Wipe and wash solder joints clean.
 - 4. Install sealant so it will not be visible on outside of joints.
- I. Fabricate elements complete with required connection pieces.
- J. Fabricate all components with allowance for expansion at joints. Provide enlarged or oval holes at all piercing fasteners.

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- K. Integral Scuppers: Locate integral scuppers along length of roof edge. Fabricate to the existing roof scupper dimensions. Include a minimum 4 inches wide flange on three sides for embedment into the roofing system.
- L. Through Wall Parapet Scuppers:
 - 1. Fabricate scuppers of dimensions to match existing conditions with closure flange trim to exterior, four inches wide flanges to interior, and base extending four inches beyond interior edge of the parapet wall and into the field of the roof. Fasten flange to the wood nailer, which has been securely fastening to the roof's substrate.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify that field measurements, surfaces, substrates, and conditions are as required, and ready to receive Work.
 - 1. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
 - 2. Verify roofing termination and base flashings are in place, sealed, and secure.
- B. Report in writing to Owner's Representative prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.
- C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.02 PREPARATION

- A. Field measure site conditions prior to fabricating Work. Contractor shall be responsible for all dimensions for all sheet metal applications and installations.
- B. Apply manufacturer's approved protective backing paint, to a minimum dry film thickness of 15-mil, on surfaces in contact with dissimilar materials.

3.03 INSTALLATION - VARIOUS SHEET METAL COMPONENTS

- A. Install starter and edge strips, and cleats before starting installation.
- B. Install reglets and / or receivers on vertical surfaces to receive counterflashings.
 - 1. Sawcut new reglets where required.
 - a. Install receiver component and anchor with lead wedges at 12-inches on center.
 - b. Provide bayonet style lap joints, minimum 4-inch overlap.
 - c. Fill voids between wedges with backer rod.
 - d. Seal receiver to vertical face of wall.
 - 2. Install surface mounted reglets true to lines and levels.
 - a. Fasten to substrate with neoprene head screws at 12-inches on center maximum.
 - b. Seal top of reglets with sealant.
- C. Insert flashings into reglets or receivers to form tight fit. Apply 1/4-inch bead of sealant and lap sheet metal minimum 4-inches.
 - 1. Reglets: Secure in place with plastic wedges at maximum 6-inches on center.
 - 2. Receivers: Secure in place with neoprene head screws at maximum 12-inches on center.

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3. Seal flashings into reglets with sealant.
-
- D. Secure flashings in place using concealed fasteners. Use exposed fasteners only in locations approved by Owner's Representative.
 - E. Metal coping shall be secured to the parapet with a continuous metal cleat. The 22-gauge metal cleat shall be secured with appropriate fastener, spaced 12 inches on center, to both sides of the parapet wall.
 - F. Fit flashings tight in place. Make corners square surfaces true and straight in planes and lines accurate to profiles.
 - G. Provide minimum 6-inch wide backer and corner plates at copings. Fit to ensure complete and permanent watertight seal of joints.
 1. Apply ¼-inch bead of sealant between each layer of metal at each edge.
 2. Corner and Backer Plates: Secure with the Backer Plates by using appropriate fasteners and securing to the parapet wall.
 3. Cover Plates: Hook front or exposed face of cover plate over drip edge; and enclosing or clamping interior seam to the metal coping drip edge.
 4. Do not use mastic between sheet metal components.
 - H. Where indicated in project drawings, provide perimeter metal edging form from the Pre-Finished Edge Grip Fascia. Fascia width shall exceed a minimum of 2 inches below the wood nailer.
 - I. Provide metal scuppers form from the PVC Coated metal at all roof scuppers. Contractor to verify scupper dimension prior to fabrication of the metal scuppers.
 - J. Lock and seal all sheet metal joints watertight.
 - K. Provide Stainless Steel Rain Hoods and Umbrellas at all hot stacks, hot pipe penetrations, and at insulated pipe penetrations.
 - L. For enclosing top of insulated wall panels, fabricated from 18-gauge galvanized metal, an enclosure metal cap. The metal cap dimension shall be the approximate ½ inch wider than the width of the insulated wall panel with approximate of a minimum of 6 inches.
 - M. **Pitch pans are not desired.** Construct pitch pans from Sarnaclad metal. Install only where specifically indicated or approved by Owner's Representative. Provide flanged umbrellas at all pitch pans.
 1. Fill with non-shrink group to 1-inch from top of flange.
 2. Top with Pitch Pan Filler - Sealant Type II.
 - M. Protect all membrane penetrations as indicated and as recommended in SMACNA and NRCA manuals.

3.05 SCHEDULE - MATERIALS

- A. Exposed to View Components:
 1. Through Wall Scuppers: Sarnaclad, color to be selected from standard colors.
 2. Scupper Face Plate: Prefinished galvanized steel
 3. Metal Coping and associated components: Prefinished galvanized steel.
 4. Perimeter Metal Edge: Sarnaclad; color to be selected from standard colors.
 5. Wrap downspout straps and other heavy gauge materials with prefinished galvanized steel.
- B. Concealed Components, (Counterflashings, Etc.): Unfinished 24-gauge galvanized steel.
- C. Drip Pans Accessories: Stainless steel

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- D. Rain Hoods and Umbrellas: Stainless steel.

3.06 SCHEDULE - MINIMUM STEEL THICKNESS

- A. Metal Copings, Metal Coving Caps, Scupper Face Plate, and Counter flashing: ASTM A 653, Grade A, G90, 24-gauge minimum core steel.
- B. Perimeter Metal Fascia: ASTM A 653, Grade A, G90, 24-gauge minimum core steel.
- C. PVC Coated Metal: 24-gauge minimum core steel.
- D. Rain Hoods and Umbrellas: Stainless Steel 24-gauge.
- E. Hook Cleats: 22-gauge minimum core steel.
- F. Insulated wall panel end cap enclosure: 18-gauge.

3.06 TESTING AND ADJUSTING

- A. Per Section 01400, test all modified, relocated, and new systems and equipment.
- B. Correct all deficiencies identified, including replacement of parts and components when required.
- C. Adjust all Products and equipment to ensure proper operation and function.

3.07 CLEANING

- A. Clean work under provisions of Section 01700.
- B. Clean Owner-occupied areas when soiled by Work or operations of this Division.

END OF SECTION

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SECTION 07710 - ROOF HATCH

PART ONE - GENERAL

1.01 SUMMARY

- A. Work included: Furnishing and installing factory fabricated roof hatches
- B. Related Work:
 - 1. Single Ply Membrane Roofing: Division 7.
 - 2. Flashing and Sheet Metal: Division 7 Flashing and Sheet Metal Section.

1.02 RELATED SECTIONS

- A. Related Sections include the following:
 - 1. Division 6, Section 06 10 00 – “Carpentry Work for Roofing”
 - 2. Division 7, Section 07 54 19 – “Thermoplastic Membrane Roofing”
 - 3. Division 7, Section 07 62 00 – “Sheet Metal Flashing and Trim”
 - 4. Division 7, Section 07 92 00 – “Joint Sealants”
 - 5. Division 15, Section 15 01 00 – “Basic Mechanical Requirements”

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM), 100 Bar Harbor Drive, West Conshocken, PA 19428-2959; (610) 832-9585, fax (610) 832-9555
 - 1. ASTM A 36-93a: Standard Specification for Structural Steel
- B. Federal Aviation Administration (FAA):
 - 1. JO 3900.63A – Air Traffic Organization Fall Protection Program

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer’s product data for all materials in this specification.
- B. Shop Drawings: Show profiles, accessories, location, and dimensions.
- C. Samples: Manufacturer to provide upon request; sized to represent material adequately.
- D. Contract Closeout: Roof hatch manufacturer shall provide the manufacturer’s Warranty prior to the contract closeout.

1.05 PRODUCT HANDLING

- A. All materials shall be delivered in manufacturer’s original packaging.
- B. Store materials in a dry, protected, well-vented area. The contractor shall thoroughly inspect product upon receipt and report damaged material immediately to delivering carrier and note such damage on the carrier’s freight bill of lading.
- C. Remove protective wrapping immediately after installation.

1.06 SUBSTITUTIONS

- A. Proposals for substitution products shall be accepted only from bidding contractors and not less than (10)

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working days before bid due date. Contractor guarantees that proposed substitution shall meet the performance and quality standards of this specification.

1.07 JOB CONDITIONS

- A. Verify that other trades with related work are complete before installing roof hatch(s).
- B. Mounting surfaces shall be straight and secure; substrates shall be of proper width.
- C. Refer to the construction documents, shop drawings, and manufacturer's installation instructions.
- D. Coordinate installation with roof membrane and roof insulation manufacturer's instructions before starting.
- E. Observe all appropriate OSHA safety guidelines for this work.

1.08 WARRANTY/GUARANTEE

- A. Manufacturer's standard warranty: Roof Hatch shall be free of defects in material and workmanship for a period of five years from the date of purchase. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge. Electrical motors, special finishes, and other special equipment (if applicable) shall be warranted separately by the manufacturers of those products.

PART TWO - PRODUCTS

2.01 MANUFACTURER

- 1. Approved Manufacturers
 - 1. The BILCO Company, P.O. Box 1203, New Haven, CT 06505
1-203-934-6363, Fax: 1-203-933-8478, Web: www.bilco.com
 - 2. Owner Approved Equal.

2.02 ROOF HATCH

- A. Furnish and install where indicated on plans, size to match existing roof hatch(s). The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer and made from galvanized steel.
- B. Roof Hatch Type: Type S roof hatch.
- B. Performance characteristics:
 - 1. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m2) with a maximum deflection of 1/150th of the span or 20 psf wind uplift.
 - 2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
 - 3. Operation of the cover shall not be affected by temperature.
 - 4. Entire hatch shall be weathertight with fully welded corner joints on cover and curb.
- C. Cover: Shall be 14 gauge paint bond G-90 galvanized steel with a 3" (76mm) beaded flange with formed reinforcing members. Cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- D. Cover insulation: Shall be fiberglass of 1" (25.4mm) thickness, fully covered and protected by a metal liner 22 gauge paint bond G-90 galvanized steel.

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- E. Curb: Shall be a minimum 12" (305mm) in height and of 14 gauge paint bond G-90 galvanized steel. The curb shall be formed with a 3-1/2" (89mm) flange with 7/16" (11.1mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, that features the Bil-Clip® flashing system, including stamped tabs, 6" (153mm) on center, to be bent inward to hold single ply roofing membrane securely in place.
- F. Curb insulation: Shall be rigid, high-density polyisocyanurate of 1" (25.4mm) thickness on outside of curb.
- G. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe for steel construction: through bolted to the curb assembly.
- H. Hardware
 - 1. Heavy pintle hinges shall be provided
 - 2. Cover shall be equipped with a spring latch with interior and exterior turn handles
 - 3. Roof hatch shall be equipped with interior and exterior padlock hasps.
 - 4. The latch strike shall be a stamped component bolted to the curb assembly.
 - 5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25.4mm) diameter red vinyl grip handle to permit easy release for closing.
 - 6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed. Springs shall have an electrocoated acrylic finish for corrosion resistance.
 - 7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
- I. Finishes: Factory finish shall be alkyd based red oxide primed steel. (Note: Contractor is to paint the curbs with two coats of approved enamel paint. Color to be selected by owner's representative.)

2.03 ROOF HATCH GUARDRAIL

- A. Furnish and install a Roof Hatch Safety Rail System at each roof hatch. The hatch rail system shall be field assembled and installed per the manufacturer's instructions.
 - 2. Approved Manufacturers
 - a. The BILCO Company, P.O. Box 1203, New Haven, CT 06505
1-203-934-6363, Fax: 1-203-933-8478, Web: www.bilco.com
 - b. Leading Edge Safety, LLC, 1345 Taney St.; North Kansas City, MO 64116;
Toll Free Tel: 888-990-2990; Fax: 816-472-0822;
Email: request info (sales@leadingedgesafety.net); Web: <https://leadingedgesafety.net>
 - c. .Owner Approved Equal.
- B. Product: Roof Hatch Guardrail-Powder Coated Steel as manufactured by Leading Edge Safety.
 - 1. System Design: Roof Hatch Guardrail with patented GrabSafe horizontal hand-holds and self-closing gate provides safe egress and ingress through roof hatches in addition to providing protection against accidental falls through the roof opening while the roof hatch is open. GrabSafe horizontal hand-holds act as an extension of the ladder for more comfortable and safe climbing and allows pass-through to the roof surface. Guardrail extensions create a landing area for safe transition to the roof surface before operating the gate. Self-closing gate ensures full perimeter protection.
 - 2. Standards: Meets and exceeds OSHA Standards CAL-OSHA Section 3212, CAL-OSHA Section 3209, ANSI/ASSE A1264.1-2007, ANSI/ASSE A14.3-2008 section 5.3.4.3 and US Army Corps of Engineer Requirement EM 385-1-1.
- C. Components:
 - 1. Uprights: 1.625 inches x .065 inch steel tube (ASTM C1008/1010) welded to 10 gauge steel (ASTM A1011 CS Type B) bracket with 3/8 inch pre-punched slots for thru-bolt attachment.

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2. Horizontal Rails: 1.625 inches x .065 inch (ASTM C1008/1010) and 1.375 inches x .065 inch (ASTM C1008/1010) steel tube adjustable slide rails.
3. GrabSafe: 1 inch x 10.5 inches steel tube (ASTM A513) welded to 10 gauge steel (ASTM A1011 CS Type B) bracket.
4. Self-Closing Gate: 1.625 inches x .065 inch steel tube (ASTM C1008/1010), 16 gauge steel plate (ASTM A1008 CS Type B).
5. Finish: Powder coated steel.
6. Colors: Numerous colors to match Kynar sheet metal, building components and RAL colors.
7. Hardware: 3/8 inch-16 x 1 inch zinc plated steel.
8. Labels: Applicable safety warnings and manufacturer's contact information.
9. Size: Match roof hatch.

2.04 Requirements. Major requirements are summarized below. The systems are listed in the order of preference for use. (FAA JO 3900.63A Appendix J)

- B. Guardrail Systems. These systems must meet the following criteria:
1. Systems must be 42 inches, in height, with a maximum opening of 19 inches between any midrails associated with the railing system.
 2. Toeboards must be solid and a minimum of three and one half (3.5) inches high and not have more than 1/4" clearance above the walking-working surface with no openings greater than 1 inch in any dimension.
 3. The system must have a capability of withstanding 200 pounds of outward/downward force at the top rail, 150 pounds of outward/downward force at the midrail and 50 pounds of outward force at the toeboard.
 4. If a guardrail system is used, the ladderway or stairway opening must also be guarded or so offset that a person cannot walk directly into the opening.
 5. Openings at the work platform floor used for access from an internal ladder must be equipped with a hatch that can be fully closed after entry into the work platform, and the closed hatch must be capable of supporting 250 pounds or the maximum intended load, whichever is greater.
 6. When hatches are associated with elevated platforms or rooftops, they must be secured against accidental displacement.

PART THREE - EXECUTION**3.01 INSPECTION**

- A. Verify that roof hatch installation will not disrupt other trades. Verify that the substrate is dry, clean, and free of foreign matter. Report and correct defects prior to any installation.

3.02 INSTALLATION

- A. Submit product design drawings for review and approval to the owner's representative before fabrication.
- B. The installer shall check as-built conditions and verify the manufacturer's roof hatch and hatch rail system details for accuracy to fit the application prior to fabrication and installation.
- C. The installer shall comply with the Roof Hatch and Hatch Rail System Manufacturer's installation instructions.
- D. The manufacturer shall furnish fasteners necessary for installing hatch rail system on hatch.

END OF SECTION

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SECTION 07920
WEATHERPROOFING SILICONE SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section covers exterior weatherproofing silicone sealant material and application.
- B. The manufacturers' application instructions for each product used are considered part of this specification and should be followed at all times.

1.2 RELATED WORK:

- A. Elastomeric Wall Coating: Section 07120.

1.3 QUALITY CONTROL:

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results from a qualified testing agency based on testing current sealant formulations within a 12-month period.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct testing indicated, as documented according to ASTM E548.
 - 2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920, and where applicable, to other standard test methods.
- D. A Mock-Ups:
 - 1. Prepare mock-ups for sealants and for each type of surface using same materials, tools, equipment, and procedures intended for actual surface preparation and application under actual use and environmental conditions.
 - 2. Verify adhesion of sealants and compatibility of material(s) in contact with or in close proximity to sealants.
 - 3. Test for sealant and surface staining or discoloration.
 - 4. Obtain Resident Engineer's (RE) approval of mock-ups.
 - 5. Retain mock-ups to establish intended standards by which sealants will be judged.

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1.4 SUBMITTALS:

- A. Comply with Submittals in Division 1 - Submittal Procedures.
- B. Manufacturer's installation instructions for each product used.
- C. Cured samples of exposed sealants for each color where required to match adjacent material.
- D. Manufacturer's Literature and Data:
 - 1. Primers
 - 2. Sealing compound, each type, including compatibility when different sealants are in contact with each other.
 - 3. Back-up rod.
- E. Product Data: Submit manufacturer's product data, including joint design, surface preparation, and application instructions.
- F. Color Samples: Submit manufacturer's color samples.
- G. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
- H. Warranty: Submit manufacturer's standard sample warranty.
- I. Applicator Approval: Submit letter from manufacturer stating applicator is approved to install the concrete deck coating system.

1.5 PROJECT CONDITIONS:

- A. Environmental Limitations:
 - 1. Do not proceed with installation of joint sealants under following conditions:
 - a. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 °C (40 °F).
 - b. When joint substrates are wet.
- B. Joint-Width Conditions:
 - 1. Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions:
 - 1. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.6 DELIVERY, HANDLING, AND STORAGE:

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying
 - 1. Product name.
 - 2. Manufacturer.

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3. Sealant color.
4. Sealant batch or lot number.
5. Sealant use-before date.

B. Storage:

1. Store materials in a clean, dry area indoors in accordance with manufacturer's instructions.
2. Store sealants within temperature range in accordance with manufacturer's instructions.
3. Keep containers sealed until ready for use.
4. Do not use materials after manufacturer's use-before date.

C. Handling: Protect materials from damage and contamination during handling and application.

1.7 DEFINITIONS:

- A. Definitions of terms in accordance with ASTM C717 and as specified.
- B. Back-up Rod: A type of sealant backing.
- C. Bond Breakers: A type of sealant backing.
- D. Filler: A sealant backing used behind a back-up rod.

1.8 QUALITY ASSURANCE AND GUARANTY:

- A. Applicator Qualifications: Applicators shall be approved to install specified system by the product manufacturer.
- B. Guaranty exterior sealing against leaks, adhesion, and cohesive failure, and subject to terms of "Guaranty" Article specified in Section 01740, GENERAL CONDITIONS, except that guaranty period shall be extended to twenty (20) years.
- C. General Guaranty:
 1. Special guarantees specified in this Article shall not deprive Government of other rights Government may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other guarantees made by Contractor under requirements of Contract Documents.
- D. Product manufacturer approved contractor for twenty (20) yeas guaranty.

1.9 APPLICABLE PUBLICATIONS AND REFERENCES:

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - C509-94..... Elastomeric Cellular Preformed Gasket and Sealing Material.
 - C717-99..... Standard Terminology of Building Seals and Sealants.

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- C919-98..... Use of Sealants in Acoustical Applications.
- C920-98..... Elastomeric Joint Sealants.
- C1193-91..... Standard Guide for Use of Joint Sealants.
- C510 - Staining and Color Change of Single or Multi-Component Joint Sealants.
- C639 - Rheological (Flow) Properties of Elastomeric Sealants.
- C920 - Elastomeric Joint Sealants.
- C794 – Adhesion-in-Peel of Elastomeric Joint Sealants.
- C1248 – Staining of Porous Substrate by Joint Sealants.
- C. Federal Specification TT-S-00230C - Sealing Component, Elastomeric Type, Single Component.
- D. Federal Specification TT-S-001543B - Sealing Compound: Silicone Rubber Base (For Sealing, and Glazing in Buildings and Other Structures).
- E. Sealant, Waterproofing and Restoration Institute (SWRI).
The Professionals' Guide

PART 2 - PRODUCTS

2.1 SEALANTS:

- A. Silicone Sealant shall be GE SilPruf SCS2000 or meeting the following characteristics:
 - 1. Description: One-component, medium-modulus, high strength, neutral-cure, 100% silicone polymer sealant.
 - 2. Compliance:
 - a. ASTM C 920, Type S, Grade NS, Class 25.
 - b. Federal Specification TT-S-001543B.
 - c. Federal Specification TT-S-00230C.
 - 3. Properties: After 21 days @ 70° F and 50% relative humidity.
 - a. Dynamic Movement Capability, ASTM C 719: +/-50%.
 - 4. Application: Field applied as indicated on the drawings.
 - 5. Color: To be selected by RE
 - 6. Compatible with GE SilShield SEC3100 coating.
 - 7. Compatible with GE SS4044P sealant primer.

2.2 JOINT SEALANT BACKING:

- A. General: Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are

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approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Material: Non-gassing polyethylene or flexible polyurethane foam rod.
 2. Width: 25 to 50 percent greater than width of joint to extend continuous pressure against joint walls.
 3. Material must expand and contract with bead movement without pushing sealant out of joint during compression cycle.
 4. Do not use rubber backup materials, unless tested for compatibility with sealants and approved by RE.
- B. Cylindrical Sealant Backings: ASTM C1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
1. Type C: Closed-cell material with a surface skin.
- C. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 32 °C (minus 26 °F). Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and otherwise contribute to optimum sealant performance.
- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.3 FILLER:

- A. Mineral fiber board: ASTM C612, Class 1.
- B. Thickness same as joint width.
- C. Depth to fill void completely behind back-up rod.

2.4 PRIMER:

- A. Apply primer, SS4044P, as recommended by manufacturer of sealant and material.
- B. Stain free type.
- C. Perform trial applications to check adhesion of sealants to specific materials to be used.
- D. Allow primer to dry before applying sealant.

2.5 MASKING:

1. Apply masking tape to surfaces as required to ensure a neat application of sealants and to protect adjoining surfaces.

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2. Do not allow masking tape to touch clean surfaces to which sealants are to adhere.
3. Remove masking tape immediately after tooling and before sealants begin to cure.

PART 3 - EXECUTION

3.0 REMOVAL OF EXISTING SEALANT

- A. Remove existing urethane sealant down to the bond line with suitable sharp knife or reciprocating cutting blades. Scrape or cut as much urethane sealant as possible from the surfaces.
- B. On porous substrates, concrete, brick, stone, etc., grind or saw cut the surface to remove all traces of urethane sealant. Diamond blades work faster and do not gum up as fast as carbide blades.
- C. On non-porous substrates, metal, glass, etc., remove any residues of polyurethane with synthetic abrasive pads, Scotch Brite, or similar, and suitable solvent (MEK, IPA, Xylene, etc.). A fine two rag wipe should remove any final residues.
 1. Two Rag Wipe – using a clean white solvent wet cloth, wipe clean the substrates and then immediately follow the first wipe with a second dry wipe to remove the solvent before it evaporates allowing the solvent to flash / evaporate before wiping it off with the second rag can simply re-deposit the residue loosened / cleaned from the first wipe instead of removing it.
 2. Note: on paint surfaces, test to be sure the solvent chosen does not dissolve, lift, or otherwise harm the paint finish. Also, use caution when scrubbing with abrasive pads so as not to harm the finish.
- D. After a suitable removal and cleaning technique has been established, apply test beads of newly specified sealant with and without primer according to product datasheet guidelines and check adhesion, using the field adhesion test method. Sufficient cure time of the silicone is required before testing for adhesion. Contact manufacture's representative for a cure time estimate but in most cases 7 days minimum is required.
- E. Proceed with the application using the best result of the field adhesion test above and monitor adhesion as the work progresses.

3.1 INSPECTION:

- A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.

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- C. Coordinate for repair and resolution of unsound substrate materials.

Inspect for uniform joint widths and that dimensions are within tolerance established by sealant manufacturer.

- D. Examine joints to receive sealants. Notify RE if conditions are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

3.2 PREPARATIONS:

- A. Prepare joints in accordance with manufacturer's instructions and SWRI.
- B. Clean surfaces of joint to receive sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.
1. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants.
 2. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
 - a. Concrete.
 - b. Masonry.
 3. Remove laitance and form-release agents from concrete.
- C. Do not cut or damage joint edges.
- D. Apply masking tape to face of surfaces adjacent to joints before applying primers, or sealing compounds.
1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Apply primer to sides of joints by compound manufacturer's printer instructions.
1. Apply primer prior to installation of back-up rod or bond breaker tape.
 2. Use brush or other approved means that will reach all parts of joints.
- F. Take all necessary steps to prevent three sided adhesion of sealants.
- G. Prepare joints in accordance with manufacturer's instructions.
- H. Clean surfaces within 1 to 2 hours before applying sealants.

3.3 BACKING INSTALLATION:

- A. Install back-up material, to form joints enclosed on three sides as required for specified depth of sealant.

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- B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.
- C. Cut fillers installed by others to proper depth for installation of back-up rod and sealants.
- D. Install back-up rod, without puncturing the material, to a uniform depth, within plus or minus 3 mm (1/8 inch) for sealant depths specified.
- E. Where space for back-up rod does not exist, install bond breaker tape strip at bottom of joint so sealant bonds only to two opposing surfaces.
- F. Take all necessary steps to prevent three sided adhesion of sealants.

3.4 SEALANT DEPTHS AND GEOMETRY:

- A. At widths up to 6 mm (1/4 inch), sealant depth equal to width.
- B. At widths over 6 mm (1/4 inch), sealant depth 1/2 of width up to 13 mm (1/2 inch) maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

3.5 INSTALLATION:

- A. General:
 - 1. Apply sealants only when ambient temperature is between 5 degrees C and 38 degrees C (40 and 100 degrees F).
 - 2. Do not use polysulfide base sealants where sealant may be exposed to fumes from bituminous materials, or where water vapor in continuous contact with cementitious materials may be present.
 - 3. Do not use sealant type listed by manufacture as not suitable for use in locations specified.
 - 4. Apply sealing compound in accordance with manufacturer's printer instructions.
 - 5. Avoid dropping or smearing compound on adjacent surfaces.
 - 6. Fill joints solidly with compound and finish compound smooth.
 - 7. Tool joints to concave surface unless shown or specified otherwise.
 - 8. Finish paving or floor joints flush unless joint is otherwise detailed.
 - 9. Apply compounds with nozzle size to fit joint width.
 - 10. Test sealants for compatibility with each other and substrate. Use only compatible sealant.
- B. For application of sealants, follow requirements of ASTM C1193 unless specified otherwise.
- C. Install backer rod in joint to allow for appropriate depth of sealants and to prevent 3-sided adhesion.

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- D. Install bond breaker tape when joint depth is too shallow to allow backer rod.
- E. Apply sealant depth of 1/8 inch minimum to 3/8 inch maximum over crown of backer rod.
- F. Apply sealants in a continuous operation, horizontally in 1 direction and vertically from bottom to top of joint opening. Apply positive pressure adequate to properly fill and seal joint width.
- G. Tool or strike sealants with appropriate tool applying light pressure to spread sealants against back-up material and joint surfaces to ensure void-free application. Do not use soap or detergent solutions for tooling.

3.6 FIELD QUALITY CONTROL:

- A. Field-Adhesion Testing: Field-test joint-sealant adhesion to joint substrates as recommended by sealant manufacturer:
 - 1. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform 10 tests for first 300 m (1000 feet) of joint length for each type of elastomeric sealant and joint substrate.
 - b. Perform one test for each 300 m (1000 feet) of joint length thereafter or one test per each floor per elevation.
- B. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field adhesion test log.
- C. Inspect tested joints and report on following:
 - 1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
 - 2. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 - 3. Whether sealants filled joint cavities and are free from voids.
 - 4. Whether sealant dimensions and configurations comply with specified requirements.
- D. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
- E. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
- F. Evaluation of Field-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements, will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing

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or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.7 CLEANING:

- A. Remove excess sealants from porous surfaces after initial cure or set-up.
- B. After filling and finishing joints, remove masking tape.
- C. Leave adjacent surfaces in a clean and unstained condition.

3.8 PROTECTION

- A. Protect sealants in joints from damage until fully cured.

END OF SECTION 07920

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SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard hollow metal doors and frames.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Extra Heavy Duty Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.
- C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and finishes.
- B. Shop Drawings: Include the following:
 1. Elevations of each door design.
 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 4. Locations of reinforcement and preparations for hardware.
 5. Details of each different wall opening condition.
 6. Details of anchorages, joints, field splices, and connections.
 7. Details of accessories.
 8. Details of moldings, removable stops, and glazing.
 9. Details of conduit and preparations for power, signal, and control systems.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Oversize Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
- E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

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1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure, or as close to neutral pressure as possible according to NFPA 252, UBC Standard 7-2, or UL 10C.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.
- D. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.
 - 1. Provide additional protection to prevent damage to finish of factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit aircirculation.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

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1.7 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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. Amweld Building Products, LLC.
 - 2. Benchmark; a division of Therma-Tru Corporation.
 - 3. Ceco Door Products; an Assa Abloy Group company.
 - 4. Curries Company; an Assa Abloy Group company.
 - 5. Deansteel Manufacturing Company, Inc.
 - 6. Firedoor Corporation.
 - 7. Fleming Door Products Ltd.; an Assa Abloy Group company.
 - 8. Habersham Metal Products Company.
 - 9. Karpen Steel Custom Doors & Frames.
 - 10. Kewanee Corporation (The).
 - 11. Mesker Door Inc.
 - 12. Pioneer Industries, Inc.
 - 13. Security Metal Products Corp.
 - 14. Steelcraft; an Ingersoll-Rand company.
 - 15. Windsor Republic Doors.
 - 16. Or approved equal.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 or A60 metallic coating.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

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- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.
- F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
- G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.
- I. Glazing: Comply with requirements in Section 08 80 00 "Glazing."
- J. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
 - 1. Design: Flush panel.
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core.
 - a. Fire Door Core: As required to provide fire-protection ratings indicated.
 - b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 4.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 - 1) Locations: Exterior doors.
 - 3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
 - 4. Top and Bottom Edges: Closed with flush of same material as facesheets.
 - 5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
 - 1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless).

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- C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- D. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- wide steel.
- C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.5 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
 - 3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
- D. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- E. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Section 08 71 00 "Door Hardware."
 - 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDIA250.8.
 - 2. Reinforce doors and frames to receive non-templated, mortised and surface-mounted door hardware.
 - 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 - 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

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2.6 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
- B. Factory-Applied Paint Finish: Manufacturer's standard, complying with ANSI/SDI A250.3 for performance and acceptance criteria.

2.7 Color and Gloss: As selected by Architect/Engineer from manufacturer's fullrange.

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 the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

- C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 - 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 - 5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
 - 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for

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- securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
- Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
- Non-Fire-Rated Standard Steel Doors:
 - Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 - Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - Smoke-Control Doors: Install doors according to NFPA 105.
- D. Glazing: Comply with installation requirements in Section 08 80 00 "Glazing" and with hollow metal manufacturer's written instructions.
- Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.
- 3.4 ADJUSTING AND CLEANING
- Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
 - Remove grout and other bonding material from hollow metal work immediately after installation.
 - Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
 - Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08 11 13

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SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes items known commercially as finish or door hardware that are required for swing, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.
- B. This Section includes the following:
 - 1. Hinges.
 - 2. Lock cylinders and keys.
 - 3. Lock and latch sets.
 - 4. Closers.
 - 5. Exit Devices.
 - 6. Miscellaneous door control devices.
 - 7. Protection Plates.
 - 8. Gasketing for interior doors.
 - 9. Astragals or meeting seals on pairs of doors.
 - 10. Thresholds.
- C. Products furnished but not installed under this Section include:
 - 1. Cylinders for locks on doors.
 - 2. Final replacement cores and keys to be installed by Government.

1.2 SUBMITTALS

- A. Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
- B. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
 - a. Type, style, function, size, and finish of each hardware item.
 - b. Name and manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of each hardware set cross referenced to indications on drawings both on floor plans and in door and frame schedule.
 - e. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for hardware.
 - g. Door and frame sizes and materials.
 - h. Keying information.

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2. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work that is critical in the Project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by door hardware, and other information essential to the coordinated review of schedule.

- C. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.3 QUALITY ASSURANCE

- A. Single Source Responsibility: Obtain each type of hardware such as latch and lock sets, hinges, and closers, from a single manufacturer.
- B. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project.
- C. Fire-Rated Openings: Provide door hardware for fire-rated openings that complies with NFPA Standard No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels.

1.4 PRODUCT HANDLING

- A. Tag each item or package separately with identification related to final hardware schedule, and include basic installation instructions with each item or package.
- B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
- C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
- D. Deliver individually packaged door hardware items promptly to place of installation (shop or Project site).
- E. Provide secure lock-up for door hardware delivered to the Project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the Work will not be delayed by hardware losses both before and after installation.

1.5 MAINTENANCE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for the Government's continued adjustment, maintenance, and removal and replacement of door hardware.

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PART 2 - PRODUCTS

2.1 SCHEDULED HARDWARE

- A. Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:
1. ANSI/BHMA designations used elsewhere in this Section or in schedules to describe hardware items or to define quality or function are derived from the following standards. Provide products complying with these standards and requirements specified elsewhere in this Section.
 - a. Butts and Hinges: ANSI/BHMA A156.1.
 - b. Bored and Preassembled Locks and Latches: ANSI/BHMA A156.2.
 - c. Door Controls - Closers: ANSI/BHMA A156.4.
 - d. Auxiliary Locks and Associated Products: ANSI/BHMA A156.5.
 - e. Architectural Door Trim: ANSI/BHMA A156.6.
 - f. Template Hinge Dimensions: ANSI/BHMA A156.7.
 - g. Interconnected Locks and Latches: ANSI/BHMA A156.12.
 - h. Mortise Locks and Latches: ANSI/BHMA A156.13.
 - i. Closer Holder Release Devices: ANSI/BHMA A156.15.
 - j. Auxiliary Hardware: ANSI/BHMA A156.16.
 - k. Materials and Finishes: ANSI/BHMA A156.18.

2.2 MATERIALS AND FABRICATION

- A. Hand of door: Drawings show direction of swing or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
- B. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to COTR.
1. Manufacturer's identification will be permitted on rim of lock cylinders only.
- C. Base Metals: Produce hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.
- D. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.
- E. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.
- F. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts

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are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use sex screw fasteners.

- G. Tools and Maintenance Instructions for Maintenance: Furnish a complete set of specialized tools and maintenance instructions as needed for Government's continued adjustment, maintenance, and removal and replacement of finish hardware.

2.3 HINGES, BUTTS, AND PIVOTS

- A. Screws: Provide Phillips flat-head screws complying with the following requirements:
 - 1. For metal doors and frames install machine screws into drilled and tapped holes.
 - 2. Finish screw heads to match surface of hinges or pivots.
- B. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - 1. Access Control Doors: Non-removable pins.
 - 2. Interior Doors: Non-rising pins.
 - 3. Tips: Flat button and matching plug, finished to match leaves.
- C. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges per door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches of additional height.
 - 1. Fire-Rated Doors: Not less than 3 hinges per door leaf for doors 86 inches or less in height with same rule for additional hinges.
 - 2. Contractor shall be responsible for verifying and determining the hand swing of each door as shown on floor plans for coordination when ordering.

2.4 LOCK CYLINDERS AND KEYING

- A. Provide construction cores and keys during the construction period. Construction, control and operating key and cores shall not be part of the FAA's permanent keying system. Permanent cores and keys shall be FAA furnished.
- B. All cylinders shall be Best 7 pin, interchangeable core.
- C. Coordinate with FAA installation of interchangeable cores by Contractor in locksets. At completion of installation deliver keysets back to COTR. COTR will test locksets and keying to ensure proper installation. Contractor shall perform necessary corrections as directed by COTR.
- D. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.

2.5 LOCKS, LATCHES, AND BOLTS

- A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.
 - 1. Provide flat lip strikes for locks with 3-piece, anti-friction latchbolts as recommended by manufacturer.

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- B. Lock Throw: Provide 5/8-inch minimum throw of latch on pairs of doors. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.
 - 1. Provide 1/2-inch minimum throw of latch for other bored and preassembled types of locks and 3/4-inch minimum throw of latch for mortise locks. Provide 1-inch minimum throw for all dead bolts.
- C. Flush Bolt Heads: Minimum of 1/2-inch-diameter rods of brass, bronze, or stainless steel with minimum 12-inch-long rod for doors up to 7 feet-0 inch in height. Provide longer rods as necessary for doors exceeding 7 feet-0 inch in height.
- D. Locksets/Latchsets
 - 1. Provide locksets with 7 pin (Best Manufacturing) interchangeable core cylinders.
 - 2. Locksets and latchsets shall be heavy duty mortise type with hinged anti-friction throw latch bolt with antifriction piece made of self-lubricated stainless steel. Functions and design as indicated in the hardware sets.
 - 3. Furnish lockset and latchsets with sufficient strike lip to protect door trim.
- E. Fire Exit Devices: Provide a concealed vertical rod exit device with electric latch and signal switch. Coordinate and connect mechanism with Work of Division 16 for electrical connections to door frame and control devices.
 - 1. The exit device is with 5/8 inch throw and latch bolt.
 - 2. The electric latch device shall be UL approved for Class II circuit applications and shall be installed by using an electrical power transfer. When the door is closed, the electrical power transfer unit should be concealed and tamper-resistant.
 - 3. The latch bolt shall be equipped for monitoring with a device equipped with an internal SPDT switch.
 - 4. The exit device and specified equipment should be obtained from the same manufacturer.
 - 5. Power supplies for electric locking or monitoring on single or double door applications. Terminal block will accept up to 14 gage stranded wire. Enclosure is 10 inches by 10 inches by 4 inches.

2.6 CLOSERS AND DOOR CONTROL DEVICES

- A. Size of Closer Units: Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit depending on size of door and anticipated frequency of use.
- B. Provide UL listed astragal for fire rated double doors.
- C. Provide UL listed coordinator for fire rated double doors.
- D. Overhead Door Stop: coordinate installation with door closer.

2.7 DOOR TRIM UNITS

- A. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine screws or self-tapping screws.

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- B. Fabricate edge trim of stainless steel to fit door thickness in standard lengths or to match height of protection plates.
- C. Fabricate protection plates as indicated on Hardware Schedule.
 - 1. Metal Plates: 0.050 inch (U.S. 18 gage).

2.8 GASKETING AND SEALS

- A. General: Provide continuous gasketing on interior doors where indicated or scheduled.
- B. Gasketing to comply with UBC7-2, UL10-B and UL10-C.
- C. Gasketing at Jambs and Heads: Provide bumper-type resilient insert and metal retainer strips, surface applied unless shown as mortised or semi-mortised, and of following metal, finish, and resilient bumper material:
 - 1. As indicated on Hardware Schedule.

2.9 THRESHOLDS

- A. General: Except as otherwise indicated, provide standard metal threshold unit of type, size, and profile as shown or scheduled.
- B. Hinged Doors: Provide units not less than 4 inches wide, formed to accommodate change in floor elevation where indicated, fabricated to accommodate door hardware and to fit door frames.
- C. ANSI/BHMA Classification: J32130

2.10 HARDWARE FINISHES

- A. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.
- B. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.
- C. The designations used in schedules and elsewhere to indicate hardware finishes are the industry-recognized standard commercial finishes, except as otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations except as shown on drawings.

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1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.
- B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in Section 099100, "Painting." Do not install surface-mounted items until finishes have been completed on the substrates involved.
- C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- D. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.
- E. Gasketing and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
 1. Where door hardware is installed more than one month prior to acceptance or occupancy of a space or area, return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Instruct the FAA's personnel in the proper adjustment and maintenance of door hardware and hardware finishes.

3.3 INSPECTION

- A. After installation has been completed, the inspection shall check each opening for conformance with the approved hardware schedule.
- B. The final inspection shall determine that hardware was installed according to the manufacturer's recommended instructions. Adjust hardware which is not operating properly.

3.4 INSTALLATION

- A. The mounting heights for the finishing hardware shall be as listed in the DHI Publication "Recommended Locations for Builders Hardware for Custom Steel Door and Frames."
- B. The handling of doors shall be as listed in the Finish Hardware Schedule, and shall follow the DHI Publication "Basic Builders Hardware."

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3.5 HARDWARE SCHEDULE

- A. See Door schedule on drawings for Hardware.

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SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
- B. Do not install gypsum board manufactured in China.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

2.2 INTERIOR GYPSUM BOARD

- A. Gypsum Wallboard: ASTM C 1396/C 1396M.
 - 1. Thickness: 1/2 inch.
 - 2. Long Edges: Tapered.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Thickness: 5/8 inch.
 - 2. Long Edges: Tapered.

2.3 SPECIALTY GYPSUM BOARD

- A. Gypsum Board, Type C: ASTM C 1396/C 1396M. Manufactured to have increased fire- resistive capability.
 - 1. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
 - 2. Long Edges: Tapered.
- B. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Core: 5/8 inch, Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

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2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
- B. Aluminum Trim: ASTM B 221, Alloy 6063-T5.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 - 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.6 AUXILIARY MATERIALS

- A. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing).
 - 1. Recycled Content of Blankets: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent.
- E. Acoustical Joint Sealant: ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings as demonstrated by testing according to ASTM E 90.
 - 1. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 APPLYING AND FINISHING PANELS

- A. Comply with ASTM C 840.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations and trim edges with edge

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trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

- D. Install trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
 - 1. Aluminum Trim: Install in locations indicated on Drawings.
 - 2. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- E. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- F. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- G. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- H. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 4: For all gypsum wall and ceiling panels not otherwise indicated as Level 1.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- I. Protect adjacent surfaces from drywall compound and texture finishes and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- J. Remove and replace panels that are wet, moisture damaged, and mold damaged.

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SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes ceilings composed of acoustical panels and exposed suspension systems and fire rated acoustic panels and exposed suspension systems, including design and construction for seismic systems indicated in this Section.

1.2 SUBMITTALS

- A. Provide MSDS for all adhesives, sealants and cleaners specified in this Section.
- B. Coordination drawings for reflected ceiling plans drawn accurately to scale and coordinating penetrations and ceiling-mounted items. Show the following:
 - 1. Ceiling suspension system members.
 - 2. Method of attaching suspension system hangers to building structure.
 - 3. Ceiling-mounted items including light fixtures; air outlets and inlets; speakers; sprinklers; and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed acoustical panel ceilings similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 - 1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
 - 2. ASCE/SEI 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
- C. Single-Source Responsibility for Ceiling Units: Obtain each type of acoustical ceiling panel from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.
- D. Single-Source Responsibility for Suspension System: Obtain each type of suspension system from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying the Work.

1.4 DELIVERY, STORAGE, AND HANDLING

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- A. Deliver acoustical panels and suspension system components to Project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, 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.

1.5 PROJECT CONDITIONS

- A. Space Enclosure and Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet-work in spaces is completed and dry, work above ceilings is complete, and ambient temperature and humidity conditions are being maintained at the levels indicated for Project when occupied for its intended use.

1.6 COORDINATION

- A. Coordinate layout and installation of acoustical panels and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system components (if any), and partition assemblies (if any).

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
 - 1. Acoustical Ceiling Units: Furnish quantity of full-size units equal to 2.0 percent of amount installed.
 - 2. Exposed Suspension System Components: Furnish quantity of each exposed component equal to 2.0 percent of amount installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design: Subject to compliance with requirements, acoustical panels that may be incorporated in the Work are specified on Drawings.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Acoustical Panel Standard: Provide manufacturer's standard panels as indicated on drawings.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.

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- B. Finishes and Colors: As noted on drawings.
- C. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1.
- 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. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
 - 3. Size: Select wire diameter so its stress at three 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. Angle Hangers: Angles with legs not less than 7/8 inch wide, formed with 0.0396-inch-thick galvanized-steel sheet complying with ASTM A 446, G 90 Coating Designation, with bolted connections and 5/16-inch-diameter bolts.
- F. Sheet-Metal Edge Moldings and Trim: Type and profile indicated, or if not indicated, manufacturer's standard moldings for edges and penetrations that fit acoustical panel edge details and suspension systems indicated; formed from sheet metal of same material and finish as that used for exposed flanges of suspension system runners.
 - 1. 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.
 - 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
 - 3. For narrow-face suspension systems, provide suspension system and manufacturer's standard edge moldings that match width and configuration of exposed runners.
 - 4. 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 according to paint manufacturer's specifications for cleaning, conversion coating, and applying organic coating.
 - a. Color: Match color of finish on flanges of suspension system surfaces.

2.4 ACOUSTICAL SEALANT

- A. Acoustical Sealant: Refer to Section 07 92 00 "Joint Sealants" for requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and 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 tolerance and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 PREPARATION

- A. Measure each ceiling area and establish the layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and conform to the layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to 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 the supporting structure or of the ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of 3 tight turns. Connect hangers either directly to structures or to inserts, eye screws, or other devices that are secure, that are appropriate for substrate, and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 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 shown; and 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 over 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.

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- E. Install acoustical panels with undamaged edges and fitted accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide neat, precise fit.
1. Arrange directionally patterned acoustical panels in the manner indicated on reflected ceiling plans.
 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. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer
 6. Install hold-down clips in areas indicated and in areas required by governing regulations, or for fire-resistance ratings; space as recommended by panel manufacturer, unless otherwise indicated or required.
 7. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's 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.

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**SECTION 09915
EXTERIOR REPAINTING**

PART 1 - GENERAL

1.1 Description:

1. Section Includes: All labor, materials, tools and other equipment, services and supervision required to complete all exterior repainting work as indicated on Finish Schedules and to the full extent of the drawings and specifications.
2. Work under this Contract shall also include, but not necessarily be limited to:
 - a. High pressure washing and abrasive blasting.
 - b. Moisture testing of substrates.
 - c. Surface preparation of substrates as required for acceptance of paint, including cleaning, small crack repair, patching, caulking, and making good surfaces and areas to the limits defined under **MPI** Repainting Manual Preparation requirements.
 - d. Specific pre-treatments noted herein or specified in the **MPI** Repainting Manual.
 - e. Sealing / priming surfaces for repainting in accordance with **MPI** Repainting Manual requirements.
3. Refer to drawings and schedules (e.g., Finish Schedule) for type, location and extent of exterior repainting required, and include all touch-ups necessary to complete work shown, scheduled or specified.
4. This Section along with the drawings forms part of the Contract documents and is to be read, interpreted and coordinated with all other parts.

1.2 Related Sections:

1. Unless otherwise noted, the following work or conditions are not included under this Section of work:
 - a. Scaffolding, platforms and housekeeping services [and temporary weather-proof coverings as well as heating and lighting if required].
 - b. Condition of substrates, correction of DSD-4 defects and deficiencies in substrates which may adversely affect repainting work, except for minimal work performed by this trade and preparation of surfaces to receive paint and finishes under this section of work.
 - c. Painting of new surfaces.
 - d. Repainting of interior surfaces.

1.3 Quality Assurance:

1. This Contractor shall have a minimum of five (5) years proven satisfactory experience and shall show proof before commencement of work that he will maintain a qualified crew of painters throughout the duration of the work. When requested, Contractor shall provide a list of the last three comparable exterior repainting jobs including, name, location, specifying authority / project manager, start / completion dates and value of the work.
2. Only qualified journeypersons, as defined by local jurisdiction, shall be engaged in exterior repainting work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyperson in accordance with trade regulations.
3. All materials, preparation and workmanship shall conform to the standards contained in the latest edition of the Master Painters Institute (**MPI**) Maintenance and Repainting Manual (herein referred to as the **MPI** Repainting Manual) as issued by the local **MPI** Accredited Quality Assurance Association having jurisdiction.
4. All exterior repainting work shall be inspected by a Paint Inspection Agency (inspector) acceptable to the specifying authority and the local **MPI** Accredited Quality Assurance Association. The painting contractor shall notify the Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of the project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish

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Schedule.

5. **All surfaces requiring repainting shall be inspected** by the Painting Subcontractor who shall notify the Consultant, Paint Inspection Agency, and General Contractor in writing of any defects or problems, prior to commencing repainting or after preparation work.

1.4 Regulatory Requirements:

1. Conform to work place safety regulations for storage, mixing, application and disposal of all paint related materials to requirements of those authorities having jurisdiction.
2. Conform to safety precautions in accordance with the latest requirements to Industrial Health and Safety Regulations, latest edition, of authorities having jurisdiction.
3. Notify the Paint Inspection Agency on award of contract and make application for assignment of an Inspector using appropriate forms supplied by the Agency as well as provide a copy of the project repainting specification, drawings, color schedule and list of proposed materials for review purposes prior to commencement of work.
4. Fully cooperate at all times with the requirements of the Paint Inspection Agency in the performance of their duties, including providing access and assistance as required to complete inspection work.
5. To reduce the amount of contaminants entering waterways, sanitary / storm drain systems or into the ground the following procedures shall be strictly adhered to:
 - a. Retain cleaning water for water-based materials to allow sediments to be filtered out. In no case shall equipment be cleaned using free draining water.
 - b. Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - c. Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - d. Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
 - e. Empty paint cans are to be dry prior to disposal or recycling (where available).
 - f. Close and seal tightly partly used cans of materials including sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.
6. Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

1.5 Mock-Ups:

1. When requested by the Resident Engineer or Paint Inspection Agency, prepare and repaint a designated exterior surface area or item to requirements specified herein, with specified paint or coating showing selected colors, gloss / sheen, texture and workmanship to **MPI** Repainting Manual standards for review and approval. When approved, exterior surface area and/or item shall become acceptable standard of finish quality and workmanship for similar on-site repainting work.

1.6 Submittals:

1. All submittals shall be in accordance with the requirements of Section 01300 - Submittals.
2. Submit written proof of ability to supply a 100% two (2) year Maintenance Bond, if Paint Association warranty option is not used with Bid Submission.
3. Submit list of all painting materials to the Consultant and the Paint Inspection Agency for review prior to ordering materials.
4. Submit two sets of Material Safety Data Sheets (MSDS) prior to commencement of work for review and for posting at job site as required.
5. Submit certification reports for ecologo paint products used.

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6. Submit invoice list of all paint materials ordered for project work to Paint Inspection Agency indicating manufacturer, types and quantities for verification and compliance with specification and design requirements if requested.
7. Submit work schedule for various stages of work for the Consultant's review and Owner's approval if requested.
8. At project completion provide an itemized list complete with manufacturer, paint type and color coding for all colors used for Owner's later use in maintenance.
9. At project completion provide properly packaged maintenance materials as noted herein and obtain a signed receipt.

1.7 Product Delivery, Storage and Handling:

1. Deliver all painting materials in sealed, original labeled containers bearing manufacturer's name, brand name, type of paint or coating and color designation, standard compliance, materials content as well as mixing and/or reducing and application requirements.
2. Store all paint materials in original labeled containers in a secure (lockable), dry, heated and well ventilated single designated area meeting the minimum requirements of both paint manufacturer and authorities having jurisdiction and at a minimum ambient temperature of 45° F (7° C). Only material used on this project is to be stored on site.
3. Where toxic and/or volatile / explosive / flammable materials are being used, provide adequate fireproof storage lockers and take all necessary precautions and post adequate warnings (e.g. no smoking) as required.
4. Take all necessary precautionary and safety measures to prevent fire hazards and spontaneous combustion and to protect the environment from hazard spills. Materials that constitute a fire hazard (paints, solvents, drop clothes, etc.) shall be stored in suitable closed and rated containers and removed from the site on a daily basis.
5. Comply with requirements of authorities having jurisdiction, in regard to the use, handling, storage and disposal of hazardous materials.

1.8 Project / Site Requirements:

1. UNLESS specifically pre-approved by the specifying body, Paint Inspection Agency and the applied product manufacturer, perform no exterior repainting work when the ambient air and substrate temperatures are below 50° F (10° C).
2. Perform no exterior repainting work unless environmental conditions are within MPI and paint manufacturer's requirements or until adequate weather protection is provided. Where required, suitable weatherproof covering and sufficient heating facilities shall be in place to maintain minimum ambient air and substrate temperatures for 24 hours before, during and after paint application.
3. Perform no exterior repainting work when the relative humidity is above 85% or when the dew point is less than 5° F (3° C) variance between the air / surface temperature.
4. Perform no exterior repainting work when the maximum moisture content of the substrate exceeds:
 - a. 12 % for concrete and masonry (clay and concrete brick / block).
5. Conduct all moisture tests using a properly calibrated electronic Moisture Meter.
6. Test concrete and masonry surfaces for alkalinity as required.
7. Apply paint only to dry, clean, and adequately prepared surfaces in areas where dust is no longer generated by construction activities such that airborne particles will not affect the quality of finished surfaces.

1.9 Scheduling:

1. Schedule repainting operations to prevent disruption of Owner's operations or building occupants. Obtain written authorization from Consultant / Owner for changes in work schedule.

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2. Phased work shall be in accordance with the requirements of Sections 01010 - Summary of Work and/or 01060 - Special and Regulatory Requirements.

1.10 Guarantee:

1. Furnish a one (1) year Painting Association Guarantee or a 100% one (1) year Maintenance Bond both in accordance with **MPI** Repainting Manual requirements. The Maintenance Bond shall be obtained from an approved bonding company and shall warrant that all repainting work has been performed in accordance with **MPI** Repainting Manual requirements.
2. All exterior repainting work shall be in accordance with **MPI** Repainting Manual requirements and shall be inspected by the Painting Association whether using the Painting Association Guarantee or the Maintenance Bond option. The cost for such Painting Association inspections as well as either the Painting Association Guarantee or Maintenance Bond shall be included in the Base Bid Price.
3. Painting Subcontractors choosing the Maintenance Bond option shall provide written proof of their ability to supply same at time of bidding.

1.11 Maintenance Materials:

1. At project completion provide a minimum of 4 liters (1 gallon) of each type and color of paint from same production run (batch mix) used in unopened cans, properly labeled and identified for Owner's later use in maintenance. Store where directed.

PART 2 - PRODUCTS

2.1 Materials:

1. All materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) shall be products listed in the latest edition of the **MPI** Approved Product List and shall be from a single manufacturer for each system used.
2. Other paint materials such as linseed oil, shellac, turpentine, etc. shall be the highest quality product of an approved manufacturer listed in the **MPI** Approved Product List and shall be compatible with other coating materials as required.
3. All materials and paints shall be lead and mercury free.
4. All paint materials shall have good flowing and brushing properties and shall dry or cure free of blemishes, sags, air entrapment, etc. Refer to 3.5, Field Quality Control / Standard of Acceptance requirements.

2.2 Equipment:

1. Painting Equipment: to best trade standards for type of product and application.
2. Spray-Painting Equipment: of ample capacity, suited to the type and consistency of paint or coating being applied and kept clean and in good working order at all times.

2.3 Mixing and Tinting:

1. Unless otherwise specified or pre-approved, all paints shall be ready-mixed and pre-tinted. Re-mix all paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and color and gloss uniformity.
2. Paste, powder or catalyzed paint mixes shall be mixed in strict accordance with manufacturer's written instructions.
3. Where thinner is used, addition shall not exceed paint manufacturer's recommendations.

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4. If required, thin paint for spraying in strict accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Consultant.

2.4 Finish and Colors:

1. Unless otherwise specified herein, all exterior repainting work shall be done in accordance with **MPI** Premium Grade requirements.
2. Colors shall match existing.

2.5 Gloss / Sheen:

1. Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following **MPI** gloss / sheen standard values:

Gloss Level	Description	Units @ 60 degrees	Units @ 85 degrees
G1	Matte or Flat finish	0 to 5	10 maximum
G2	Velvet finish	10 maximum	10 to 35
G3	Eggshell finish	10 to 25	10 to 35
G4	Satin finish	20 to 35	35 minimum
G5	Semi-Gloss finish	35 to 70	
G6	Gloss finish	70 to 85	
G7	High-Gloss finish	> 85	

2.6 Painted Metal Surfaces:

1. Use MPI #94 Alkyd, Exterior, Semi-Gloss (MPI Gloss Level 5)
2. The following products are approved for use.

Columbia Paint	Premium Pro	Alkyd Int/Ext Semi-Gloss Enamel	CX03241
Davis Paint	Da-Tex	Alkyd Int/Ext Low Lustre Enamel	5455
Durant Perf Coating	Dur-A-Plex	Exterior Alkyd Semi-Gloss Enamel	9400
KCC Corp	Bio-Perfect	Bio-Perfect Sensemel Semi-Gloss	MS711S
Kelly-Moore	Weather Shield	Ext-Int Alkyd Semi-Gloss Enamel	1275-111
Samhwa paint Ind Co	Samhwa Paint	MPI 94 Enamel SG	3200103
Sherwin-Williams	Protective & Marine	DTM Alkyd Semi-Gloss	B55W00101

PART 3 - EXECUTION

3.1 Condition of Surfaces:

1. Prior to commencement of repainting work, thoroughly examine (and test as required) all exterior conditions and

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surfaces scheduled to be repainted and report in writing to the Owner and General Contractor where applicable any conditions or surfaces that will adversely affect work of this section.

2. The degree of surface deterioration (DSD) shall be assessed using the assessment criteria indicated in the **MPI** Maintenance Repainting Manual. In general the **MPI** DSD ratings and descriptions are as follows:

Condition	Description
DSD-0	Sound Surface (may include visual (aesthetic) defects that do not affect film's protective properties).
DSD-1	Slightly Deteriorated Surface (may show fading; gloss reduction, slight surface contamination, minor pin holes scratches, etc.) / Minor cosmetic defects (runs, sags, etc.).
DSD-2	Moderately Deteriorated Surface (small areas of peeling, flaking, slight cracking, staining, etc.).
DSD-3	Severely Deteriorated Surface (heavy peeling, flaking, cracking, checking, scratches, scuffs, abrasion, small holes and gouges).
DSD-4	Substrate Damage (repair or replacement of surface required by others).

3. Other than the repair of DSD-1 to DSD-3 defects included under this scope of work, structural and DSD-4 substrate defects discovered prior to and after surface preparation or after first coat of paint shall be made good and sanded by others ready for painting, unless otherwise agreed to by the Owner and painter to be included in this Work.
4. No repainting work shall commence until all such DSD-4 adverse conditions and defects have been corrected and surfaces and conditions are acceptable to the Painting Subcontractor. The Painting Subcontractor shall not be responsible for the condition of the substrate or for correcting defects and deficiencies in the substrate, which may adversely affect the painting work except for minimal work normally performed by the Painting Subcontractor and as, indicated herein. It shall always, however, be the responsibility of the Painting Subcontractor to see that surfaces are properly prepared before any paint or coating is applied. It shall also be the Painting Subcontractor's responsibility to paint the surface as specified providing that the owner accepts responsibility for uncorrected DSD-4 substrate conditions.

3.2 Preparation of Surfaces:

1. Prepare all exterior surfaces for repainting in accordance with MPI Repainting Manual requirements. Refer to the MPI Repainting Manual in regard to specific requirements for the following:
 - a. environmental conditions.
 - b. rust stain removal.
 - c. mildew removal.
 - d. vertical and horizontal concrete surfaces.
 - e. structural steel and miscellaneous metals.
 - f. aluminum and copper surfaces.
2. Where required, pressure wash exterior surfaces prior to repainting in accordance with MPI standards for type of surfaces and recommended pressures to ensure complete removal of all loose paint, stains, dirt, and other foreign matter. This work shall be carried out only by qualified tradesman experienced in pressure water cleaning. The use of water hose cleaning will not be considered satisfactory, unless specifically specified. Allow sufficient drying time and test all surfaces using an electronic moisture meter before commencing work.
3. Sand, clean, dry, etch, neutralize and/or test all surfaces under adequate illumination, ventilation and temperature requirements.
4. Remove and securely store all miscellaneous hardware and surface fittings / fastenings (e.g. electrical lights, mechanical louvers, door and window hardware (e.g. hinges, knobs, locks, trim, frame stops) and, removable hazard / instruction labels. from wall and soffit surfaces, doors and frames, prior to repainting and replace upon completion. Carefully clean and replace all such items upon completion of repainting work in each area. Do not use solvent or reactive cleaning agents on items that will mar or remove finishes (e.g. lacquer finishes). Doors shall be removed before repainting to paint bottom and top edges and then re-hung.
5. Protect all exterior surfaces and areas, including landscaping, walks, drives, all adjacent building surfaces

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(including glass, aluminum surfaces, etc.) and equipment and any labels and signage from repainting operations and damage by drop cloths, shields, masking, templates, or other suitable protective means and make good any damage caused by failure to provide such protection.

3.3 Application:

1. Do not commence repainting unless substrates and all environmental conditions are acceptable for the application of products.
2. Apply primer, paint or stain in accordance with **MPI** Painting Manual Premium Grade finish requirements.
3. Apply primer, paint or stain in a workmanlike manner using skilled and trade qualified applicators as noted under Quality Assurance.
4. Apply primer, paint or stain within an appropriate time frame after cleaning and preparation to prevent weathering or water staining of substrate or before environmental conditions encourage flash-rusting, rusting, contamination or when the manufacturer's paint specifications require earlier applications.
5. Primer, paint or stain coats specified are intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer's recommendations.
6. Tint each coat of paint progressively lighter to enable confirmation of number of coats.
7. Unless otherwise approved by the painting inspection agency, apply a minimum of four coats of paint where deep or bright colors are used to achieve satisfactory results.
8. Sand and dust between each coat to provide an anchor for next coat and to remove defects (runs, sags, etc.) visible from a distance up to 1000 mm (39").
9. Do not apply finishes on exterior surfaces that are not sufficiently dry. Unless manufacturer's directions state otherwise, each coat shall be sufficiently dry and hard before a following coat is applied.
10. To avoid air entrapment in applied coats, apply materials in strict accordance with manufacturer's spread rates and application requirements.

3.4 Exterior Finish / Coating Systems:

Repaint exterior surfaces in accordance with the following **MPI** Repainting Manual requirements:

1. **Concrete Vertical Surfaces:** (including horizontal soffits)

REX 3.1F	Elastomeric coating.
REX 3.1G	Water repellent non-paintable finish for use on surfaces previously coated with similar water repellent.
REX 3.1H	Water repellent paintable finish.
2. **Structural Steel and Metal Fabrications:**

REX 5.1A	Quick dry enamel G5 finish.
REX 5.1B	Waterborne light industrial G5 coating (over epoxy zinc rich primer).
REX 5.1C	Waterborne light industrial G5 coating (over alkyd primer).
REX 5.1D	Alkyd G5 finish.
REX 5.1F	High build epoxy finish.
REX 5.1G	Pigmented polyurethane finish (over epoxy zinc rich primer and high build epoxy).
REX 5.1H	Pigmented polyurethane finish (over high build epoxy).
REX 5.1J	Aluminum paint finish.
REX 5.1K	Waterborne light industrial G5 coating (over waterborne primer).
REX 5.1L	Waterborne light industrial G5 coating (over epoxy primer).
REX 5.1M	Pigmented polyurethane G5 finish (over epoxy zinc rich primer and epoxy).
REX 5.1N	Latex G5 finish (over an alkyd primer).

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3. **Aluminum:** (unanodized) sash, sills and frames, flashing, posts and railings, downpipes, etc.)

REX 5.4A	Alkyd G5 finish.
REX 5.4B	Pigmented polyurethane finish.
REX 5.4C	Aluminum paint finish.
REX 5.4D	Bituminous finish G5
REX 5.4E	Epoxy finish.
REX 5.4F	Waterborne light industrial G5 coating.
REX 5.4G	Latex G5 finish (over quick dry primer).

3.5 Field Quality Control / Standard of Acceptance:

1. All surfaces, preparation and paint applications shall be inspected.
2. Repainted exterior surfaces shall be considered to lack uniformity and soundness if any of the following defects are apparent to the Painting Inspection Agency inspector:
 - a. brush / roller marks, streaks, laps, runs, sags, drips, heavy stippling, hiding or shadowing by inefficient application methods, skipped or missed areas, and foreign materials in paint coatings.
 - b. evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles.
 - c. damage due to touching before paint is sufficiently dry or any other contributory cause.
 - d. damage due to application on moist surfaces or caused by inadequate protection from the weather.
 - e. damage and/or contamination of paint due to wind blown contaminants (dust, sand blast materials, salt spray, etc.).
3. Repainted exterior surfaces shall be considered unacceptable if any of the following are evident under natural lighting conditions:
 - a. visible defects are evident on vertical surfaces when viewed at 90 degrees to the surface from a distance of 1000 mm (39").
 - b. visible defects are evident on horizontal surfaces when viewed at 45 degrees to the surface from a distance of 1000 mm (39").
 - c. visible defects are evident on soffit and other overhead surfaces when viewed at 45 degrees to the surface
 - d. when the final coat on any surface exhibits a lack of uniformity of sheen across full surface area.
4. Repainted surfaces rejected by the inspector shall be made good at the expense of the Contractor. Small affected areas may be touched up; large affected areas or areas without sufficient dry film thickness of paint shall be repainted. Runs, sags of damaged paint shall be removed by scraper or by sanding prior to application of paint.

3.6 Protection:

1. Protect all newly repainted exterior surfaces from rain and snow, condensation, contamination, dust, salt spray and freezing temperatures until paint coatings are completely dry. Curing periods shall exceed the manufacturer's recommended minimum time requirements.
2. Erect barriers or screens and post signs to warn, limit or direct traffic away or around work area as required.

3.7 Clean-up:

1. Remove all paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
2. Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris.
3. Remove combustible rubbish materials and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.

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4. Clean equipment and dispose of wash water / solvents as well as all other cleaning and protective materials (e.g. rags, drop cloths, masking papers, etc.), paints, thinners, paint removers/strippers in accordance with the safety requirements of authorities having jurisdiction.

END OF SECTION 09915

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SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete.
 - 2. Steel.
 - 3. Galvanized metal.
 - 4. Gypsum board.

1.2 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples: For each type of paint system and in each color and gloss of topcoat.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

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PART 2 - PRODUCTS

2.1 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 1. Nonflat Paints and Coatings: 150 g/L.
 - 2. Primers, Sealers, and Undercoaters: 200 g/L.
 - 3. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
 - 4. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
 - 5. Floor Coatings: 100 g/L.

2.2 PRIMERS/SEALERS

- A. Interior Latex Primer/Sealer: MPI #50.
 - 1. VOC Content: Less than 90 g/L.

2.3 METAL PRIMERS

- A. Industrial Low-Odor/VOC flat Acrylic primer.
 - 1. VOC Content: 90 g/L or less, as specified in Part 3.

2.4 LATEX PAINTS

- A. Institutional Low-Odor/VOC Latex (Eggshell): MPI #145 (Gloss Level 3).
 - 1. VOC Content: Zero, as specified in Part 3.
- B. Institutional Low-Odor/VOC Latex (Semigloss): MPI #147 (Gloss Level 5).
 - 1. VOC Content: 90 g/L or less, as specified in Part 3.

2.5 FLOOR COATINGS

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- A. Sealer, Water Based, for Concrete Floors: MPI #99.
- B. Sealer, Solvent Based, for Concrete Floors: MPI #104.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Masonry (Clay and CMU): 12 percent.
 - 3. Wood: 15 percent.
 - 4. Gypsum Board: 12 percent.
 - 5. Plaster: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

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- B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

- A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:

- 1. Institutional Low-Odor/VOC Latex System: MPI INT 5.3N.
 - a. Prime Coat: Waterborne galvanized-metal primer.
 - 1) Basis-of-Design: Pitt-Tech Plus Series 90-912 DTM Industrial Primer; 100% Acrylic Formula, VOC 90 g/L or less.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex (semigloss).
 - 1) Basis-of-Design: Pitt-Tech Plus 90-1210 Series; 100% Acrylic Formula with VOC of 90 g/L or less.

B. Gypsum Board Substrates:

- 1. Institutional Low-Odor/VOC Latex System: MPI INT 9.2M.
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex (eggshell).
 - d. Basis-of-Design: Refer to Interior Materials Finish Schedule on Drawings.

C. Concrete Substrates, Nontraffic Surfaces:

- 1. Institutional Low-Odor/VOC Latex System:
 - a. Prime Coat: Interior latex primer/sealer.
 - b. Intermediate Coat: Institutional low-odor/VOC interior latex matching topcoat.
 - c. Topcoat: Institutional low-odor/VOC interior latex (eggshell).
 - d. Basis-of-Design: Refer to Interior Materials Finish Schedule on Drawings.

D. Concrete Substrates, Traffic Surfaces:

- 1. Solvent-Based Clear Sealer System:
 - a. First Coat: Sealer, solvent based, for concrete floors, MPI #104.
 - b. Topcoat: Sealer, solvent based, for concrete floors, MPI #104.
 - c. Basis-of-Design: Refer to Interior Materials Finish Schedule on Drawings.

END OF SECTION 099123

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PPG Paints
High Performance Coatings
099600

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. High performance coatings.
- B. Surface preparation.

1.02 RELATED REQUIREMENTS

- A. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 09 9113 - Exterior Painting.

1.03 REFERENCE STANDARDS

- A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency current edition.
- B. ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating 2005 (Reapproved 2017).
- C. SSPC-Paint 16 - Coal Tar Epoxy-Polyamide Black (or Dark Red) 2006 (Reaffirmed 2015).
- D. SSPC-SP 1 - Solvent Cleaning 2015, with Editorial Revision (2016).
- E. SSPC-SP 2 - Hand Tool Cleaning 1982, with Editorial Revision (2004).
- F. SSPC-SP 3 - Power Tool Cleaning 1982, with Editorial Revision (2004).
- G. SSPC-SP 6 - Commercial Blast Cleaning 2007.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of all products to be used, with the following information for each:
 - 1. Manufacturer's name, product name and/or catalog number, and general product category (e.g. "alkyd enamel").
 - 2. Cross-reference to specified coating system(s) product is to be used in; include description of each system.
 - 3. If proposal of substitutions is allowed under submittal procedures, explanation of all substitutions proposed.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of coating, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

- C. Coating Materials: Store at minimum ambient temperature of 45 degrees F(7 degrees C) and a maximum of 90 degrees F(32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.07 FIELD CONDITIONS

- A. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
- B. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the coating product manufacturer.
- C. Do not install materials when temperature is below 55 degrees F(13 degrees C) or above 90 degrees F(32 degrees C).
- D. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- E. Provide lighting level of 80 ft candles(860 lx) measured mid-height at substrate surface.
- F. Restrict traffic from area where coating is being applied or is curing.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Provide high performance coating products from the same manufacturer.
- B. High-Performance Coatings:
 - 1. PPG Paints: www.ppgpaints.com/#sle.
 - 2. Substitutions: Section 01 6000 - Product Requirements.

2.02 TOP COAT MATERIALS

- L. Fluoropolymer Coating:
 - 1. Top Coat(s): Air Dry Fluoropolymer, Two Component.
 - a. Finish: Metallic.
 - b. Products:
 - 1) PPG Paints; Coraflon ADS: www.ppgpaints.com/#sle.
 - 2. Primer: As recommended by coating manufacturer for specific substrate.

2.03 PRIMERS

- A. Primers: Provide a primer if recommended by Fluoropolymer coating manufacturer.

2.04 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Do not begin application of coatings until substrates have been properly prepared.
- C. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.

- D. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
- E. Test shop-applied primer for compatibility with subsequent cover materials.
- F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
 - 1. Cementitious Substrates: Do not begin application until substrate has cured 28 days minimum and measured moisture content is not greater than 12 percent.
 - 2. Plaster and Stucco: 12 percent.
 - 3. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
 - 4. Concrete Floors and Traffic Surfaces: 8 percent.
 - 5. Wood: Do not begin application if substrate has moisture content over 12 percent.
- G. Proceed with coating application only after unacceptable conditions have been corrected.

3.02 **PREPARATION**

- A. Clean surfaces of loose foreign matter.
- B. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.
- C. Remove finish hardware, fixture covers, and accessories and store.
- D. Existing Painted and Sealed Surfaces:
 - 1. Remove loose, flaking, and peeling paint. Feather edge and sand smooth edges of chipped paint.
 - 2. Clean with mixture of trisodium phosphate and water to remove surface grease and foreign matter.
- E. Aluminum: Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
- F. Galvanized Surfaces:
 - 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 - 2. Prepare surface according to SSPC-SP 2.
- G. Ferrous Metal:
 - 1. Solvent clean according to SSPC-SP1.
 - 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
 - 3. Remove rust, loose mill scale, and other foreign substances using using methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning", and protect from corrosion until coated.
- H. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.03 **PRIMING**

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.04 **COATING APPLICATION**

- A. Apply coatings in accordance with manufacturer's written instructions, to thicknesses specified.
- B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

3.05 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

- A. Protect finished work from damage.

END OF SECTION

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SECTION 22 14 20 - BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic Mechanical Requirements specifically applicable to Division 15 Work, in addition to Division 1 - General Requirements.
- B. Lifting, moving, re-installation, and minor modifications to existing equipment, curbs, pipe, gas and electrical supports, and service lines and connections.
- C. Plumbing and piping for roof drains, soil pipes and vents, and equipment piping and drain lines.
- D. Anchors, brackets, fasteners, hardware, and accessories for related Work.

1.02 WORK SEQUENCE

- A. Install work in stages to accommodate Owner's occupancy requirements during the construction period. Coordinate schedule and operations with Owner's Representative.

1.03 RELATED SECTIONS

- A. Related Sections include the following:
 - 1. Division 5, Section 05 52 13 – “Wall Mounted Guard Rail”
 - 2. Division 6, Section 06 10 00 – “Carpentry Work for Roofing”
 - 3. Division 7, Section 07 54 19 – “Thermoplastic Membrane Roofing”
 - 4. Division 7, Section 07 62 00 – “Sheet Metal Flashing and Trim”
 - 5. Division 7, Section 07 71 00 – “Roof Hatch”
 - 6. Division 7, Section 07 92 00 – “Joint Sealants”
 - 7. Division 15, Section 15 06 20 – “Non-Penetrating Rooftop Pipe and Equipment Supports”
 - 8. Division 16, Section 16 01 00 – “Basic Electrical Requirements”

1.04 SUBMITTALS

- A. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
- B. Mark dimensions and values in units to match those specified.
- C. Proposed Products List: Include Products specified in this Section and all Products required for execution of Work.
- D. Shop Drawings:
 - 1. Provide layout of any new / or modification changes to pipe supports.
 - 2. Provide layout of any new roof drains and associated drain piping.
 - 3. Provide layout of any new / or modification changes to any mechanical curb and / or supports
- E. Schedule: List each area of work and all systems or equipment affected. Indicate proposed time of disconnection, reconnection, and installation of any existing or new equipment, pipe supports, and roof drains and to show the location of shutdowns within the facility.

1.05 QUALIFICATIONS

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- A. Installer: Company specializing in installing the work of this Division with a minimum of five (5) years documented experience working with the systems and Products in place and proposed or required. Company shall be license by jurisdictions having authority to perform the required work.
- B. Conform to Uniform Mechanical and Plumbing Codes and other applicable for all work performed under this Division.
- C. Obtain permits, and all required inspections from governing authority having jurisdiction.

1.06 PROJECT / SITE CONDITIONS

- A. Install Work in existing locations and as required as directed, unless prevented by Project conditions.
- B. Prepare drawings showing proposed re-arrangement of Work to Project conditions, including changes or additions to Work specified in other Sections. Obtain written permission of Owner's Representative before proceeding.

1.07 SEQUENCING AND SCHEDULING

- A. Construct Work in sequence under provisions of Section 01300.
- B. Coordinate installation of new plumbing drains and drain lines and any disconnection to minimize disruptions to Owner's occupancy.
- C. Coordinate the raising and lowering of all refrigeration piping, gas piping, and electrical conduits to minimize disruptions to Owner's occupancy.
- D. Ensure sufficient materials and workforces are on hand for all operations. Do not take equipment, drainage systems, and electrical systems out of operation longer than one day, unless specifically authorized in writing by Owner's Representative.

1.08 PROJECT RECORD DOCUMENTS

- A. Submit in accordance with Sections 01300 and 01700.
- B. Accurately record locations of utilities remaining, rerouted utilities, and new utilities by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Primary Products: Those required for installation of new roof drains.
- B. Piping Materials:
 - 1. Cast Iron Soil Pipe and Fittings: ASTM A 74, Class SV.
 - 2. Push-on Caskets for Cast Iron Soil Pipe: ASTM C 564.
 - 3. Caulked Joints for CI Soil Pipe: FS HH-P_117, Type II.
 - 4. No Hub Joints: ASTM D 3183.
 - 5. Copper Tubing: ASTM B 75.
 - 6. Wrought Copper Solder Fittings: ANSI B 16.22.
 - 7. Steel Pipe: ASTM A 53B.
 - 8. Malleable Iron Threaded Fittings: ANSI B 16.3.
 - 9. Cast Iron Threaded Fittings: FS WW-P-501E.
 - 10. Flange Bolt, Sets: ASME Pressure Piping.
 - 11. PVC Piping and Fittings: Schedule 40.

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12. Unions in Copper or Brass Lines: 125 pound all brass, screwed pattern, ground joint, equal to Chase, Crane or Mueller.
 13. Mechanical Couplings: Victaulic Style 77.
- C. Roof Drain: Cast Iron body; minimum 6-inch diameter, with deck clamp, strainer, and accessories required for installation conditions.
- D. Product Substitution: For any proposed change in materials or for any new materials, submit request for substitution under provisions of Section 01600.

2.02 TESTS

- A. Test in accordance with recognized standards and as recommended by equipment manufacturers and per local governing agencies.
- B. Notify Owner's Representative 24 hours prior to all testing.
- C. Record all test results and corrective measures taken. Provide results to Owner with Project Record Documents under provisions of Section 01700.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Inspect existing conditions prior to commencing Work, including elements subject damage or movement during Work.
- B. Prior to starting the proposed work, verify all roof drains, soil pipes, flutes, roof equipment, steel decking and associated members, piping, electrical conduit, and other roof top equipment are secured to the building structure and are in a functional condition. Contractor shall communicate in writing to Owner's Representative any item found to be not properly secured or in a non-functional condition. Beginning work indicates acceptance of existing conditions, including operability of plumbing, mechanical and electrical items / equipment located in the referenced work area(s).
- C. Base Vertical Membrane Flashings: Coordinate roof insulation and cover board thickness with adjacent base flashing height, to maintain not less than 8-inch (203 mm) membrane flashing height. Adjust base vertical flashing height including substrates and changes in exterior wall materials to maintain minimum height. Contractor will be responsible for all cost for any modifications required to roof top equipment, i.e. roof hatches, exhaust fans, pipe and electrical penetrations, metal counter flashings, cut-in reglet, to meet the minimum 8-inch membrane flashing height.
- D. Prior to starting the roofing project, the roofing contractor shall verify the existing roof drains and drain piping are clear of debris, open and functional, that piping is properly connected and sealed to drain bowls, the drain bowls are at a proper height to match the thickness of the roofing insulation, and all drain components are in serviceable condition. Roofing contractor shall include all cost associated with raising or lowering the primary roof drains to a height to match the tapered insulation drain sump thickness at the top of the drain bowl.
- E. Roofing contractor shall include all cost associated for lowering or raising the overflow drains. The overflow drains having the same size as the roof drains shall be installed with the inlet flow line located 2 inches (51 mm) above the low point of the roof, or overflow scuppers having three times the size of the roof drains and having a minimum opening height of 4 inches (102 mm) shall be installed in the adjacent parapet walls with the inlet flow located 2 inches (51 mm) above the low point of the roof served. The installation and sizing of overflow drains, leaders and conductors shall comply with Sections 1106 and 1108 as applicable of the International Plumbing Code. Overflow drains shall discharge to an approved location and shall not be connected to roof drain lines.

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- F. Contractor shall include in his proposal the cost for utilizing a licensed mechanical contractor for any applicable application to where designated refrigeration lines or equipment is to be lifted or lowered from the roof to facilitate the installation of the roofing system.
- G. After uncovering existing work, inspect conditions affecting performance of Work.
- H. Confirm operational condition of equipment and systems. Notify Owner in writing of any deficiencies prior to Work.
- I. Beginning Work means acceptance of existing conditions and responsibility to return system or equipment to operating condition upon completion of Work.

3.02 PREPARATION

- A. Provide temporary supports to ensure structural integrity of the Work.
- B. Provide devices and methods to protect other portions of Project from damage, debris, or contamination.
- C. Provide protection from elements for areas that may be exposed by uncovering work.
- D. Provide temporary connections and maintain operational capacity of systems or equipment that will be displaced more than one day, unless instructed otherwise.

3.03 INSTALLATION

- A. Execute work by methods that will avoid damage to other Work and provide proper surfaces for the installation of new or existing roof drains, new or existing pipe and conduit supports, and equipment curbs, or to accommodate reinstallation and reconnection of equipment and/or systems.
- B. Execute work by method that will not cause damage to the existing refrigeration piping, electrical conduits, gas lines, and roof mounted mechanical equipment as to accommodate the installation of the new roofing system.
- C. Employ skilled, licensed and experienced installer to perform all operations for all mechanical and electrical work.
- D. Modified equipment curb or roof penetration as required to ensure equipment and roof penetration has a sufficient height for installing a minimum eight (8") inch high roof membrane flashing.
- E. Cut rigid materials with manufacturer approved equipment.
- F. Ensure roofing system is watertight to elements and around roof penetrating elements.

3.04 TESTING AND ADJUSTING

- A. Test all modified, relocated, and new systems and equipment.
- B. Correct all deficiencies identified, including replacement of parts and components when required.
- C. Adjust all Products and equipment to ensure proper operation and function.

3.05 CLEANING

- A. Clean work under provisions of Section 01700.
- B. Clean Owner-occupied areas when soiled by Work or operations of this Division.

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END OF SECTION

SECTION 22 14 21 - NON-PENETRATION ROOFTOP PIPE & EQUIPMENT SUPPORTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Portable, non-penetrating, rooftop support system for:
 - 1. Piping.
 - 2. Ducts.
 - 3. HVAC equipment.
 - 4. Walkways, Crossovers, Stairs and Ramps.

1.02 RELATED DIVISIONS AND SECTIONS

- A. Related Division and Sections include the following:
 - 1. Division 7 Section 07 54 19 - "Thermoplastic Membrane Roofing"
 - 2. Division 7 Section 07 59 00 - "Preparation of Reroofing"
 - 3. Division 7 Section 07 62 00 - "Sheet Metal Flashing and Trim"
 - 4. Division 7 Section 07 92 00 - "Joint Sealants"
 - 5. Division 15 Section 15 01 00 - "Basic Mechanical Requirements"
 - 6. Division 16 Section 16 01 00 - "Basic Electrical Requirements"

1.03 REFERENCES

- A. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A 525 - Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
- D. ASTM D 1929 - Standard Test Method for Determining Ignition Temperature of Plastics.
- E. MSS SP-58 - Pipe Hangers and Supports -- Materials, Design and Manufacture; Manufacturers Standardization Society of the Valve and Fittings Industry.
- F. MSS SP-69 - Pipe Hangers and Supports -- Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry.

1.04 SYSTEM DESCRIPTION

- A. Support piping on roof with an engineered prefabricated PHP System designed for installation without roof penetrations, flashing or damage to the roofing material. The system shall consist of bases, made of high density polypropylene plastics with UV Protection, an HDG structural steel frame and suitable pipe hangers for the application. Nuts, threaded rods and washers shall be HDG, spring nuts and bolts for spring nuts will be electro-plated. System shall be custom designed to fit piping and conduit to be installed and the actual conditions of service.

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- B. Support ductwork on roof with an engineered prefabricated PHP-Duct System designed for installation without roof penetrations, flashing or damage to the roofing material. The system shall consist of bases, made of high density polypropylene plastics with UV Protection, and an HDG structural steel frame. Nuts, threaded rods and washers shall be HDG, spring nuts and bolts for spring nuts will be electro-plated. System shall be custom designed to fit the load requirements that will be required.
- C. Support elevated walkway systems routed across the roof with an engineered prefabricated PHP-Walkway System designed for installation without roof penetrations, flashing or damage to the roofing material. The system shall consist of bases, made of high density polypropylene plastics with UV Protection, a galvanized structural steel frame, walkway planking, and handrail if required. Nuts, threaded rods and washers shall be HDG, spring nuts and bolts for spring nuts will be electro-plated. System shall be custom designed to fit the load requirements that will be required.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Show installation layout, sizes of units, and details of installation.
- D. Verification Samples: Actual samples of bases, each type of support, hanger, and fasteners, and not less than 12 inches (300 mm) of framing members.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- F. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic checking and adjustment of components.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing pipe support systems, with a minimum of eight years of documented experience.
- B. Installer Qualifications: Company approved by manufacturer and with not less than five years of experience in installation of piping support systems.
- C. References: Submit list of references comprising not less than 10 installations that have been in use for a minimum of five years. Include contact name and phone numbers for each reference.
- D. Pre-Installation Meeting: After approval of submittals, but before beginning installation, conduct a meeting at project site attended by Architect, Contractor, installers of roofing, and mechanical and electrical piping to be installed on pipe support systems.
 - 1. Purpose of meeting is to describe in detail the installation process and to establish agreement, coordination, and responsibilities.
 - 2. Prepare detailed meeting report and distribute copies to the Architect and all attendees.

1.07 DELIVERY, STORAGE, AND HANDLING

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- A. Deliver all materials to project site in manufacturer's original packaging, marked with manufacturer's name, product model names and catalog numbers, identification numbers, and other related information.
- B. Store materials under cover until needed for installation.

1.08 WARRANTY

- A. See Section 01780 - Closeout Submittals, for additional warranty requirements.
- B. Warranty: Manufacturer's 5-year limited warranty to repair or replace, at our option, any products we find to be structurally defective in material or workmanship. Warranty is not valid if System was modified, installed incorrectly, or not designed by Manufacturer's Design Team.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. PHP Systems/Design, Houston, TX 77020; Web: <https://www.phpsd.com/>
 - 2. Eberl Iron Works, Buffalo, NY 14204-1492; Web: <https://www.eberliron.com/>
- B. Requests for substitutions will be considered in accordance with provisions of Section 01600.
- C. Substitutions must be submitted and approved seven days prior to date of pre-bid conference.

2.02 APPLICATION

- A. Support pipes, conduit, cable trays, and ducts minimum of 6 inches (150 mm) above roof surface.
 - 1. Support Spacing: eight feet maximum.
 - 2. For Electrical and Gas Lines 2-1/2 inches (64 mm) in Diameter or Less, up to 10 inches (254 mm) above roof: Portable Pipe Hanger Model number: SS8 or equal.
 - 3. For Electrical and Gas Lines 3-1/2 inches (89 mm) in Diameter or less, up to 16 inches (406 mm) above roof: Portable Pipe Hanger Model number PP10 or equal.
 - 4. For single Electrical and Gas Lines 3 to 8 inches (80-200 mm) in Diameter: Portable Pipe Hanger Model number PS 1-2 or equal.
 - 5. For Multiple Lines: Portable Pipe Hanger Model number PSE custom or equal.
 - 6. For Ductwork: Portable Pipe Hanger Model number PPH-D - Goal Post style or equal.
- B. Walkway, Crossover, Stairs, Ramps and Equipment Platform Access: Elevated walkway systems as manufactured by the approved manufacturers.
 - 1. Bases High Density Polypropylene plastics with additives for UV protection
 - 2. Substructure: 12-gauge back-to-back strut G-1012A or approved equal supported directly from the bases.
 - 3. Grating: Mill-galvanized carbon steel in accordance with ASTM A525:
 - a. Gauge 18-ga. steel.
 - b. Section Width: 12 inches (305 mm) (standard),
 - c. Channel Height: 2 inches (51 mm) (standard).
 - d. Flange Options: FM
 - e. Flange Options: MM.
 - f. Surface Condition: MG-traction grip
 - 4. Handrail: 12 gauge, 1-5/8-inch (41 mm) strut G-5812 or approved equal.

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5. All substructures and handrails shall be galvanized steel. Spring nuts and bolts for spring nuts will be electro-plated.

2.03 MATERIALS

- A. Portable Support System: Engineered, portable system specifically designed for installation without the need for roof penetrations or flashings, and without causing damage to the roofing membrane.
 1. Design system using high density / high impact polypropylene bases with carbon black, anti-oxidants for UV protection, and steel framing for support is 1-5/8-inch (41 mm) B22TH or 1-7/8-inch (48 mm) BTS22TH.
 2. Custom design system to fit piping, conduits, equipment, or walkways to be installed and actual conditions of service and loading.
 3. Piping Supports: Provide suitable hangers and supports.
 4. Duct and Equipment Supports: Factory fabricated to support exact duct sizes and equipment to be installed.
 5. Walkways and Platforms: Provide galvanized slotted metal grating, in configurations as indicated, and tubular handrails where indicated.
- B. Bases: Injection molded high density / high impact polypropylene with UV-inhibitors and anti-oxidants, conforming to the following:
 1. Moisture Content: Negligible.
 2. Shrinkage/Swelling Due to Moisture: Negligible.
 3. Density: 55.8 lb/cu ft (894 kg/cu m).
 4. Insect Resistance: No known insect damage potential.
 5. Chemical Resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, and sulfuric acid: No visual or physical change apparent.
 6. Flammability: No ignition after 10 minutes, 25 kW/m, when tested in accordance with ASTM D 1929.
 7. Sized as required by loading conditions and as indicated on the drawings.
 8. Shop fabricated with inserts for square tubing or threaded rods as required.
 9. Color: Integral black color as molded.
 10. Bases for Mechanical Attachment: Sealant chamber around penetration point, with injection port for sealing after fastening; beveled lip for sealant bead around entire diameter.
 11. Do not use bases containing carbonated plastics, press molded recycled rubber and plastics, steel, stainless steel, or any injection molded threaded receivers.
- C. Stainless Steel Framing:
 1. Channel Types: 1-5/8 inch (41.3 mm) or 1-7/8 inch (47.6 mm), as required for loading conditions.
 2. Thickness: 12 gauge (2.7 mm).
 3. Form: Roll-formed 3-sided or tubular shape.
 4. Finish: Mill finish.
 5. Do not use tubing or tube steel.
- D. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69 and as follows:
 1. Fabricate of stainless steel where framing is stainless steel; finished same as framing.
 2. Sizes 2-1/2 inch (63 mm) and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
 3. Sizes 3 inch (76 mm) and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.
- E. Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system.

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1. Stainless Steel: Mill finish.
2. For Mechanical Fastening to Deck: On wood and steel decks, use bolts with toggle wings; on concrete decks use threaded rods and adhesive anchors, with rod embedded at least 1-3/4 inches (44 mm) into concrete.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that roofing system is complete and that roof surfaces are smooth, flat, and ready to receive work of this section.
- B. Verify that roof surface temperature is at minimum 60 degrees F (15.5 degrees C), for proper adhesive performance.

3.02 PREPARATION

- A. Clean surfaces of roof in areas to receive portable support bases.
 1. Remove dirt, dust, oils, and other foreign materials.
- B. Use care in handling portable support system components during installation, to avoid damage to roofing, flashing, equipment, or related materials.

3.03 INSTALLATION

- A. Pipe, Duct, Cable, and Conduit Support Systems:
 1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping, ducts, and conduit, whether or not all required devices are shown.
 2. The use of wood for supporting piping is not permitted.
 3. Provide supports spaced so deflection of piping does not exceed 1/240 of span.
 4. Install framing at spacing indicated, but in no case at greater than 10 feet (3 m) on center.
 5. Accurately locate and align bases.
 - a. Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
 - b. Set isolation pads in adhesive if required by manufacturer's instructions.
 - c. Place bases on isolation pads.
 - d. Adhere or mechanically attach if required by code.
 - e. Where applicable, replace gravel around bases.
 6. Set framing posts into bases and assemble framing structure as indicated.
 7. Use stainless steel fasteners for stainless steel framing.
- B. Duct Support Systems
 1. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping, ducts, and conduit, whether or not all required devices are shown.
 2. Accurately locate and align bases.
 - a. Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
 - b. Set isolation pads in adhesive if required by manufacturer's instructions.
 - c. Place bases on isolation pads.
 - d. Adhere or mechanically attach if required by code.
 - e. Where applicable, replace gravel around bases.

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3. Place pre-assembled support on bases and attach framing post to base bracket with 1/2-inch bolts provided and adjust as needed. Support shall be adjustable to maintain existing elevation and slope.
 4. Use stainless steel fasteners for stainless steel framing.
- C. Walkway, Crossover & Equipment Platform Access:
1. Install substructures at spacing indicated, but not greater than 5 feet (1.5 m) on center.
 2. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all structures.
 3. Accurately locate and align bases.
 - a. Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
 - b. Set isolation pads in adhesive if required by manufacturer's instructions.
 - c. Place bases on isolation pads.
 - d. Adhere or mechanically attach if required by code.
 - e. Where applicable, replace gravel around bases.
 4. Set legs of substructures into bases as indicated.
 5. Use stainless steel fasteners for stainless steel framing.
 6. Layout and fasten planking to substructures.
 7. Where handrails are required, install as follows:
 - a. Install intermediate rails without tightening.
 - b. Make minor adjustments as needed, such as spacing of substructures to accommodate intermediate handrails, and install hold-downs.
 - c. Secure intermediate handrails and install top handrails.

3.04 FIELD QUALITY CONTROL

- A. Provide a factory-trained representative of the manufacturer to visit the site while the work is in progress to assure that the installation conforms to the design requirements and the manufacturer's installation requirements.

3.05 CLEANING AND PROTECTION

- A. Remove all packaging, unused fasteners, adhesive, and other installation materials from the project site.
- B. Remove adhesive from exposed surfaces of supports and bases and leave the work in clean condition.
- C. Provide protection as required to leave the work in undamaged condition at the time of substantial completion.

END OF SECTION

SECTION 260500 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Basic Electrical Requirements specifically applicable to Division 16 Sections, in addition to Division 1 - General Requirements.
 - 2. Lifting, moving, re-installation, repairs, and minor modifications to existing equipment, and service lines and connections.
 - 3. Anchors, brackets, fasteners, hardware, and accessories for related Work.
- B. Related Division and Sections include the following:
 - 1. Division 5, Section 05 52 13 – “Wall Mounted Guard Rail”
 - 2. Division 7, Section 07 54 19 – “Thermoplastic Membrane Roofing”
 - 3. Division 7, Section 07 62 00 – “Sheet Metal Flashing and Trim”
 - 4. Division 7, Section 07 92 00 – “Joint Sealants”
 - 5. Division 22, Section 22 14 20 – “Basic Mechanical Requirements”
 - 6. Division 22, Section 22 14 21 – “Non-Penetrating Rooftop Pipe and Equipment Supports”

1.03 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

- A. Submit under provisions of Division 1 Section “Administration Requirements”.
- B. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal.
- C. Mark dimensions and values in units to match those specified.
- D. Proposed Products List: Include Products specified in this Section and all Products required for execution of Work:
- E. Certification: Provide current letter(s) on Company’s letterhead, signed by an authorized employee or corporate officer attesting to all following items:
 - 1. Qualifications: Certify and document items in Article on Qualifications, and;
 - 2. Products: Certify that selected products meet or exceed specified requirements;
 - 3. Manufacturer's Certification: Each product meets or exceeds specified requirements.

1.05 QUALIFICATIONS

- A. Electrical Contractor: Company specializing in installing, inspecting, and certification of the work of this Division with a minimum of five (5) years documented experience working with the systems and Products in place and proposed or required. Licensed by jurisdictions having authority for inspection and certification of the required work.
- B. Contractor shall include in his proposal the cost for utilizing a licensed electrical contractor for any applicable application to where designated electrical conduit or equipment is to be removed from the roof, or where the electrical supply / conduit needs modifications to allow proper installation of the roofing system, or where any electrical supply needs to be disconnected or reconnect to facilitate the installation of the roofing system.

1.06 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70 and applicable local Building Code for all electrical work.
- B. Obtain permits, and request inspections from authority having jurisdiction.

1.07 PROJECT/SITE CONDITIONS

- A. On the referenced project roofing areas, the Contractor is to inspect the existing electrical system for any unacceptable or defective component. Any unacceptable item shall be brought to the attention of the Owner's representative prior to executing work.
- B. Install Work in existing locations and as directed or as required unless prevented by Project conditions.
- C. Prepare drawings showing proposed re-arrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Owner's Representative before processing.

1.08 SEQUENCING AND SCHEDULING

- A. Construct Work in sequence under provisions of Division 1 Section "Administrative Requirements."
- B. Coordinate with other Trades and Owner to ensure electrical conduit and wiring removal does not inhibit other Work.

1.09 PROJECT RECORD DOCUMENTS

- A. Submit in accordance with Division 1 Section "Execution Requirements."
- B. Accurately record locations of lightning protection system by horizontal dimensions and elevations.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Primary Products: Those required for original installation.
- B. Product Substitution: For any proposed change in materials or for any new materials, submit request for substitution under provisions of Division 1 Section "Product Requirements."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Inspect existing conditions prior to commencing Work, including elements subject to damage or movement during Work.
- B. After uncovering existing work, inspect conditions affecting performance of Work.
- C. Confirm operational condition of equipment and systems. Notify Owner in writing of any deficiencies prior to Work.
- D. Beginning Work means acceptance of existing conditions and responsibility to return system or equipment to operating condition upon completion of Work.

3.02 PREPARATION

- A. Provide temporary supports to ensure structural integrity of the Work.
- B. Provide devices and methods to protect other portions of Project from damage, debris, or contamination.
- C. Provide protection from elements for areas that may be exposed by uncovering work.
- D. Provide temporary connections and maintain operational capacity of systems or equipment that will be displaced more than one day, unless instructed otherwise.

3.03 PERFORMANCE

- A. Execute work by methods that will avoid damage to other Work and provide proper terminations to accommodate reinstallation and reconnection.
- B. Employ skilled and experienced installer to perform all operations.
- C. Employ original installer to perform operations on systems or equipment under warranty.
- D. Restore Work with new Products, as required for original installation, and in accordance with requirements of Contract Documents.
- E. Fit Work water tight to adjacent elements and around penetrating elements.

3.04 TESTING AND ADJUSTING

- A. Test all modified and relocated systems and equipment by a certified electrical company.
- B. Correct all deficiencies identified, including replacement of parts and components when required.
- C. Adjust all Products and equipment to ensure proper operation and function.

3.05 CLEANING

- A. Clean work under provisions of Division 1 Section "Execution Requirements."
- B. Clean Owner-occupied areas when soiled by Work or operations of this Division.

END OF SECTION

ATTACHMENT NO.1



U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Air Traffic Organization Policy

ORDER
JO 3900.63A

Effective Date:
01/26/2021

SUBJ: Air Traffic Organization Fall Protection Program

-
1. This order defines the Air Traffic Organization (ATO) Fall Protection Program (FPP) and identifies program standards, establishes roles and responsibilities, and provides procedures for identifying and minimizing fall hazard risks, providing fall protection training and personal protective equipment, and implementing safe work procedures.
 2. This order requires the recognition and evaluation of fall hazards, communication of identified hazards to affected personnel, and establishment of appropriate protective measures. This order identifies the minimum requirements for the ATO FPP; however, site-specific requirements may be more stringent based upon local risk assessments.
 3. Compliance with this order enforces the Occupational Safety and Health Administration (OSHA) General Industry and Construction Standards and applicable consensus standards related to fall protection and walking-working surfaces.

Teri L. Bristol Digitally signed by Teri L. Bristol
Date: 2021.01.26 13:02 -

Teri L. Bristol
Chief Operating Officer
Air Traffic Organization

01/26/2021

JO 3900.63A

RECORD OF CHANGES

DIRECTIVE NO. JO 3900.63A

CHANGE TO BASIC	SUPPLEMENTS			OPTIONAL USE	CHANGE TO BASIC	SUPPLEMENTS			OPTIONAL USE
	MM	DD	YY			MM	DD	YY	

FAA Form 6000-25 (10/12)

01/26/2021

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Chapter 1. General Information

1. Purpose of This Order. This order defines the ATO FPP, a comprehensive fall protection program designed to protect ATO employees from existing and foreseeable fall hazards, which include: work on elevated work surfaces four (4) feet or more above the next lower level, where hazards may exist on walking-working surfaces and areas used for access to elevated work areas.

a. The ATO FPP defined by this order was developed to operate in accordance with requirements defined by the OSHA and the American National Standards Institute (ANSI), American Society of Safety Professionals (ASSP) and International Safety Equipment Association (ISEA).

b. The ATO FPP establishes program-specific roles and responsibilities, defines the fall protection requirements, and identifies program standards (including ANSI/ASSP Z359, The Fall Protection Code).

2. Audience. This order is intended for use by all ATO employees exposed to existing and foreseeable fall hazards, which include: performing work on elevated work areas four (4) feet or more above the next lower level, on walking-working surfaces and areas used for access to elevated work areas. Reference specific Fall Protection Policy documents for Flight Program Operations (AJF) organizations.

3. Where Can I Find This Order. You can find an electronic copy of this order on the Directives Management System (DMS) website: https://employees.faa.gov/tools_resources/orders_notices/. Or go to the [MyFAA employee website](#), select “Tools & Resources” and then select “Orders and Notices”.

4. Cancellation. This order cancels the previous version of this order, JO 3900.63, Air Traffic Organization (ATO) Fall Protection Program, dated April 6, 2011.

5. Explanation of Policy Changes. This order reflects changes in the ATO organization and revisions to fall protection program policy and procedures. This order applies standards created for all Environmental and Occupational Safety and Health (EOSH) program-specific directives to the ATO FPP.

6. Scope and Application. The ATO FPP applies to ATO personnel performing work on all elevated work areas that are four (4) feet or more above the next lower level, where hazards may exist on walking-working surfaces and areas used for access to elevated work areas. This program presents the minimum requirements for the FPP. Additional site-specific requirements may be more stringent based upon local risk assessments.

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Chapter 2. Roles and Responsibilities

1. ATO Executive-level Managers. ATO Executive-level Managers ensure compliance with and incorporate the requirements of this order into programs and activities managed by their organizations, including those involving deployment of new systems and modernization projects that require fall protection or existing fall protection systems brought into compliance with current requirements.

2. ATO Managers. ATO Managers must:

- a. Manage the requirements and ensure compliance with this order.
- b. Coordinate with building owners/property managers to ensure all applicable fall protection requirements are incorporated into lease agreements. Ensure that building conditions incorporate fall protection requirements, as applicable for leased and non-FAA owned/controlled workplaces without conventional leases.
- c. Complete the Manager/Supervisor EOSH Awareness Course.

3. ATO EOSH Services Group. ATO EOSH Services Group must:

- a. Designate a National ATO FPP Lead (FPP Administrator).
- b. Serve as the Office of Primary Responsibility (OPR) to revise this order.
- c. Develop, disseminate and revise fall protection documents as necessary to supplement this order.
- d. Provide technical guidance, assistance and requirements to all ATO organizations for the ATO FPP.
- e. Provide resources for the overall management of the ATO FPP.
- f. Coordinate with and provide technical assistance to the Office of Safety and Technical Training (AJT) on fall protection training requirements for ATO employees.
- g. Conduct an annual evaluation to determine the effectiveness of the FPP.

4. Technical Operations Managers. Technical Operations Managers must:

- a. Ensure compliance and implementation of the requirements of this order within their respective organizations.
- b. Incorporate fall protection requirements, including appropriate engineering controls in accordance with the fall protection hierarchy of controls outlined in paragraph 2, Chapter 3 into all construction, renovation, demolition, installation, commissioning and other modification projects managed by the organization.

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c. Ensure the use of applicable work permits and the latest revision of ATO Order JO 3900.57, Environmental and Occupational Safety and Health (EOSH) Requirements in the Planning and Execution of Construction and Maintenance Activities at National Airspace System (NAS) Facilities.

d. Ensure timely evaluation of fall protection concerns within their organization and initiate necessary response actions.

e. Coordinate with the ATO Safety and Health Specialist within their organization regarding fall protection issues and incidents.

f. Ensure that personal protective equipment (PPE) and other fall protection equipment are available at applicable work locations within their organizations, where required.

g. Ensure that all personnel are trained to the appropriate level for assigned tasking, and all training is recorded in the appropriate system of record.

h. Ensure routine maintenance is performed on elevated work areas as outlined in applicable Federal Aviation Administration (FAA) maintenance orders.

i. Ensure required Facility Fall Hazard Survey Checklist information, as described in Appendix L and in accordance with ANSI Z359.2, is completed before initiating work at heights, updated and maintained at each applicable facility.

5. ATO Safety and Health Specialists. ATO Safety and Health Specialists must:

a. If serving as a designated point of contact and providing oversight for fall protection activities, maintain proficiency in the overall FPP and all its elements, and receive formal training as a Competent Person.

b. As required, serve as designated points of contact and provide oversight for fall protection activities in their areas of responsibility.

c. As required, assist in coordinating and selecting appropriate fall protection training for employees that are expected to perform maintenance or work activities at elevated work areas.

d. As required, assist in the validation and selection of approved fall protection equipment.

e. As required, assist with the development of local procedures, as appropriate, and rescue plans in accordance with this FPP.

f. As required, assist in the resolution of Unsatisfactory Condition Reports (UCRs) and complaints regarding fall protection.

g. As required, provide assistance to resolve workplace inspection findings as related to the FPP.

h. As required, assist in the completion of the Facility Fall Hazard Survey Checklist in accordance with ANSI Z359.2 for all elevated work areas, platforms, ladders and towers that require work tasks at height when requested (See Appendix L).

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i. As required, review design drawings to ensure fall protection compliance is incorporated for construction, routine maintenance and other foreseeable work tasks at height.

j. As required, perform review of contractors' FPP to ensure fall protection compliance when contractors are working at FAA facilities.

6. Frontline Managers and Supervisors. Frontline Managers and Supervisors must:

a. With assistance of the ATO Safety and Health Specialist, manage and ensure compliance with the ATO FPP.

b. Ensure that a minimum of two (2) trained persons are available for all work at heights in accordance with Subsection 9.a. of Chapter 3.

c. Ensure that work requiring the use of active fall protection is not assigned to employees with a total combined aloft weight (body + clothing + gear + tools + misc. load) of less than 130 lbs or greater than 310 lbs per ANSI/ASSP Z359 fall protection requirements.

d. Ensure that the Facility Fall Hazard Survey Checklists, as described in Appendix L and in accordance with ANSI Z359.2, are completed by a Competent Person for all towers and elevated work areas before assigning employees work at affected locations.

e. Ensure that a determination of the safety of the fall protection environment is made using the Facility Fall Hazard Survey Checklist.

f. Ensure all facility upgrades, modifications and renovations are promptly updated in the Facility Fall Hazard Survey Checklist and maintained at each applicable facility.

g. Ensure rescue plans are developed, are kept up-to-date with current rescue information, and have been reviewed and confirmed by a Competent Person.

h. As applicable, ensure that a Competent Person reviews the written procedures and strategies submitted from a responding emergency rescue services organization to ensure they are capable of performing rescues at the applicable facilities.

i. Ensure employees who work at heights and utilize fall protection equipment have received the appropriate level of training. Prior to training, communicate with employees about their self-assessment to ensure they meet the ANSI required 130-310 lbs weight range and are physically and mentally capable to safely perform work at heights per Chapter 3 Subsection 6.a.

j. Ensure that fall protection equipment is provided and properly used, maintained, and inspected in accordance with manufacturer's instructions before each use by Authorized Persons and at least annually by a Competent Person.

k. Ensure annual Competent Person inspections are documented and maintained for the life of the equipment.

l. Ensure that defective or impacted fall protection equipment identified by trained ATO personnel is removed from service, rendered unusable, disposed of as solid waste, and replaced. If needed, the manager may consult a Competent Person regarding the equipment's integrity.

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Some equipment may be returned to the manufacturer for repair as per manufacturer instructions/recommendations.

m. Prohibit work at heights on any structures deemed unsafe by a Competent Person or Qualified Person and post appropriate signage. Ensure information is communicated to all FAA employees and site visitors.

n. Ensure routine maintenance is performed on elevated work areas outlined in applicable FAA maintenance orders, including annual inspections by people trained to conduct those inspections.

o. Report any falls or near misses in accordance with accident reporting requirements in FAA Order 3900.19, FAA Occupational Safety and Health Program, and through use of standard reports and systems.

p. Ensure the use of applicable work permits and the latest revision of ATO Order JO 3900.57.

q. Ensure that contractors working at FAA sites for which the organization has oversight responsibilities have independent FPPs and comply with all applicable federal and state OSHA requirements.

r. Ensure that all fall protection facility project requirements are entered into the Corporate Work Plan (CWP).

7. ATO Project Managers/Project Implementers. ATO Project Managers/Project Implementers must:

a. Incorporate ATO FPP requirements and appropriate engineering controls into all construction, renovation, demolition, installation, commissioning and other modification projects they manage. Ensure FPP costs associated with the project are included in project cost estimates.

b. Identify and resolve non-compliant fall protection issues of all affected work areas and elevated maintenance areas affected by renovation projects prior to project execution.

c. Ensure that all fall protection project requirements are entered into the CWP.

d. Notify the Front Line Manager and ATO Safety and Health Specialist of all fall protection installations, upgrades, modifications and renovations and provide project documents and engineering package as necessary for review.

e. Ensure the use of applicable work permits and the latest revision of ATO Order JO 3900.57.

f. Ensure that specifications, solicitations, requests for proposal and contract documents contain clauses requiring contractor fall protection programs for applicable projects.

g. Ensure that contractors working at FAA sites have independent FPPs and comply with all applicable federal and state OSHA requirements.

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8. Employees. Employees must:

a. Notify manager/supervisor prior to commencing unforeseen work activities involving exposure to fall hazards (e.g., work on elevated platforms, towers, ladders and scaffolds) to ensure activities are planned and all fall hazards are addressed.

b. Review the Facility Fall Hazard Survey Checklist information and visually inspect towers and/or elevated work surfaces prior to accessing work area. Notify manager/supervisor of any observed safety deficiencies. If any safety deficiencies are identified prior to or during work at heights, suspend any further activity and notify the manager/supervisor immediately. If the manager/supervisor is not immediately available, cease any further activity until contact is made.

c. Complete the proper level of training as assigned by manager/supervisor.

d. Prior to attending fall protection training, perform a self-assessment including physical and mental capability to safely work at heights per Chapter 3 Subsection 6.a. In accordance with ANSI/ASSP Z359, workers must be between 130-310 lbs with a total combined aloft weight (body + clothing + gear + tools + misc. load) to attend fall protection training and conduct work at heights as an Authorized Person. Discuss any concerns with manager prior to attending training.

e. Properly wear, maintain, and use fall protection equipment.

f. Inspect fall protection equipment prior to each use, and verify inspection is performed annually by a Competent Person prior to utilizing equipment.

g. Identify defective equipment or equipment that has been impacted by a fall; return it to supervisor and request a replacement.

h. Be familiar and comply with site-specific rescue plans, including available means of communication.

i. Assess ability to safely work at heights on the day of the task per Chapter 3 Subsection 6.a. and 6.b.

j. Return personally issued fall protection equipment to the appropriate ATO Manager (such as Front Line Manager) upon leaving the Agency.

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Chapter 3. ATO Fall Protection Program

1. ATO FPP. The ATO will manage the ATO FPP and ensure employees are protected from fall hazards while working on elevated work surfaces four (4) feet or more above the next lower level, on walking-working surfaces and areas used for access to elevated work areas. The details for this comprehensive program are identified within the sections of this chapter.

2. Hierarchy of Fall Protection Controls. The following controls must be considered, in order, when selecting fall protection:

a. Hazard Elimination. The hazard or process is redesigned to eliminate the worker's exposure to the hazard. Special training is not required, and the worker does not actively have to apply fall protection. Examples of hazard elimination include, relocating junction boxes to a height lower than 4 feet from the ground or installing a telescoping support pole that allows work on mounted equipment to be performed at ground level.

b. Passive Fall Protection. The hazard is mitigated by a barricade preventing workers from reaching the fall hazard. Passive fall protection (also known as "fall hazard prevention") is the most versatile hazard resolution method since specialized training is not required, no fall protection PPE/equipment is required, and, when used properly, does not require the worker to actively apply fall protection. Examples of fall hazard prevention are guardrails on rooftops or work platforms, hole/well covers, and roof edge parapet walls, providing they meet OSHA design and construction requirements.

c. Fall Restraint. A fall protection system is utilized to restrain the worker's movement to a point where they cannot access the fall hazard. Fall restraint systems are considered the most preferred of the active fall protection systems (fall restraint, fall arrest, and administrative controls). Training is required to recognize the hazard and correctly utilize the system. Fall restraint requires the worker to don a full body harness while using the system. Examples of fall restraint are a restraint system that includes an anchor point and a fixed-length lanyard which keep a worker from reaching the fall hazard, or a fixed-length lanyard that is attached to a worker inside the platform/bucket of an aerial lift.

d. Fall Arrest. A fall arrest system is used to stop a fall after it has started. These systems allow workers to traverse vertical and horizontal work areas to perform work safely at most locations. Training is required to recognize the hazard, correctly use the system and to develop and/or review a rescue plan. Examples of fall arrest systems include ladder safety systems, energy absorbing lanyards, self-retracting lanyards, and vertical lifelines. All fall arrest systems require the worker to wear a full body harness while using the system.

e. Administrative Controls. Procedures are implemented when the risk of a fall hazard cannot be mitigated. These are typically used on rooftops with unprotected sides and edges where there is no means to affix a fall restraint system. Examples of administrative controls/techniques are warning line systems (designated areas) and safety monitors.

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3. General Program Requirements.

a. Fall protection must be provided when accessing any elevated work area that has an exposed edge or floor opening 4 feet or more in height than the adjacent floor or ground level, when a fall hazard exists on walking-working surfaces and for areas used for access to elevated work areas. Fall protection must also be provided to any employee who works on towers or elevated structures, as identified within this FPP order.

b. All structures that require the use of fall protection equipment must be inspected according to ATO Order 6930.25, Maintenance of Structures and Buildings, and the requirements and procedures provided within this order (including Appendix L).

c. To ensure program integrity and implementation, periodic program evaluations must be conducted at the discretion of the FPP Administrator. Evaluations and/or findings must be maintained with other pertinent FPP recordkeeping data.

d. A Competent Person must be utilized to conduct the following:

- (1) Identify existing and potential hazards associated with elevated work areas.
- (2) Utilize the hierarchy of fall protection controls to minimize hazards associated with elevated work areas.
- (3) Develop site-specific fall protection procedures and rescue plans based on data compiled from the Facility Fall Hazard Survey Checklists.
- (4) Complete Fall Hazard Survey Checklists for all towers, elevated work platforms and structures that require work at heights in accordance with ANSI Z359.2, Section 6.

e. Qualified Persons must be utilized to assess fall hazards associated with structural defects identified by a competent person and for the design of specialized fall protection systems.

f. Fall Hazard Survey Checklists must be completed for all elevated work areas by the ATO organizations who maintain and perform work on elevated work areas (See Appendix L).

4. Fall Protection Requirements for Specific Working Conditions.

a. **Climbing Non-FAA Owned Structures.** Fall Hazard Survey Checklists must be completed for all towers and/or elevated walking-working surfaces that are not FAA-owned, and on which ATO personnel work at heights. The Fall Hazard Survey Checklist must be completed by a Fall Protection Competent Person or Qualified Person. Site-specific fall protection and emergency response procedures (i.e., rescue plans) will be implemented as required by this FPP.

b. **Fixed Ladders.** Fixed ladders must comply with OSHA Standard 29 CFR 1910.23 and applicable industry consensus standards.

(1) The minimum perpendicular distance from the centerline of the steps, rungs, or grab bars, of both to the nearest permanent object in the back of the ladder is 7 inches.

(2) Fixed ladders should have a clear width of at least 15 inches from the centerline of the ladder to the nearest permanent object.

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(a) The step-across distance from the centerline of the ladder to the nearest edge of the structure must be as follows:

(i) For through ladders not less than 7 inches and not more than 12 inches.

(ii) For side step ladders not less than 15 inches and not more than 20 inches.

(3) Side rails of fixed ladders must extend at least 42 inches above the elevated surface being accessed. Side rails of through ladder extensions must be flared to provide 24 to 30 inches of clearance between the side rails. When a Ladder Safety System (LSS) is provided on through ladders, a maximum clearance between side rails must not exceed 36 inches.

(4) For side-step ladders, the rungs and steps must be continuous in the extension.

(5) Fixed ladders terminating at hatch covers are not required to extend above the elevated surface being accessed. However, hatch openings accessed by fixed ladders must be equipped with grab bars or equivalent means to facilitate entry and exit through the hatch.

(6) A minimum perpendicular distance of 30 inches is required from the centerline of the steps of rungs to the nearest object on the climbing side. When unavoidable obstructions are encountered, the minimum clearance at the obstruction may be reduced to 24 inches, provided deflector plates are installed.

(7) Personnel must use a compliant fixed ladder for ascent/descent when present rather than structure climbing. For ladders which are an integral part of towers, structures or other equipment the compliant use of a LSS or other Personal Fall Arrest Systems (PFASs) may be utilized.

(8) Fixed ladders must be inspected prior to use and maintained in a safe condition.

(9) Fixed ladders extending over 24 feet above a lower level must have a LSS installed that is approved by the FPP Administrator and which complies with ANSI A14.3 Ladders – Fixed – Safety Requirements and ANSI/ASSP Z359.16 as applicable. The LSS must be installed per manufacturers' instructions.

(10) Personnel must use fall protection (i.e., a LSS or other Personal Fall Arrest Systems (PFASs)) when climbing fixed ladders that extend more than 24 feet above a lower level.

(11) Ladder cages are prohibited for new installations.

c. Rooftops or Elevated Platforms.

(1) The requirements in this section apply to elevated platforms and low-slope rooftops that are four feet or more above the next lower level. Before working on steep rooftops, contact the organizational ATO Safety and Health Specialist for guidance in selecting appropriate fall protection.

(2) Selection of Fall Protection for Rooftops or Elevated Platforms.

(a) Fall Protection is selected from available fall protection options (passive, active or administrative controls) in accordance with the hierarchy of controls (See Section 2 of this Chapter).

(b) When selecting fall protection from the available fall protection options, the most protective option must be used unless this option is not feasible.

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(c) The following available fall protection options must be selected in decreasing order of preference: guardrails or parapets, fall restraint, fall arrest, warning lines, and safety monitors (See Figure 3-1, Rooftop/Elevated Work Platform Fall Protection Decision Tree, for help in selecting the best fall protection option).

(3) **Fall Protection Options for Rooftops or Elevated Platforms.** Fall Protection methods and options for Rooftops or Elevated Platforms, and the requirements inherent with each, are described below.

(a) **Guardrails/Parapets.** Guardrails or parapets are the preferred means of fall protection on rooftops and elevated platforms. Guardrails and parapets must meet OSHA standards for design and installation (See Appendix J, Work on Elevated Walking-Working Surfaces).

(i) Facilities must be constructed with guardrails or parapets on all low-slope rooftop or platform edges. The height of the guardrails/parapets must be a minimum of 42 inches from the upper surface of the top rail/parapet to the floor level.

(ii) If the guardrails/parapets are less than 42 inches in height, they must be upgraded to a minimum height of 42 inches when the facility is renovated.

(iii) If guardrails are less than 42 inches in height and employees are working within 15 feet of the guardrails, then they must use secondary protection such as fall restraint or fall arrest.

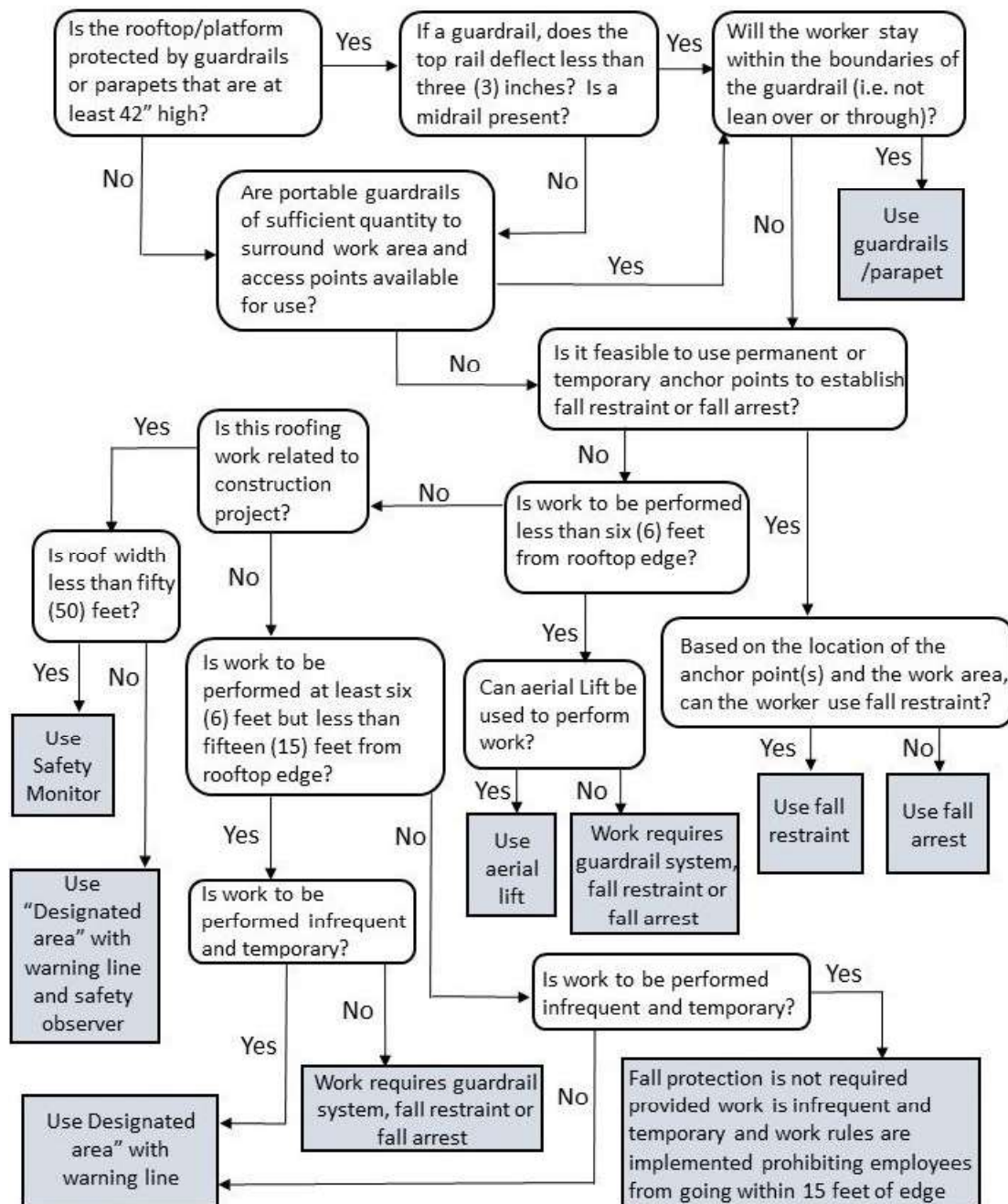
(iv) Fall protection training level requirements as described in this order are not required for using compliant guardrails and parapets where the worker stays within the boundaries of the guardrail/parapet (not lean over or through). Agency provided awareness training provides information regarding the use of compliant guardrails, the identification of fall hazards and associated reporting requirements. A different level of training may be required depending on how employees gain access to the rooftop/elevated platform (See Table 8-1, FPP Training Level Duties and Training Requirements, for further details).

(b) **Fall Restraint.** If guardrails/parapets are not present or are not compliant, employees must use fall restraint when working on rooftops or elevated platforms.

(i) If a fall restraint anchorage is not already present, a permanent or portable restraint anchor must be installed. The anchorage for fall restraint must be capable of supporting at least 5,000 pounds (22.2kN) for each employee attached. The system anchorage may be less than 5,000 pounds if designed, installed, and used, under the supervision of a qualified person as part of a complete personal fall protection system that maintains a safety factor of at least two. Contact a Competent Person or Qualified Person for assistance in selecting the most feasible option. Install anchorages in accordance with manufacturers' instructions.

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Figure 3-1: Rooftop/Elevated Work Platform Fall Protection Decision Tree.

(ii) Employees who use fall restraint on rooftops or elevated platforms must have completed Authorized Person Level I or Authorized Person Level II initial or refresher training within the past two years. This training requirement applies specifically to rooftop/elevated platform work. A different level of training may be required depending on how

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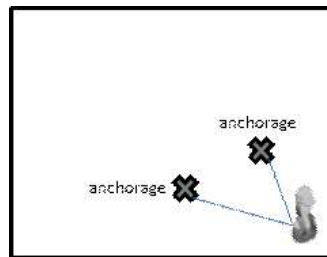
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employees gain access to the rooftop/elevated platform (See Table 8-1, FPP Training Level Duties and Training Requirements, for further details).

(c) **Fall Arrest.** If fall restraint is not possible, utilize fall arrest.

(i) There are limited circumstances when fall restraint is not feasible, but fall arrest is feasible. One example is working near a corner of a rooftop or elevated platform. To establish fall restraint in a corner, two anchorage points are required to provide fall restraint on both edges (See Figure 3-2, Fall Restraint in Corners). If only one anchorage point is available, fall restraint may be infeasible, but fall arrest may be feasible.

Figure 3-2: Fall Restraint in Corners.



(ii) If a fall arrest anchorage is not already present, a permanent or portable fall arrest anchor must be installed. The anchorage for fall arrest must be capable of sustaining a static load of 5,000 pounds per worker connecting to it or two times the maximum arresting force per employee if designed by a Qualified Person. Contact a Competent Person or Qualified Person for assistance in selecting the most feasible option. Install anchorages in accordance with manufacturers' instructions.

(iii) Employees who use fall arrest must have completed Authorized Person Level II initial or refresher training within the past two years.

(d) **Designated Areas (applies only to low-sloped roofs).** If fall arrest is not feasible, employees must use a warning line system (designated area) on low-slope rooftops where employees will work a minimum of 15 feet from the rooftop edge. The designated area must meet OSHA standards for design and installation (See Appendix J, Work on Elevated Walking-Working Surfaces). In addition, the following work rules apply to the use of designated areas:

(i) The warning lines must be placed 15 feet or more from the rooftop edge.

Note: When work to be performed is between six (6) feet and fifteen (15) feet of the rooftop edge, and is both infrequent and temporary (i.e., short and brief tasks such as equipment repair and annual maintenance), a designated area may be established.

(ii) When work is performed fifteen (15) feet or more from the rooftop edge, each employee must be protected by a guardrail system, fall restraint system, personal fall arrest system or designated area (warning line system). Fall protection is not required provided the work is both infrequent and temporary (i.e., short and brief tasks such as equipment repair and

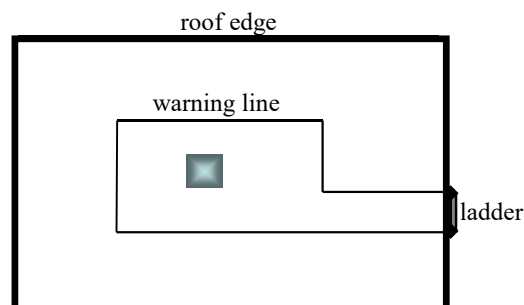
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annual maintenance) and work rules are implemented prohibiting employees from going within fifteen (15) feet of the rooftop edge without using fall protection.

(iii) The warning lines must completely surround the work area and must be erected as close to the work area as the task permits (See Figure 3-3, Warning Lines).

Figure 3-3: Warning Lines.



(iv) Employees must not engage in any work or work activities in the area between the warning lines and the rooftop edge. If employees must work within 15 feet of the rooftop edge, they must use fall restraint or fall arrest.

(v) Employees who use designated areas on rooftops must have completed Authorized Person Level I or Authorized Person Level II initial or refresher training within the past two years. A different level of training may be required depending on how employees gain access to the rooftop (See Table 8-1, FPP Training Level Duties and Training Requirements, for further details).

(vi) For construction only, employees engaged in roofing activities on low sloped roofs, with unprotected sides and edges may use a safety monitor in association with a warning line system that meets the OSHA 29 CFR 1926, Subpart M requirements for construction warning lines on roofs greater than fifty (50) feet. On roofs fifty (50) feet or less in width, the use of a safety monitoring system alone is permitted for employees engaged in roofing activities.

(e) **Safety Monitors.** Safety monitors are the last resort of fall protection. Safety monitors may ONLY be used during construction projects on rooftops that are less than 50 feet wide in the area where employees will work and if no other form of fall protection is feasible. Safety monitors must warn an employee when it appears the employee is unaware of a fall hazard or is acting in an unsafe manner.

(i) Employees being monitored must immediately comply with any of the safety monitor's fall hazard warnings.

(ii) The safety monitor must be trained to recognize fall hazards, stationed on the same rooftop as the employees being monitored and within their views, located close enough to the employees being monitored to communicate orally, and freed of other responsibilities which could distract him/her from the monitoring duties.

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(iii) Both the safety monitors and the employees being monitored on rooftops must have completed Authorized Person Level I or Authorized Person Level II initial or refresher training within the past two years. A different level of training may be required depending on how employees gain access to the rooftop (See Table 8-1, FPP Training Level Duties and Training Requirements, for further details).

d. Hatches and Other Floor Openings at Elevated Walking-Working Surfaces.

Employees must be protected from falling through holes and openings (e.g., hatches, stairway or ladder openings, manholes, vaults, skylights, and pits) by OSHA-compliant permanent or portable guardrails and toeboards, or covers of standard strength and construction which will support twice their expected loads.

(1) The covers must be secured against accidental displacement.

(2) When floor/roof/platform hatches are left open and employees are working in the area, there must be:

(a) An OSHA-compliant permanent or portable guardrail installed around each exposed edge of the opening or;

(b) A monitor watching each hatch to warn people of the hazards. This monitor must not have any other duties which will interfere with his or her responsibility to alert people in the area of the hazards.

(3) Ladder extensions or grab bars must be installed for fixed ladders that terminate at hatches to allow employees to safely enter and exit hatches.

(4) Additional requirements apply to specific types of floor openings:

(a) Stairway openings, except at the entrance point, must be protected by OSHA-compliant guardrails. If guardrails are infeasible, stairway openings must be guarded by OSHA-compliant hinged covers and removable guardrails.

(b) Ladder openings, except at the entrance point, must be guarded by OSHA-compliant guardrails. The entrance point must be protected by a self-closing swinging gate or the entrance must be offset so employees cannot walk directly into the opening (see Figure 3-4).

(c) Skylights must be guarded by standard load-bearing skylight screens or guardrails on all exposed sides.

(d) Temporary floor openings must be protected by guardrails or must be constantly monitored by a Safety Monitor.

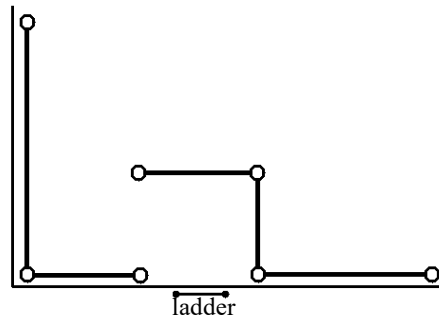
(5) Hoist Area.

(a) If guardrail systems, or portions thereof, are removed to facilitate hoisting operations (e.g., during landing of materials), or an employee must lean through the access opening or out over the edge of the access opening (e.g., to receive or guide equipment and materials), that employee must be protected from fall hazards by a personal fall restraint or arrest system.

(b) Provide barricades to prevent employees from working under a suspended load.

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Figure 3-4: Offset Ladder Opening.**e. Portable Ladders.**

(1) All new portable ladders must be ANSI compliant, be a minimum of Type 1A capacity rating, and be made of fiberglass to reduce electrical hazards.

(2) All portable wooden ladders must be rendered unusable and removed from service.

(3) All portable ladders must be inspected per manufacturers' recommendations prior to use.

(4) Portable ladders (i.e., extension ladders, stepladders, straight ladders, etc.) do not require the use of fall protection, provided the worker uses proper safety procedures as outlined in this order, including Appendix H, SOP for Portable Ladders.

(5) Portable ladders are prohibited from being used on elevated platforms since it increases the fall hazard and compromises the protection afforded by the guardrails. If it is required to elevate the worker higher than the platform, a Competent Person must be consulted for an alternative fall protection method.

(6) See Appendix H for additional guidance on portable ladders.

f. Poles. Work on poles must be performed utilizing the following hierarchy:

(1) Where accessible, aerial lifts must be utilized for all work at elevated work areas on poles.

(2) Where not accessible with aerial lifts, OSHA-compliant fixed ladders must be installed. An LSS is required for fixed ladders extending over 24 feet.

(3) ATO personnel must not climb poles unless the poles are equipped with OSHA-compliant fixed ladders.

(4) When a pole requires replacement, it must be replaced with a tilt-down or telescoping type tower.

g. Fall Protection in Aerial Lifts, Scissor Lifts, and Manbaskets.

(1) Personnel who ride in aerial lifts must use either fall restraint or fall arrest connected to the appropriately rated anchorage installed by the manufacturer. Use fall restraint only if your waist is not above the top guardrail. Before using fall arrest, ensure that the anchorage can support 5,000 pounds and all other manufacturers' requirements or operation limitations are met. See Appendix K for further guidance regarding aerial lifts.

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(2) Employees using scissor lifts with compliant guardrails are not required to use fall restraint or fall arrest. Employees using scissor lifts with non-compliant guardrails must use fall restraint or fall arrest connected to the appropriately rated anchorage installed by the manufacturer. Use fall restraint only if your waist is not above the top guardrail. Before using fall arrest, ensure that the anchorage can support 5,000 pounds and all other manufacturers' requirements or operation limitations are met.

(3) Based on the fall hazards associated with the use of manbaskets, only use manbaskets when all other options are more hazardous or infeasible. Contact a Fall Protection Competent Person for guidance when planning to use a manbasket.

h. Scaffolding SOP. See Appendix I for Scaffolding Standard Operating Procedures.

5. Facilities, Systems, and Equipment Acquisitions.

a. Fall protection requirements must be incorporated as early as possible in all design, acquisition, construction, renovation, demolition, installation, maintenance, and other modification projects and programs. FPP costs associated with the project must be included in project cost estimates.

b. Fall protection issues for all work areas and elevated maintenance areas affected by projects must be identified and resolved prior to project execution.

c. New facilities or existing facilities that receive upgrades must take into account fall hazards and work to eliminate them. If elimination is not possible, fall protection must be built into the systems that meet or exceed OSHA and ANSI requirements. Fall protection provided must be in accordance with the Fall Protection Hierarchy of Control. The most protective option must be used, unless infeasible (See Section 2 of this Chapter). Examples include:

(1) Installing OSHA-compliant parapets or guardrails on rooftops and elevated work platforms, and;

(2) Installing permanent compliant anchor points and/or LSSs on towers or other structures prior to commissioning.

d. A Qualified Person or a Competent Person and, as appropriate, planners and engineers must ensure that designs and plans indicate locations and types of fall protection systems to be installed, and that approved fall protection systems and/or components are permanently identified prior to 100 percent design.

6. FPP Requirements for Personnel.

a. Physical Capabilities.

(1) Prior to attending fall protection training and performing work at heights, employees must conduct a self-assessment to ensure that they are physically and mentally capable of performing the specific task at heights.

(2) Properly utilize fall protection equipment of which the employee's level of training allows.

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(3) Workers At Height are restricted by ANSI/ASSP Z359 to a total combined weight (body + clothing + gear + tools + misc. load) between 130 and 310 pounds. Weights outside this range do not meet ANSI requirements for fall protection equipment.

b. Environmental Conditions.

(1) Evaluate weather conditions for the day and location of the elevated work activity. If inclement weather is expected, consider postponing elevated work activity until the weather has improved to a point that the employee feels secure to access work at heights.

(2) Do not perform elevated work activities during lightning, icy conditions, high winds, extreme temperatures or any other atmospheric conditions that may be dangerous to life or health.

(3) Employees must assess wind conditions and postpone elevated work activities if the following conditions exist:

(a) The employees would be exposed to winds that may blow them from elevated locations, or;

(b) The employees could lose control of equipment or materials.

7. Fall Protection Equipment.

a. Personal Fall Protection Equipment.

(1) General Requirements.

(a) Personal fall protection equipment will be provided for each affected ATO employee at no cost to the employee. Employees are not permitted to use personally procured fall protection equipment.

(b) All personal fall protection equipment must meet the current ANSI/ASSP standard Z359 and A14.3, as applicable.

(c) All equipment used for work positioning must meet, at a minimum, ANSI/ASSP standard Z359 or A10.32 Personal Fall Protection Used in Construction and Demolition Operations.

(d) Anchorages.

(i) Anchorages used to attach to personal fall protection equipment must be independent of any anchorage used to suspend employees or platforms on which employees work.

(ii) Must be capable of supporting at least 5,000 pounds (22.2 kN) for each employee attached; or designed, installed, and used, under the supervision of qualified person, as part of a complete personal fall protection system that maintains a safety factor of at least two.

(e) ATO contractors must provide their own fall protection equipment that meets ANSI/ASSP standard Z359 requirements and this order.

(2) Personal fall protection equipment provided is based on training and anticipated work tasks and must consist of the following for both Authorized Person Level I and II worker at height:

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(a) Full Body Harness.

(i) The harness must include front, back, and hip D-rings, all rated for fall protection use.

(ii) A standard harness is designed to support a combined weight (body + clothing + gear + tools + misc. load) between 130 and 310 pounds. Weights outside this range cannot utilize ANSI rated fall protection equipment.

(iii) For activities involving potential exposure to arc flash electrical hazards, an appropriately rated harness must be worn.

(iv) Body belts and lineman's belts are prohibited for use as fall protection devices.

(b) Climbing Helmet with Chinstrap.

(i) At a minimum, a Type I climbing helmet with a three-point chin strap that meets the current ANSI/ISEA Z89.1 Industrial Head Protection standard is required.

(ii) The ANSI/ISEA Z89.1 Type II helmet provides additional protection against side impact and is strongly encouraged.

(iii) For activities involving potential exposure to electrical hazards, Class E (up to 20,000 Volt (V)) or G (up to 2,200V) helmets must be worn.

(c) Work Positioning Lanyard.

(i) A standard work positioning lanyard is designed to support a maximum combined weight (body + clothing + gear + tools + misc. load) of 310 pounds.

(ii) Snaphook components must be stamped ANSI/ASSP-Z359 and have a 3,600-pound gate-load rating. If a component does not have the appropriate ANSI rating and 3,600-pound gate-load rating stamped into the component, the lanyard containing that component will be removed from service.

Note: Limitations are based on the weight capacity of the LSS safety sleeves and applicable ANSI compliance. If the combined weight (body + clothing + gear + tools + misc. load) of a Worker At Height is below 130 or exceeds 310 pounds, he/she cannot utilize ANSI compliant fall protection equipment, and therefore would be noncompliant and pose a possible safety hazard to him/herself and others.

(3) In addition to the equipment listed above, Authorized Person Level II workers at height need the following personal fall protection equipment (the specific types depend on the work tasks):

(a) Energy Absorbing Lanyard(s) single leg or twin leg (i.e., a Y-lanyard).

(i) A standard energy absorbing lanyard is designed to support a maximum combined weight (body + clothing + gear + tools + misc. load) of 310 pounds.

(ii) Snaphook components must be stamped ANSI-Z359 and have a 3,600-pound gate-load rating. If a component does not have the appropriate ANSI rating and 3,600-pound gate-load rating stamped into the component, the lanyard containing that component will be removed from service.

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(b) Anchor Strap (also known as a tie-off adapter or connector). A standard anchor strap is designed to support a maximum combined weight (body + clothing + gear + tools + misc. load) of 310 pounds.

(c) Connectors and/or Carabiners. If a carabiner does not have the appropriate ANSI rating and 3,600 pound gate-load rating stamped into the metal, the carabiner must be removed from service.

(4) Other PPE to be used in conjunction with Personal Fall Protection Equipment.

(a) Foot Protection: Puncture Resistant (PR) footwear in conformance with American Society for Testing and Materials (ASTM) F2413 Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear and FAA Order JO 3900.19 performance requirements.

(b) Hand Protection. General-purpose work/utility glove appropriate for the work task performed.

(5) Personal Equipment Inspections and Maintenance.

(a) All equipment and PPE must be inspected by the employee before each use for wear, damage, and other deterioration.

(b) All personal fall protection equipment must be inspected at least annually by a Competent Person. Competent Persons performing annual inspections cannot inspect their own equipment. Annual inspection data must be documented and maintained at a location determined by the employee's manager for the life of the equipment. It is recommended that the annual inspection be tracked along with other preventative maintenance tasks.

(c) ATO policy is to replace all synthetic fall protection equipment (such as full body harnesses, lanyards, etc.) ten (10) years from the date of manufacture as indicated on the equipment label, or sooner, if determined to be unsafe during inspection.

(d) Personal fall protection equipment that arrests a fall or fails inspection must be destroyed and discarded. As an exception to this rule, if a self-retracting lanyard arrests a fall or fails inspection, return it to the manufacturer for inspection and re-certification.

(e) All fall rescue equipment must be inspected at least annually by a Competent Person. Annual inspection data must be documented and maintained at a location determined by the employee's manager for the life of the equipment. It is recommended that the annual inspection be tracked along with other preventative maintenance tasks.

(f) Follow the manufacturers' instructions and FPP Administrator guidance regarding servicing self-retracting lanyards and rescue systems.

(g) All personal fall protection equipment must be maintained in good operating condition in accordance with manufacturers' specifications and applicable preventative maintenance tasks (e.g., Maintenance Management Systems (MMS), Simplified Automated Logging (SAL), etc.).

(h) Alterations (e.g., permanent markings, removal of straps and labels, etc.) of personal fall protection equipment are prohibited.

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(i) Defective personal fall protection equipment must be rendered unusable, destroyed, and replaced prior to use for elevated work activities.

b. Structural Fall Protection Equipment.

(1) General Requirements.

(a) All LSSs must meet the current requirements of ANSI/ASSP Z359 and ANSI A14.3, as applicable. Tubular notched rails are prohibited, must not be used, and must be replaced with an approved LSS as soon as practicable.

(b) The number of workers at height allowed on a LSS at one time depends on the type of system and installation. However, the weight capacity of safety sleeves is 310 pounds, including the employee and his/her equipment (body + clothing + gear + tools + misc. load). Therefore, if the weight of an employee and his/her equipment exceeds 310 pounds, the worker must not use the LSS.

(c) Ladder cages are prohibited for existing fixed ladders that are 20 feet in height or greater. Ladder cages are prohibited for all new construction or facility modifications. LSS systems should be equipped on such ladders.

(d) No modifications can be made to fall protection systems without technical direction from a Qualified Person.

(e) Installation of unique fall protection systems (e.g., horizontal lifelines) must be approved by a Qualified Person.

(2) Structural Equipment Inspections and Maintenance.

(a) All equipment must be inspected by the employee before each use for damage or deterioration.

(b) Maintain and inspect LSSs in accordance with the manufacturers' instructions.

(c) A LSS that arrests a fall must be inspected by a Competent Person other than the employee before it is used again.

8. Training and Communication.

a. Employee Training. The training curriculum must comply with the current national EOSH training standards and training completions must be recorded in the FAA Training System of record. Periodic assessments of the effectiveness of user training must be conducted at least annually by a Competent Person to assist the FPP Administrator in determining whether additional employee training and retraining is necessary.

b. FPP Training Level Duties and Requirements. The FPP Training Level duties and requirements are identified in the following paragraphs (Categories of Workers At Heights, duties, prerequisites, and refresher training are summarized in Table 8-1).

(1) Authorized Person Level I.

(a) Climbs standard structures equipped with compliant LSS mounted onto fixed ladders or ladders installed as integral part of structure equipment.

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(b) Performs maintenance tasks that require access to rooftops or elevated work platforms with compliant guardrails/parapets; or use of fall restraint, warning lines, or safety monitors.

(c) Performs safety monitor duties (construction only).

(d) Inspects personal fall protection equipment before each use.

(2) Authorized Person Level II.

(a) Performs duties as Authorized Person I.

(b) May climb structures with non-compliant fall protection systems using 100 percent tie-off lanyard or other applicable means of fall arrest utilizing compliant anchor points.

(3) Competent Person.

(a) Identifies, evaluates and addresses existing and potential fall hazards.

(b) Provides program oversight.

(c) Select fall protection equipment in area of responsibility.

(d) Advise and approve the use of self-retracting lanyards and vertical lifelines for specific applications.

(e) Develop or design administrative techniques (e.g., SOPs) and/or plans when other options are not feasible.

(f) Assist in investigating incidents related to falls from elevated work areas.

(g) Annually inspect individually issued personal fall protection equipment and ensure inspections are documented.

Table 8-1. FPP Training Level Duties and Training Requirements.

Training Level	Duties	Prerequisites And Refresher Training
<u>Authorized Person Level I:</u> A person who performs any of the duties specified for this category. Then after meeting the prerequisite, has successfully completed the Authorized Person Level I/Rooftop training.	Climbs standard structures equipped with compliant LSSs mounted onto fixed ladders. Performs maintenance tasks that require access to rooftops and elevated work platforms with compliant guardrails/parapets, or use of fall restraint, warning lines, or safety monitors. Performs safety monitor duties. Inspects personal fall protection equipment before each use.	Physically capable of working at heights (self-assessment). Current First Aid/Cardiopulmonary Resuscitation (CPR) certification*. Level I refresher training is required every 2 years, minimum.
<u>Authorized Person Level II:</u> A person who performs any of the duties specified for this category.	Performs duties as Authorized Person Level I and: May climb structures with non-compliant fall protection systems	Physically capable of working at heights (self-assessment). Current First Aid/CPR

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Training Level	Duties	Prerequisites And Refresher Training
Then, after meeting the prerequisite, has successfully completed Authorized Person Level II training.	using 100 percent tie-off lanyard or other applicable means of fall arrest utilizing compliant anchor points.	certification*. Level II refresher training is required every 2 years, minimum.
<u>Competent Person:</u> A person who performs any of the duties specified for this category. Then, after meeting the prerequisites identified, has successfully completed Competent Person training.	Identifies, evaluates and addresses existing and potential fall hazards. Provides program oversight and selects personal protective equipment, rescue, and fall protection systems, including pre-designed anchorages and fall restraint systems. Inspects personal and structural fall protection equipment, if job duties require, per manufacturer requirements.	Successfully completed Authorized Person Level II training. Competent Person refresher training is required every 2 years.
<u>Qualified Person:</u> A person who performs any of the duties specified for this category. Then, after meeting the prerequisites identified, has successfully completed Qualified Person training.	Designs, analyzes, evaluates and specifies anchorages, fall protection systems and rescue systems.	Recognized degree or professional certificate and extensive knowledge and experience in the fall protection and rescue field.
<u>Authorized Rescuer**:</u> A person who performs any of the duties specified for this category. Then, after meeting the prerequisites identified, has successfully completed Authorized Rescuer training.	Performs rescue at elevated work areas.	Physically capable of performing rescue duties at heights (self-assessment)**. Successfully completed and maintains currency in Authorized Person Level II training and has climbing experience. Authorized Rescuer formal refresher training every two (2) years. Competency demonstrated at least annually (See the Competency requirements identified in Paragraph 8.c.(5)).

* First Aid/CPR refresher training frequency must meet the requirements of the provider (American Red Cross, American Heart Association, etc.) or a minimum of every 2 years.

** Authorized Rescuer is a voluntary training level and should only be completed by employees who are physically capable and willing to perform the duties it includes.

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(h) Complete fall hazard surveys and configure fall protection systems such as fall arrest, fall restraint, and rescue.

(i) Identify existing and potential hazards associated with elevated work areas to develop appropriate control measures.

(j) Assist in conducting an inventory of all elevated work areas.

(k) Review site rescue plans to verify all information is accurate and all lines of communication function properly.

(l) Assist in the development and review of fall protection procedures where necessary based on work requirements and findings from the completed Facility Fall Hazard Survey Checklist.

(m) Utilize the Hierarchy of Fall Protection controls to minimize hazards associated with elevated work areas.

(4) Qualified Person.

(a) Oversee and approve the installation and use of horizontal lifelines and anchorages utilized by ATO personnel.

(b) Assess fall hazards associated with potential structural defects identified by competent persons.

(c) Assist engineers with facility designs, as needed, to ensure compliant fall protection is incorporated into new and renovated facilities.

(d) Develop or design administrative techniques (e.g., SOPs) and/or plans when other options are not feasible.

(e) Participate in the investigation of incidents related to falls from elevated work areas.

(5) Authorized Rescuer.

(a) Performs rescues at elevated work areas.

(b) Ensure rescue equipment is available and ready for immediate use at the facility when climbing activities are being performed.

(c) Remain on the ground, while another employee is working at an elevated work area, until called upon to perform a rescue.

(d) Remain in visual and audible range of the worker at all times.

c. Refresher Training.

(1) All refresher training should be provided in the following situations:

(a) Job duties change, or;

(b) Changes in the workplace or changes in the types of fall protection systems or equipment used render the previous training obsolete, or;

(c) Site observations or evaluations determine inadequacies in the employee's subject matter knowledge or skill.

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(2) Authorized Person Level I and Authorized Person Level II refresher training is required every two (2) years.

(3) Competent Person refresher training is required every two (2) years.

(4) Qualified Person does not require refresher training at established intervals. However, he/she must stay current with fall protection and rescue knowledge through continuing education.

(5) Authorized Rescuers must attend formal refresher training every two (2) years. They must also complete rescue competency check at least annually by completing a rescue drill and a written practical demonstration. The rescue drill must be assessed by another Authorized Rescuer.

(6) For training requiring a refresher every two (2) years, if more than 2 years has lapsed since the employees refresher due date, the employee is no longer eligible for refresher training and must attend the initial training course for the training level required.

d. Trainer Qualifications. Trainers must meet the requirements as outlined in Table 8-2. Contact the FPP Administrator for additional information on applicable training standards.

e. First Aid/CPR.

(1) Employees that perform work at heights must have current First Aid/CPR certification as required by 29 CFR 1910.151 and 29 CFR 1910.268.

(2) First Aid/CPR refresher training must meet the requirements of the provider (American Red Cross, American Heart Association, etc.) or a minimum of every two (2) years.

(3) All fall protection trainers must hold current First Aid/CPR certifications.

Table 8-2. Fall Protection Trainer Requirements.

Course Title	Trainer Requirements
Authorized Person Level I and Authorized Person Level II	<ul style="list-style-type: none"> • Instructor(s) must possess current First Aid/CPR certification. • Instructor must be a current Fall Protection Competent Person and current Authorized Person Level II Worker At Height. • Instructors must be approved by the FPP Administrator and complete Facility Instructor Training (FIT) FAA Course 10501, or be granted an equivalency by the FPP Administrator. <p>Course material must be approved by the FPP Administrator.</p>
Competent Person	<ul style="list-style-type: none"> • Instructor must possess current First Aid/CPR certification. • Instructor must be a current Fall Protection Competent Person, current Authorized Person Level II Worker At Height, and current Authorized Rescuer. • Have knowledge and understanding of the specific equipment and inspection criteria assigned to all the employee/student personnel. • Instructors must be approved by the FPP Administrator and complete Facility Instructor Training (FIT) FAA Course 10501, or be granted an equivalency by the FPP Administrator. • Course material must be approved by the FPP Administrator.

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Course Title	Trainer Requirements
Authorized Rescuer	<ul style="list-style-type: none"> • Instructor(s) must possess current First Aid/CPR certification. • Instructor must be a current Fall Protection Competent Person, current Authorized Person Level II Worker At Height and current Authorized Rescuer. • Have knowledge and understanding of the specific rescue equipment assigned to rescue personnel. • Instructors must be approved by the FPP Administrator and complete Facility Instructor Training (FIT) FAA Course 10501, or be granted an equivalency by the FPP Administrator. • Course material must be approved by the FPP Administrator.
Qualified Person	<ul style="list-style-type: none"> • Instructor must be a Fall Protection–Qualified Person. • Instructors must be approved by the FPP Administrator and complete Facility Instructor Training (FIT) FAA Course 10501, or be granted an equivalency by the FPP Administrator. • Course material must be approved by the FPP Administrator.

9. Fall Protection Procedures.

a. Elevated work requirements.

(1) All elevated work that utilizes fall protection equipment requires a minimum of a second person on site with current First Aid/CPR certification and fall protection training (See Table 9-1).

(2) Both employees must review the site-specific rescue plan prior to elevated work activities.

(3) Both employees must have the appropriate level of fall protection training. The second person must be qualified as a current Authorized Rescuer for any of the following activities:

- (a) The employee utilizes a compliant LSS, or;
- (b) The employee utilizes another means of fall arrest (e.g., energy absorbing lanyard or self-retracting lanyard) while working at heights, or;
- (c) The employee works on a non-compliant elevated platform requiring the use of fall arrest, or;
- (d) FAA rescue is specified as the rescue method in the rescue plan if self-rescue is not possible.

(4) The second person may be trained and current as an Authorized Person Level II if professional emergency rescue services can be on site in less than 15 minutes and have the physical capabilities to perform rescue (See Appendix D and E for additional requirements).

(5) Both employees must have proper fall protection equipment and must inspect their equipment prior to anyone beginning to work at heights.

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Table 9-1. Fall Protection Second Person Requirements.

Activity	Employee Training Level	Second (Ground) Person Training Level
Work at heights using warning lines or safety monitors.	Authorized Person Level I or II	Authorized Person Level I or II
Work at heights on a structure using a compliant LSS.	Authorized Person Level I or II	Authorized Rescuer*
Work at heights on a structure using personal fall protection systems (e.g., energy absorbing lanyard, self-retracting lanyard, fall restraint systems, LSS). Work on a noncompliant elevated platform/rooftop using fall arrest.	Authorized Person Level II	Authorized Rescuer*

* The second person may be trained as an Authorized Person Level II instead of an Authorized Rescuer if professional emergency rescue services are available within 15 minutes.

(6) Positive communication must be established between the employee working at heights and the second person on the ground.

(7) The second person must be able to perform rescue or summon rescue and/or medical services in accordance with the detailed site-specific rescue plan.

b. Emergency Rescue.

(1) OSHA requires that “The employer must provide for prompt rescue of each employee in the event of a fall” (29 CFR 1910.140 (c)(21)).

(2) ATO Rescue Plans.

(a) A formal current site-specific rescue plan is required for all facilities where there is elevated work and an employee uses personal fall protection systems. A sample rescue plan is available in Appendix G, Sample Site Rescue Plan.

(b) Rescue plans must be reviewed by a Competent Person prior to being issued by the manager.

(c) If emergency service rescue is specified in the rescue plan, prior to issuing the formal, site-specific rescue plan, each System Support Center (SSC) Manager must validate the plan by receiving local authorities’ written confirmation of their response capabilities (See Appendix D, Sample Letter to Emergency Service Entities). If the SSC Manager makes a good-faith effort to obtain written confirmation, but the local authorities refuse to provide written confirmation, the SSC Manager may use the communication log in Appendix E to document the verbal communication with the local authorities.

(d) The Manager must ensure that a rescue plan, when applicable, is in place for his/her personnel for all FAA facility work including construction and renovation projects and available for review by his/her employees at a known location (See Appendix G, Sample Site Rescue Plan).

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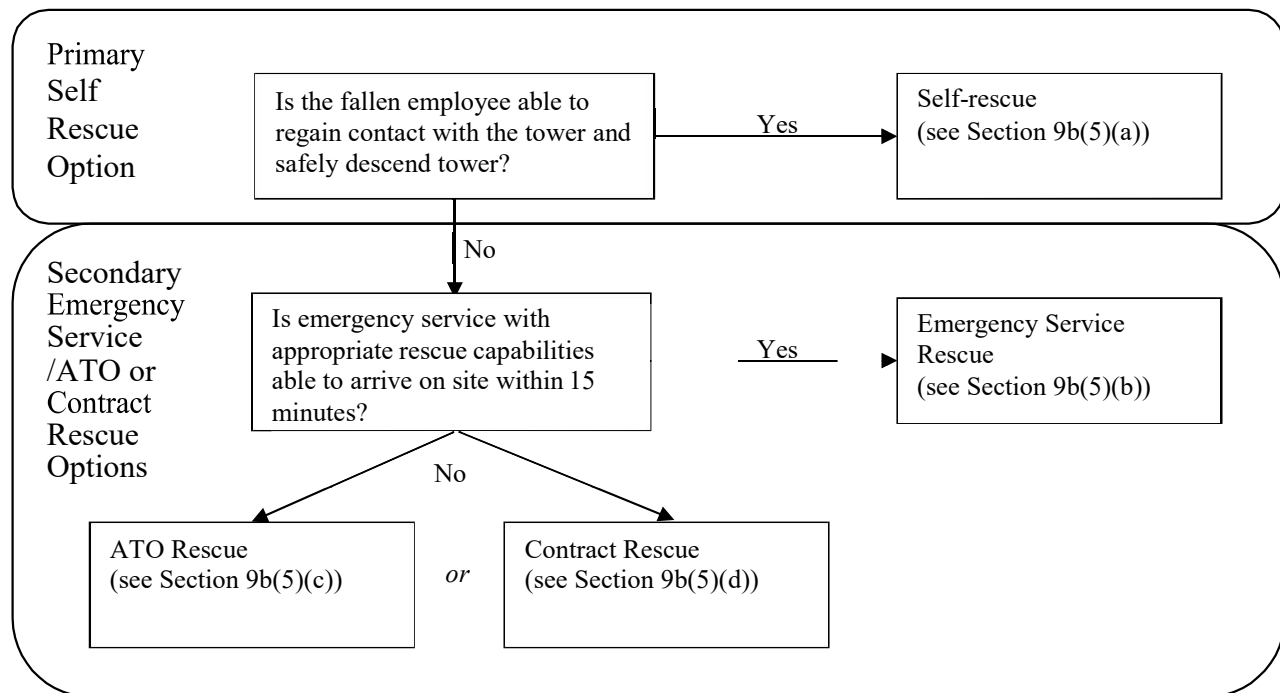
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(3) All equipment used for rescue must meet applicable consensus standards and the approval of the FPP Administrator.

(4) Rescue Competency. Rescue competency must be demonstrated at least annually by completing a rescue practical demonstration and a written exam. The rescue drill must be assessed by another Authorized Rescuer.

(5) ATO Rescue Hierarchy. Self-rescue is always the primary rescue option. There are three secondary rescue options in the ATO. Choosing which of the secondary options to use depends on the availability of rescue services. Figure 9-1, ATO Rescue Decision Tree, serves as a simplified decision-making tool. Each of the rescue options are more fully described in the text below the illustration.

Figure 9-1. ATO Rescue Decision Tree.



(a) Self-Rescue.

(i) Self-rescue is the primary method for a fallen employee to descend a structure if the work activity or the structure allows the employee to maintain hand or foot contact and he/she is physically able.

(ii) Self-rescue may be performed by grabbing onto any part of the tower, repositioning, and then descending while remaining attached to the structure using a fall protection system.

(iii) The second person should communicate with the fallen employee, monitor the employee as he/she descends to ensure the safety of the employee, and provide any additional necessary equipment (e.g., stepladder for employee to descend, etc.).

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(b) Emergency Service Rescue.

(i) Emergency service rescue is summoning emergency services (911) if available, fire department number, etc. to rescue an employee at heights.

(ii) In all instances of emergency service rescue, the rescue option must be coordinated with the emergency service entity prior to being selected. The purpose of the pre-coordination is to ensure that the entity can meet the rescue requirements and is properly trained in high angle rescue or equivalent rescue procedures. Appendix D contains a sample request letter to send to potential emergency service rescue entities.

(iii) When self-rescue is not an option for a fallen employee, emergency services rescue may be the best secondary rescue option in the rescue hierarchy, where available.

(iv) The second person should communicate with the fallen employee and assist emergency services by providing directions to the site, initial assessments of the situation, and other information requested by emergency services.

(v) If an ATO-trained Authorized Rescuer is on site with rescue equipment, and the site-specific rescue plan identifies Emergency Service Rescue as the selected option, the ATO rescuer may perform an ATO Rescue (per paragraph 9b(5)(c)) instead of the Emergency Service Rescue, as long as emergency services is contacted prior to initiating the rescue. ATO Rescue will only be exercised if the rescuer deems the situation warrants immediate rescue.

(c) ATO Rescue.

(i) ATO Rescue is required when emergency services cannot arrive on site within 15 minutes.

(ii) Rescues are to be performed only by ATO employees trained as Authorized Rescuers other than in support of FAA Fall Protection Training and contract support tasks.

(iii) A site-specific rescue plan must be developed for, and implemented at, each affected site and must include procedures for trained ATO Authorized Rescuers using pre-packaged rescue systems in accordance with Appendix F.

(iv) Rescue equipment will be made available for all Authorized Rescuers performing rescue duties.

(v) Emergency services (e.g., ambulance) contact information is required in the site rescue plan for medical transport.

(d) Contract Rescue. Contract rescue is rescue service provided on site via contract.

(i) Contract rescue is needed if emergency services and ATO rescue are not available.

(ii) The site-specific rescue plan must include procedures for contract rescue services in accordance with Appendices E and F.

(iii) Emergency services (e.g., ambulance) contact information is required in the site rescue plan for medical transport.

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10. Communications - Signs and Labels. Refer to ANSI Z535.2 for information and requirements related to fall protection signs that are applied to tower, mast, and pole structures at facility sites.

11. Incident Response and Evaluation - Mishap Reporting.

a. All fall-related incidents must be reported to the FPP Administrator and the organizational ATO Safety and Health Specialist.

b. Accident investigations must be conducted by a Competent Person in accordance with FAA Order 3900.19.

c. All incidents must be investigated promptly and must consider all factors that contributed to the event, including but not limited to:

- (1) a review of policies, procedures and training;
- (2) available fall hazard surveys;
- (3) equipment and related systems, and;
- (4) general communication.

d. All activities affecting the site or equipment involved in the incident must cease until the incident investigator permits activities to resume.

e. The work site and equipment must be secured until the investigator permits activities to resume.

f. All incidents must be documented in accordance with FAA Order 3900.19.

12. Recordkeeping. The ATO must maintain program records. The records must be maintained in accordance with the requirements in this order, 29 CFR 1910.1020, and other applicable federal regulations.

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Chapter 4. Administrative Information

- 1. Distribution.** This order will be distributed electronically.
- 2. Background.** ATO Order JO 3900.63A complements the overall FAA policy contained in FAA Order 3900.19 and establishes specific requirements for the ATO.
- 3. Delegation of Authority.** The EOSH Services Group, AJW-23, is the OPR for the ATO FPP. The OPR resides under the Director of Air Traffic Control (ATC) Facilities (AJW-2).
- 4. Authority to Change This Order.** The ATO Chief Operating Officer or his/her delegate is authorized to issue or change the content of this order when necessary.
- 5. Definitions.** The terms used within this order are contained in Appendix B. Refer to Appendix A for definitions of the acronyms used within this order.
- 6. Related Publications.** Those documents and publications having impact on the ATO FPP and related to this order are identified within Appendix C (Standards).

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Appendix A**Appendix A. Acronym List**

Acronym	Definition
ANSI	American National Standards Institute
ASC	ANSI-Accredited Standards Committee
ASTM	American Society for Testing and Materials
ATCT	Air Traffic Control Tower
ATO	Air Traffic Organization
CFR	Code of Federal Regulations
CPR	Cardiopulmonary Resuscitation
CSA	Canadian Standards Association
CWP	Corporate Work Plan
DMS	Directives Management System
EN	European Norm
EOSH	Environmental and Occupational Safety and Health
FAA	Federal Aviation Administration
FIT	Facility Instructor Training
FP	Fall Protection
FPP	Fall Protection Program
FPPA	Fall Protection Program Administrator
kN	kilonewton
LSS	Ladder Safety System
MMS	Maintenance Management Systems
NAS	National Airspace System
OPR	Office of Primary Responsibility
OSH	Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PFAS	Personal Fall Arrest System
PPE	Personal Protective Equipment
SAL	Simplified Automated Logging
SC	Service Center

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Acronym	Definition
SECM	Safety and Environmental Compliance Manager
SOP	Standard Operating Procedure
SSC	System Support Center
TSC	Technical Support Center
UCR	Unsatisfactory Condition Report

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Appendix B. Key Terms and Definitions

1. Overview. This appendix provides a dictionary of key words related to this order's subject, providing terms and definitions specific to fall protection.

2. Definitions. The terms used within this order are provided as follows:

a. Authorized Person Level I. A person who performs any of the duties specified for this category and has successfully completed the Authorized Person Level I/Rooftop training (Refer to Table 8-1, FPP Training Level Duties and Training Requirements).

b. Authorized Person Level II. A person who performs any of the duties specified for this category. Then, after meeting the prerequisites identified, has successfully completed Authorized Person Level II training. The worker may also be assigned duties specified for the Authorized Person Level I (Refer to Table 8-1, FPP Training Level Duties and Training Requirements).

c. Authorized Rescuer. A volunteer person assigned and trained to perform fall protection rescue that has also successfully completed Authorized Rescuer training (Refer to Table 8-1, FPP Training Level Duties and Training Requirements).

d. Belt (Lineman's Belt). A belt, similar to a body belt, except that its attachment points have two D-Rings on either side of the belt so that a lineman's belt can be attached to them. The lineman's belt is usually placed around a structure (pole) to position the worker around the structure (pole) or assist during the climb. The belt (Lineman's Belt) is no longer acceptable as a fall protection device by the FAA.

e. Body Belt (also, Safety Belt). A strap with means both for securing it about the waist, and for attaching it to a lanyard, lifeline, or deceleration device. The body belt is no longer acceptable as a fall protection device by the FAA.

f. Carabiner. A connector generally comprised of a trapezoidal or oval shaped body with a closed, self-locking gate or similar arrangement that may be opened to attach another object and, when released, automatically closes to retain the object.

g. Competent Person. An individual designated to be responsible for the immediate supervision, implementation, and monitoring of the employer's managed fall protection program who, by completing Competent Person training and having technical knowledge, is capable of identifying, evaluating, and addressing existing and potential fall hazards, and who has the authority to take prompt corrective action with regard to such hazards (Refer to Table 8-1, FPP Training Level Duties and Training Requirements).

h. Connector. A device that is used to couple (connect) parts of the personal fall arrest system, or positioning device system together. It may be an independent component of the system such as a carabiner, or it may be an integral component of the system such as a buckle or D-ring sewn into a full body harness, or a snap-hook spliced or sewn into a lanyard or self-retracting lanyard/lifeline.

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i. Deceleration Device. Any mechanism which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limit the energy imposed on an employee during fall arrest.

j. Designated Area. A distinct portion of a walking-working surface delineated by a warning line in which work is performed without additional fall protection.

k. Elevated Work Area. Any walking-working surface 4 feet or more above the next lower level.

l. Equivalent. Alternative designs, materials, or methods to protect against a hazard, which the employer can demonstrate, will provide an equal or greater degree of safety for employees than the methods, materials or designs specified in the standard.

m. Extension Ladder. An extension ladder is a non-self-supporting portable ladder adjustable in length. Its size is designated by the sum of the lengths of the sections measured along the side rails, even though overlapping of the sections is required by design.

n. Fall Arrest System. A system used to stop an employee after a fall is incurred, so that the worker does not fall to the ground. It may consist of a personal fall arrest system or a lifeline system.

o. Fall Hazard Survey Checklist. A written document that contains information about existing or potential fall hazards and a method or methods for eliminating or controlling those hazards.

p. Fall Protection Procedure. A written series of logical steps that describes the specific practices, equipment and methods to be used to protect authorized persons from falling when exposed to fall hazards.

q. Fall Restraint System. A system used to restrain an employee from incurring a fall from a working level. It may consist of an anchorage, connectors, and a full body harness and may include a lanyard, lifeline, or suitable combinations of these.

r. Fixed Ladder. A fixed ladder is a ladder permanently attached to a structure, building, or equipment

s. Free-Fall. The act of falling before a personal fall arrest system begins to arrest the fall.

t. Free Fall Distance. The vertical displacement of the fall arrest attachment point on the employee's full body harness between onset of the fall and just before the system begins to apply force to arrest the fall. The distance excludes deceleration distance and lifeline/lanyard elongation but includes any deceleration device slide distance or self- retracting lifeline/lanyard extension before they operate and fall arrest forces occur.

u. Full Body Harness. A single unit of straps that are woven into a specific design, that must be attached to fall arrest systems, and is worn by a worker at height to distribute and control the fall arrest forces to the body of the worker (i.e., thighs, pelvis, waist, chest, and shoulder) in the event of a fall.

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v. Gate. The element of a connector that opens to receive an object and closes when released to retain the object.

w. Grab Bar. An individual horizontal or vertical handhold installed to provide access above the height of the ladder.

x. Guardrail System. A physical barrier comprising a top rail, midrail(s), and toe board, erected to protect employees and prevent materials from falling to lower levels.

y. Hole. A gap or open space in a floor, roof, horizontal working surface, or similar surface that is at least 2 inches (5 cm) in its least dimension.

z. Ladder Extension. A continuation of a ladders side rails and rungs above the access/egress level of landing platform.

aa. Ladder Safety System (LSS). An assembly of components whose function is to arrest the fall of a user, including the carrier and its associated attachment elements (brackets, fasteners, etc.), safety sleeve, body support and connectors, wherein the carrier is permanently attached to the climbing face of the ladder or immediately adjacent to the structure.

bb. Lanyard. A flexible line of rope, wire rope, or strap that generally has a connector at each end for connecting the full body harness to a deceleration device, lifeline, or anchorage.

cc. Lanyard, positioning. A lanyard designed for a worker to work hands-free but is not to be used for fall arrest.

dd. Lanyard, energy absorbing (also known as shock-absorbing or Y-lanyard). A lanyard with a deceleration device integrated to reduce the force on the worker at height in the event of a fall, and allows for off-ladder climbing by employees trained as an Authorized Person Level II.

ee. Lifeline. A component consisting of a flexible line for connection to an anchorage at one end to hang vertically (vertical lifeline) or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline) and which serves as a means for connecting other components of a personal fall arrest system to the anchorage.

ff. Lower Levels. Those areas or surfaces to which an employee can fall. Such areas or surfaces include, but are not limited to, ground levels, floors, platforms, ramps, runways, excavation pits, tanks, material, water, equipment, structures, or portions thereof.

gg. Low-Slope Roof. A roof with a slope less than or equal to 4 in 12 (vertical to horizontal).

hh. Midrail. A fixed rail located approximately midway between the top rail of a guardrail system and the deck of a walking, working surface. Midrails must be positioned in a way that the maximum opening at any point is no greater than 19 inches. Midrails must be capable of withstanding 150 pounds of force downward or outward at any point along the member without failure.

ii. Opening. A gap or open space in a wall, partition, vertical walking-working surface, or similar surface that is at least 30 inches (76 cm) high and at least 18 inches (46 cm) wide, through which an employee can fall to a lower level.

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jj. Passive Fall Protection System. Fall protection that does not require the use of personal fall protection equipment.

kk. Personal Fall Arrest System (PFAS). A system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, and a full body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these. Rescue procedures must also be included.

ll. Personal Fall Protection System. A system (including all components) an employer uses to provide protection from falling or to safely arrest an employee's fall if one occurs. Examples of personal fall protection systems include personal fall arrest system, positioning system, and travel restraint systems.

mm. Portable Ladders. Two styles of portable ladders can be used, extension ladders and stepladders. Each style can be broken down into 'types', and each type must meet certain load limits and working specifications.

nn. Positioning Device System. A full body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free.

oo. Positive Communication. Communication procedures that have been tested and verified as operational at the site where the activity is performed.

pp. Qualified. A person who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project.

qq. Qualified Person. A person with a recognized degree or professional certification and extensive knowledge, training and experience in the fall protection and rescue field who is capable of designing, analyzing, evaluating and specifying fall protection and rescue systems (Refer to Table 8-1, FPP Training Level Duties and Training Requirements).

rr. Rescue.

(1) Self Rescue. The act of freeing oneself and descending safely to the ground following a slip or a fall from a ladder or an elevated work area.

(2) Emergency Service Rescue. Rescue service provided on an emergency basis by local first responders.

(3) Contract Rescue. Rescue services provided onsite via contract.

(4) ATO Rescue. A volunteer ATO employee or employees/contract support personnel qualified through training as an Authorized Rescuer and authorized to perform rescue of person(s) at elevated work areas.

ss. Rescue Plan. A written process that describes in a general manner how rescue is to be approached under the specified parameters, such as location or circumstances.

tt. Rescue Procedure. A written series of logical steps that describe the specific manner in which rescue is to be accomplished.

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uu. Rope Grab. A device which travels on a lifeline and automatically, by friction, engages the lifeline and locks to arrest the fall of an employee. A rope grab usually employs the principle of inertial locking, cam/lever locking, or both.

vv. Safety Monitoring System. A safety system where a Fall Protection trained employee performs the duties of recognizing and warning employees of fall hazards. This is an administrative control and should only be used in construction if fall restraint or fall arrest systems are not feasible or possible.

ww. Self-Retracting Lanyard. A deceleration device containing a drum-wound line, which can be slowly extracted from, or retracted onto, the drum under slight tension during normal employee movement, and which, after onset of a fall, automatically locks the drum and lanyard/lifeline and arrests the fall.

xx. Snaphook. A connector comprised of a hook-shaped member with a normally closed keeper, or similar arrangement, which may be opened to permit the hook to receive an object and, when released, automatically closes to retain the object. Snaphooks are generally one of two types:

(1) The locking type with a self-closing, self-locking keeper which remains closed until unlocked and pressed open for connection or disconnection; or

(2) The non-locking type with a self-closing keeper that remains closed until pressed open for connection or disconnection. The use of non-locking snaphooks as part of personal fall arrest systems, fall restraint systems, and positioning device systems is prohibited.

yy. Stepladder. A stepladder is a self-supporting portable ladder, nonadjustable in length, consisting of but one section. Its size is designated by the overall length of the side rails.

zz. Toeboard. A low protective barrier at an elevated work area that helps prevent the fall of materials and equipment to lower levels. Must be 3.5 inches tall and capable of withstanding 50lbs of force applied downward and outward without failure.

aaa. Top Rail. The highest rail of a guardrail system associated with an elevated work platform with a minimum height of 42 inches from upper surface of top rail to floor, platform, landing, etc., and capable of withstanding 200 pounds of force downward and outward without failure (Guardrail Systems higher than 42 inches may require additional midrails).

bbb. Travel Restraint System. A combination of an anchorage, anchorage connector, lanyard (or other means of connection), and body support that an employer uses to eliminate the possibility of an employee going over the edge of a walking-working surface.

ccc. Walking-Working Surface. Any horizontal or vertical surface on or through which an employee walks, works or gains access to a work area or workplace location.

ddd. Warning Line System. A visual warning/barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge, and which designates an area in which roofing work may take place without the use of a guardrail, fall restraint, fall arrest or safety net systems to protect employees in the area.

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eee. Work Area. That portion of a walking-working surface where job duties are being performed.

fff. Worker At Height. Term used in place of “climber” to represent employees who work on elevated work surfaces four (4) feet or more above the next lower level.

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Appendix C. Standards

1. Overview. The regulations identified within this appendix include information that is directly applicable to fall protection. Fall protection regulatory standards are outlined in OSHA's General Industry and Construction Standards. Additional fall protection guidance is found in the ANSI consensus standards and in FAA Order 3900.19.

2. Standards Incorporated by Reference. The following standards are incorporated into this order by reference:

a. OSHA General Industry Standards. OSHA General Industry requirements for fall protection include:

- (1) 29 CFR 1910.21, Scope and Definitions.
- (2) 29 CFR 1910.22, General Requirements.
- (3) 29 CFR 1910.23, Ladders.
- (4) 29 CFR 1910.25, Stairways.
- (5) 29 CFR 1910.28, Duty to have Fall Protection and Falling Object Protection.
- (6) 29 CFR 1910.29, Fall Protection Systems and Falling Object Protection-Criteria and Practices.
- (7) 29 CFR 1910.30, Training Requirements.
- (8) 29 CFR 1910.67, Vehicle-mounted Elevating and Rotating Work Platforms.
- (9) 29 CFR 1910.140, Personal Fall Protection Systems.
- (10) 29 CFR 1910.151, Medical Services and First Aid.
- (11) 29 CFR 1910.268, Telecommunications.

b. OSHA Construction Industry Standards. OSHA Construction Industry requirements for fall protection include:

- (1) 29 CFR 1926, Subpart L, Scaffolds.
- (2) 29 CFR 1926, Subpart M, Fall Protection.

c. ANSI Consensus Standards. ANSI consensus standards for fall protection include:

- (1) ANSI/ASSP Z359.1: The Fall Protection Code.
- (2) ANSI/ASSP Z359.2: Minimum Requirements for a Comprehensive Managed Fall Protection Program.
- (3) ANSI/ASSP Z359.3: Safety Requirements for Lanyards and Positioning Lanyards.
- (4) ANSI/ASSP Z359.4: Safety Requirements for Assisted-Rescue and Self- Rescue Systems, Subsystems and Components.

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- (5) ANSI/ASSP Z359.6: Specifications and Design Requirements for Active Fall Protection Systems.
- (6) ANSI/ASSP Z359.11: Safety Requirements for Full Body Harnesses.
- (7) ANSI/ASSP Z359.12: Connecting Components for Personal Fall Arrest Systems.
- (8) ANSI/ASSP Z359.13: Personal Energy Absorbers and Energy Absorbing Lanyards.
- (9) ANSI Z359.14: Safety Requirements for Self-Retracting Devices for Personal Fall Arrest and Rescue Systems.
- (10) ANSI Z359.15: Safety Requirements for Single Anchor Lifelines and Fall Arresters for Personal Fall Arrest Systems.
- (11) ANSI Z359.16: Safety Requirements for Climbing Ladder Fall Arrest Systems.
- (12) ANSI Z535.2: American National Standard for Environmental and Facility Safety Signs.
- (13) ANSI/Scaffold Industry Association (SIA) A92.2: American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices.
- (14) ANSI-International Safety Equipment Association (ISEA) Z89.1: American National Standard for Industrial Head Protection.
- (15) ANSI/American Society of Safety Professionals (ASSP) A1264.1: Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace, Floor, Wall and Roof Openings; Stairs and Guardrails Systems.
- (16) ANSI A10.8: Scaffolding Safety Requirements.
- (17) ANSI A10.32: Personal Fall Protection Used in Construction and Demolition Operations.
- (18) ANSI-Accredited Standards Committee (ASC) A14.3: American National Standard for Ladders—Fixed—Safety Requirements.
- (19) ANSI-Accredited Standards Committee (ASC) A14.5: American National Standard for Ladders—Portable Reinforced Plastic—Safety Requirements.

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Appendix D**Appendix D. Sample Letter to Emergency Service Entities**

U.S. Department of Transportation
Federal Aviation Administration

(Name of Fire and Rescue Service)
(Street Address)
(City, State ZIP)

(Date)

Chief (or Squad Leader):

The Federal Aviation Administration (FAA) has facilities in your jurisdiction that require FAA personnel to climb to elevated work areas with fall protection systems. In order to pre-plan rescue situations in our area, we request input from emergency services. Please answer the questions below and return in the enclosed postage-paid envelope.

Facility Information

Facility Address	# of Towers	Tower Heights	Avg. # of Climbs Per Year	Towers Accessible by Emergency Vehicles? (Explain access available, if any [i.e., from roadside, entry gate, at ATCT base, etc.])

Questions for Emergency Services

Can your facility perform a rescue from a communication type tower (i.e., high angle rescue, trained personnel, and tower rescue equipment)? ☐ Yes ☐ No

Does your facility have a ladder truck? ☐ Yes ☐ No

If yes, what is the maximum height of the ladder? _____ feet

Expected response time for Emergency Services to reach this facility: _____ minutes

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Comments:

Do you wish to visit the facility with FAA personnel to assess rescue procedures?

☐ Yes

☐ No

If yes, please provide contact information to arrange a

meeting. Name: _____

Phone #: _____

FAA Fall Protection and Climbing Plan

FAA personnel that are authorized to climb towers and similar structures are trained as Authorized Persons and will always be onsite as a team with a minimum of two persons. If the tower location is such that Emergency Services cannot respond within 15 minutes or the local authority does not have the capability to affect a tower rescue, the FAA team member on the ground will be a trained rescue climber with the appropriate equipment. Please note that the FAA climbing team will initiate a call to 911 dispatch in the event of an emergency. As described above, the FAA team member on the ground will assist Emergency Services as needed or will be in the process of a rescue climb after the First Responder system is engaged. All FAA Authorized Persons maintain current CPR and First Aid certifications.

Site-Specific Location Information

(Insert site map, 911 address, GPS and/or Lat/Long coordinates and other critical information.)

If you have any questions, please do not hesitate to call [insert name and phone number of point of contact].

Sincerely,

[Insert name of person sending
letter] [Insert title]

(NOTE to signatory: Be sure to enclose postage-paid self-addressed envelope for return of this letter).

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Appendix E**Appendix E. Sample Communication Log for Contact with Emergency Rescue Service**

Instructions: Use this communication log if the local emergency rescue service refuses to provide written confirmation of its rescue capabilities. Upon such refusal, this log will serve to meet the requirement in the Air Traffic Organization Fall Protection Program, JO 3900.63A, for SSC Supervisors to obtain local authorities' written confirmation of their response capabilities. **This log is not a substitute for requesting written confirmation.**

Facility ID and Facility Type: _____

FAA Facility Address: _____

Number of Towers: _____

Height of Each Tower: _____

How many times a year does the FAA climb
these towers (e.g., 5 times a year total or 2
times a year per tower)? _____

Can a fire truck access the towers? ☐ Yes ☐ No

Name of Emergency Rescue Service: _____

Address: _____

Phone: _____

E-Mail: _____

Fax: _____

Date initial letter requesting written confirmation of response capabilities sent: _____

Follow-up Contacts Made:

Date	_____			
Person Contacted	_____			
Communication Method	<input type="checkbox"/> Telephone	<input type="checkbox"/> Written	<input type="checkbox"/> E-mail	<input type="checkbox"/> In person
Notes	_____			

Action(s) Required	_____			

Date	_____			
Person Contacted	_____			
Communication Method	<input type="checkbox"/> Telephone	<input type="checkbox"/> Written	<input type="checkbox"/> E-mail	<input type="checkbox"/> In person
Notes	_____			

Action(s) Required	_____			

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Date				
Person Contacted				
Communication Method	Telephone	Written	E-mail	In person
Notes				
Action(s) Required				

Good-faith efforts were made, documented above, to obtain written confirmation of the local emergency rescue service's response capabilities.

☐ In place of written confirmation, the local emergency rescue service provided the information noted below. The site-specific tower rescue plan is based on this information.

☐ The local emergency rescue service did not provide the information necessary to confirm its tower rescue capabilities. Therefore, the site-specific tower rescue plan relies on FAA or contract tower rescue.

Signed:

Date:

Emergency Rescue Service Information:

What is the expected response time for emergency services to reach this facility? _____

Can the emergency rescue service perform a rescue from a communication-type tower? ☐ Yes ☐ No

What is the maximum height of the service's communication-type tower rescue capabilities? _____

Does the emergency rescue service have a ladder truck? ☐ Yes ☐ No

If yes, what is the maximum height of the ladder? _____

Does the emergency rescue service wish to view the facility with FAA personnel to assess rescue procedures? ☐ Yes ☐ No

If yes, what is the contact information to set up a meeting? Name: _____
Phone: _____

If yes, date that the emergency rescue service visited the facility: _____

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Appendix F. Guidance for ATO Rescue Activities

1. Overview of Requirement. ATO (in-house) rescue must be managed and implemented with the utmost understanding of the hazards and knowledge of the limitations of the equipment and training. ATO rescue activities must be overseen by Fall Protection Competent Persons.

2. Rescue Systems.

a. Each rescue system used in the ATO includes a rope, pulley (or other type of device that provides a mechanical advantage for the rescue system), and a braking and/or lowering system. The length of the rope must always be appropriately longer than the total tower height at which the rescue system will be used, in accordance with applicable supplier/manufacturer system criteria.

b. Rescue systems must be kept in a ready-to-use state and no one except a trained rescuer must use the system. It is recommended that rescue systems be stored in locations not accessible to anyone other than trained rescuers and affected managers.

c. Select approved systems with at least a 3:1 mechanical advantage pulley system. The FPP Administrator must be contacted to identify approved systems to ensure compliance with the FAA ATO FPP and reduce the number of different rescue systems throughout the NAS.

3. Training.

a. Training is required for any ATO personnel who will be performing in-house rescue. Due to the complexities of rescue activities, all rescuers must maintain proficiency by participating in regular rescue drills. In alternating years, Authorized Rescuers must complete formal refresher training and competency checks. The rescuers complete the competency checks by performing a rescue practical demonstration and a written exam. The rescue drill must be assessed by another Authorized Rescuer. Authorized Rescuers must also maintain current First Aid/CPR certifications.

4. Rescue Requirements.

a. Authorized Persons and rescuers must pre-plan climbs to enable rescuers to pre-determine where they will anchor the rescue systems, if needed.

b. Rescuer techniques must not include cutting the fallen worker's PFAS to drop him/her to the ground.

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Appendix G. Sample Site Rescue Plan

1. Overview of Requirement. Site-specific rescue plans must be developed for each site where employees use personal fall arrest systems (e.g., wear a full body harness and use an energy absorbing lanyard or a LSS). The rescue plans must include information specific to the type of rescue (Emergency Medical Services (EMS), ATO, or contract).

2. Sample Site Rescue Plan. The electronic version of the sample site rescue plan, can be found by navigating to the FPP link listed on the EOSH Services Group website and includes information for both EMS and ATO rescues.

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Appendix H. Standard Operating Procedure for Portable Ladders

1. Overview. This SOP provides guidance for portable ladders. Additional information about portable ladders can be found in OSHA regulations (www.osha.gov) under 29 CFR 1910.23, Ladders.

2. Types of Portable Ladders. Portable ladders approved for use are classified in two categories including:

- a. Stepladders.
- b. Straight and extension ladders.

Note: The use of wooden portable ladders is prohibited in the ATO. All portable wooden ladders must be rendered unusable and removed from service.

3. Training Requirements for Using Portable Ladders. Formal training to use portable ladders is included in Fall Protection Authorized Person Level I and Level II training but is not specifically required by regulation/standard. However, the user must be familiar with all manufacturer requirements and the information contained in this order, including this appendix.

4. Standards.

- a. 29 CFR 1910.23, Ladders.

5. Ladder Design Requirements.

a. Design Requirements for Stepladders.

- (1) Must meet OSHA standards.
- (2) May not be greater than 20 feet in height.
- (3) Must have metal spreaders that lock into position.
- (4) The feet must be covered with insulating non-slip material.
- (5) Must meet ANSI standards.
- (6) Must be labeled as ANSI compliant.
- (7) Must have minimum capacity ratings of Type 1A (300-pound working load).

b. Design Requirements for Straight and Extension Ladders.

- (1) Must meet OSHA standards.
- (2) The length of straight ladders or individual spans of extension ladders must not exceed 30 feet.
- (3) Extension ladders with two spans must not exceed 48 feet in length. Extension ladders with more than two spans must not exceed 60 feet in length.

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(4) Based on the length of the extension ladder, each span must overlap the adjacent section by the minimum number of feet stated in Table H-1, Minimum Ladder Span Overlap Distances.

- (5) Must meet ANSI standards.
- (6) The bases of the ladders must be slip-resistant.
- (7) The ladders must have minimum capacity ratings of Type 1A (300-pound working load).

Table H-1. Minimum Ladder Span Overlap Distances.

Ladder Length (feet)	Overlap (feet)
Up to and including 36	3
Over 36, up to and including 48	4
Over 48, up to 60	5

6. Maintenance and Inspection Procedures for Portable Ladders. Maintain portable ladders on a regular basis.

- a. Keep hardware and fittings in proper working condition.
- b. Ensure bolts and rivets are in place and secure.
- c. Replace padded feet or safety shoes when excessively worn.
- d. Inspect ladders prior to each use to ensure that:
 - (1) Connections are tight and the ladder does not wobble.
 - (2) Rungs/steps are free of grease, oil, built-up debris, etc.
 - (3) The ladder has no loose steps or rungs.
 - (4) The ladder is free of loose rivets, screws, bolts, or other loose hardware.
 - (5) The ladder is free of cracked, split or broken uprights, braces, steps, or rungs.
 - (6) The ladder is free of damaged or worn non-slip bases.
 - (7) (Extension ladders only) The ladder is free of loose, broken, defective, or missing extension locks.
 - (8) (Extension ladders only) The ladder is free of worn or rotted rope.
 - (9) (Stepladders only) The ladder is free of loose, bent, or broken hinge spreaders.
 - (10) (Stepladders only) The ladder has no loose hinges.

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- e. Defective ladders must be tagged out of service and removed from service immediately.
- f. Ladders may not be painted so that damage or flaws that will render them unsafe can be observed when inspected.

7. Procedures for Using a Stepladder.

- a. Position the stepladder for use so that the ladder rungs are parallel with the ground.
- b. Place the stepladder so that the feet are secure on a firm, level support surface.
- c. Only one person shall climb a ladder at a time unless the ladder is designed to support more than one person.
- d. Face the ladder when ascending or descending the ladder.
- e. Always use three points of contact when climbing the stepladder. Three points of contact is defined as two hands and a foot, or two feet and a hand.
- f. Never stand, sit or step on the top two steps of the stepladder.
- g. Keep your center of gravity near the middle of the rung to prevent the ladder from tipping sideways.
- h. Do not place the stepladder in front of doors or walkways, unless the door or walkway is blocked or guarded.
- i. Never load the stepladder beyond the manufacturer's rated capacity.
- j. Only use a fiberglass stepladder for electrical work. The ladder cannot be equipped with metal reinforcement rods along the rail.

8. Procedures for Using a Straight or Extension Ladder.

- a. Use the ladder at a slope of 4 vertical feet to 1 horizontal foot. A good way to approximate this slope is to stand straight with your toes touching the bottom of the ladder and extend your arms directly in front of you. If you can grasp the ladder with your hands without leaning or bending forward, the ladder is at the correct angle.
- b. If the top of the ladder is not secured, a second person must hold the bottom of the ladder while the first person is on the ladder.
- c. Position the ladder for use so that the ladder rungs are parallel with the ground. Do not use the ladder in a horizontal position.
- d. Place the ladder so that the ladder feet are secure on a firm, level support surface.
- e. Only one person shall climb a ladder at a time unless the ladder is designed to support more than one person.
- f. Face the ladder when ascending or descending the ladder.

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- g.** Always use three points of contact when climbing the ladder. Three points of contact is defined as two hands and a foot, or two feet and a hand in contact with the ladder at all times.
- h.** Keep your center of gravity near the middle of the rung to prevent the ladder from tipping sideways.
- i.** When using the ladder to access a platform, the top of the ladder must extend at least 3 feet beyond the level of the platform.
- j.** When using the ladder to access pits and excavation work areas, the top of the ladder must extend at least 3 feet above the top of the pit or excavation.
- k.** Do not place the ladder in front of doors or walkways, unless the door or walkway is blocked or guarded.
- l.** Never load the ladder beyond the manufacturer's rated capacity.
- m.** Only use a fiberglass ladder for electrical work. The ladder cannot be equipped with metal reinforcement rods along the rail.

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Appendix I. Scaffolding Standard Operating Procedure

1. Overview. This SOP provides guidance on the fall protection elements of safe installation and use of supported scaffolding (frame, pole, tube and coupler, and mobile scaffolds). Refer to 29 CFR 1926, Subpart L, for all OSHA requirements regarding supported and suspended scaffolding. The procedures are organized according to worksite evaluation, scaffold erection requirements, and safe work practices.

2. Training Requirements. Each employee who performs scaffolding inspections and who directs or supervises scaffolding erection, movement, alteration and dismantling must be trained as a scaffolding competent person. Each employee who performs work on scaffolding must be trained by a person qualified in the subject matter to include at a minimum:

- a. The nature of any electrical, fall and falling object hazard in the work area;
- b. The correct procedures for controlling identified hazards identified in paragraph a. above and for erecting, maintaining and disassembling the fall protection systems and falling object protection systems being used;
- c. The proper use of the scaffold, and the proper handling of materials on the scaffold;
- d. The maximum intended load and the load-carrying capacities of the scaffolds used;
- e. Any other pertinent requirements outlined under OSHA 29 CFR 1926, Subpart L.

3. Scaffolding Inspection, Assembly, and Disassembly. The erection, movement, dismantling or alteration of scaffolding must be supervised and directed by a Scaffolding Competent Person. Based on the type of scaffold and the method of assembly/ disassembly, fall protection requirements may differ.

4. Equipment Requirements. The PPE required for work involving scaffolding is based on the specific task(s) being completed as described below:

- a. PPE.
 - (1) Fall arrest with a lanyard of the appropriate length to prevent striking ground.
 - (2) Safety glasses or goggles if there are any impact hazards or flying debris.
 - (3) Gloves.
 - (4) Safety shoes (appropriately rated for task).
 - (5) Hard hat (when completing tasks involving a potential exposure to electrical hazards, wear a Class E (up to 20,000V) or G (up to 2,200V) hard hat).
 - (6) Hearing protection.
- b. Other Supplies that may be needed.
 - (1) Materials to cordon-off area (e.g., caution tape, safety cones, etc.).

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(2) Pulley system for raising and lowering tools.

(3) Positive two-way communication (if immediate verbal communication is not possible because of distance or elevated noise levels).

5. Worksite Evaluation.

a. Identify overhead lines and verify that a safe approach distance can be maintained. Ensure that the scaffolding will not come near any electrical source.

b. Evaluate the terrain and slope in the area where the scaffold will be located.

c. Check surfaces for hazards such as buried utilities, excavations, trenches, and susceptible collapses.

d. Evaluate the work area for interference from vehicular and pedestrian traffic.

6. Pre-Installation Inspections.

a. Check guardrails, planks, and other parts of scaffolding for signs of wear or damage.

b. Do not use any parts that show excessive wear or damage.

c. Inspect fall protection PPE before each use.

7. Scaffold Erection Requirements.

a. A toeboard must be erected along the edge of platforms more than 10 feet above lower levels for a distance sufficient to protect employees below.

b. Ensure supported scaffold poles, legs, posts, frames, and uprights must be bear on baseplates and mud sills or other adequate firm foundation. Footings must be level, sound, rigid, and capable of supporting the loaded scaffold without settling or displacement.

c. Tiebacks must be secured to a structurally sound anchorage on the building structure. Sound anchorages include structural member, but do not include standpipes, vents, other piping systems, or electrical conduit.

d. Verify that all planking or platforms are overlapped, minimum of 12 inches, or secured from movement.

e. Verify that platform planks are abutted and each end rests on a separate support surface.

f. Each scaffold platform and walkway should be at least 18 inches wide.

g. Provide an access ladder or equivalent means of safe access.

8. Warnings.

a. Do not use unstable objects such as barrels, boxes, loose brick, or concrete blocks to support scaffolds or planks.

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- b.** Do not use additional ladders, planks, or other materials, within the platform, to achieve additional height.
- c.** Do not use any scaffolds that have been damaged or weakened.
- d.** Do not climb on guardrails.
- e.** Do not work on scaffolds in inclement weather, such as high winds, lightning, ice, snow, etc.
- f.** Do not move or alter scaffolds while they are in use or occupied.

9. Safe Work Practices.

- a.** Always cordon off the work area to restrict non-workers from entering the work zone.
- b.** Ensure the footing or anchorage for the scaffolding is sound and capable of carrying the maximum intended load without settling or displacement.
- c.** Wear appropriate PPE.
- d.** Maintain good housekeeping practices on the platform to prevent falls and tripping hazards. Do not allow tools, materials and debris to accumulate in quantities to cause a hazard.
- e.** Use a rope and pulley to raise or lower objects to and from the ground. Do not throw objects to or from the platform.

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Appendix J. Work on Elevated Platforms

1. Overview. This guidance is for employees who work on elevated walking-working surfaces that are at, or greater than, 4 feet above the next lower level. Some examples include communication-type towers, roofs and catwalks. Employees must use one or more of the following fall protection systems when working on an elevated work platform:

- a. Guardrails or Parapets (in conjunction with hatches or covers, where required).

Note: Guardrails or fall restraint systems are required at less than 4 feet above the next lower level to protect the worker from falling into or onto dangerous equipment, unless the equipment is guarded or covered to eliminate the hazard.

- b. Fall restraint systems.
- c. Personal fall arrest systems.

2. Standards.

- a. All systems listed above must meet criteria provided in 29 CFR 1910.29 Fall Protection Systems and Falling Object Protection-Criteria and Practices and 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.

- b. Guardrails must also meet criteria provided in ANSI/ASSP A1264.1.

3. Requirements. Major requirements are summarized below. The systems are listed in the order of preference for use.

- a. **Guardrail Systems.** These systems must meet the following criteria:

- (1) Systems must be 42 inches, in height, with a maximum opening of 19 inches between any midrails associated with the railing system.

- (2) If guardrails are less than 42 inches in height, they must be upgraded to 42 inches when the facility is renovated.

- (3) If the guardrails are less than 42 inches in height and employees are working within 15 feet of the guardrails, then they must use secondary fall protection.

- (4) Toeboards must be solid and a minimum of three and one half (3.5) inches high and not have more than ¼" clearance above the walking-working surface with no openings greater than 1 inch in any dimension.

- (5) It is not permitted for tools, equipment or materials to be piled higher than the height of the toeboards without protective screening installed between the toeboard and rails.

- (6) The system must have a capability of withstanding 200 pounds of outward/downward force at the top rail, 150 pounds of outward/downward force at the midrail and 50 pounds of outward force at the toeboard.

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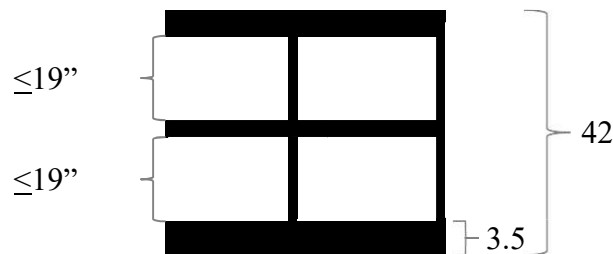
(7) If a guardrail system is used, the ladderway or stairway opening must also be guarded or so offset that a person cannot walk directly into the opening.

(8) Openings at the work platform floor used for access from an internal ladder must be equipped with a hatch that can be fully closed after entry into the work platform, and the closed hatch must be capable of supporting 250 pounds or the maximum intended load, whichever is greater.

(9) When hatches are associated with elevated platforms or rooftops, they must be secured against accidental displacement.

(10) If a worker must lean over the top rail to position for the performance of a work task, a fall restraint or fall arrest system must be utilized.

Figure J-1: Guardrail Requirements.



b. Parapets. These systems must meet the following criteria: The height and strength design requirements are the same as those indicated for guardrails (See Subsection 3.a. above).

c. Fall Restraint. These systems must meet the following criteria:

(1) An ANSI/ASSP Z359.13 rated full body harness must be worn by the employee, and must be capable of withstanding twice the maximum expected force.

(2) The employee's center of gravity cannot reach any fall hazard.

(3) Adjustable systems, such as adjustable lanyard or lifeline/rope grab systems, make a restraint system much more flexible. In these cases, extra care must be taken to ensure it is impossible to reach the fall hazard. A fixed length lanyard or other restraint system for this purpose is recommended.

(4) The system must have a breaking strength of no less than 5000 pounds and meet ANSI/ASSP Z359.3 requirements.

(5) Anchorages must be capable of supporting at least 5,000 pounds (22.2kN) pounds for each employee attached; or designed, installed, and used under the supervision of qualified person, which maintains a safety factor of at least 2.

d. PFAS. PFAS consist of a body harness, anchorage and connector. These systems must meet the following criteria:

(1) An ANSI/ASSP Z359.13 rated full body harness must be used.

(2) The system must limit free fall to 6 feet or less.

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(3) The system must limit the arresting force on the body to 1,800 pounds or less to meet OSHA requirements, or 900 pounds or less (preferred) to meet ANSI/ASSP Z359.13/ Z359.14/ Z359.15, whichever is applicable to the type of equipment used.

(4) Anchorages used to attach personal fall protection equipment must be independent of any anchorage used to suspend employees or platforms on which employees work.

(5) Anchorages must be capable of supporting at least 5,000 pounds (22.2 kN) for each employee attached; or designed, installed, and used, under the supervision of qualified person, as part of a complete personal fall protection system which maintains a safety factor of at least 2.

(6) The system must consider the rescue of a fallen worker.

e. Designated Area/Warning Line Systems (applies only to low-sloped roofs). These systems must meet the following criteria:

(1) General Industry – The designated area for general rooftop activities must meet all the OSHA General Industry requirements as specified in 29 CFR 1910, Subpart D, including, but not limited to the following:

(a) The perimeter of the designated area is delineated with a warning line consisting of a rope, wire, tape, or chain.

(b) Each warning line must have minimum breaking strength of 200 pounds.

(c) The system must be rigged and supported so that the lowest point (including sag) is no less than thirty-four (34) inches and the highest point is no more than thirty-nine (39) inches from the walking-working surface.

(d) The system must be clearly visible from a distance of twenty-five (25) feet anywhere within the designated area.

(e) The system must be erected as close to the work area as the task permits.

(2) Construction Industry – The warning line systems for construction activities on rooftops must meet all the OSHA Construction Industry requirements specified in 29 CFR 1926, Subpart M.

(a) Warning lines must be erected around all sides of the roof work area.

(b) When mechanical equipment is being used, the warning line must be erected not less than six (6) feet from the roof edge which is parallel to the direction of mechanical equipment operation, and not less than ten (10) feet from the roof edge which is perpendicular to the direction of mechanical equipment operation.

(c) When mechanical equipment is not being used, the warning line must be erected not less than six (6) feet from the roof edge.

(d) Points of access, material handling areas, storage areas, and hoisting areas must be connected to the work area by an access path formed by two warning lines.

(e) The system must consist of ropes, wires, chains and supporting stanchions, and flagged at not more than six (6) foot intervals with high visibility material.

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(f) The rope, wire or chain must have a minimum tensile strength of 500 pounds, and must be attached at each stanchion so that pulling on one section does not result in slack being taken up in adjacent sections before the stanchion tips over.

(g) The system must be capable of resisting a horizontal force of 16 pounds without tipping over.

(h) The system must be rigged and supported so that the lowest point (including sag) is no less than 34 inches from the work surface, and the highest point is no more than 39 inches from the walking-working surface.

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Appendix K. Aerial Lift Standard Operating Procedure

1. Overview. This SOP provides guidance for the safe operation of aerial lifts. An aerial lift is any vehicle-mounted device, telescoping or articulating, or both, which is used to position personnel. This SOP is organized according to training and equipment requirements, worksite evaluation, pre-operation inspection, and safe work practices.

2. Standards. The following OSHA and ANSI standards cover aerial lift requirements:

- a. 29 CFR 1910.67, Vehicle-mounted elevating and rotating work platforms.
- b. 29 CFR 1926.453, Aerial lifts.
- c. ANSI/SIA A92.2, American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices.

3. Types of Aerial Lift Equipment. Aerial lifts include the following equipment types:

- a. Extensible Boom Platforms.
- b. Aerial Ladders.
- c. Articulating Boom Platforms (“cherry pickers”).
- d. Vertical Ladders/Towers.
- e. Any combination of the above (powered or manually operated).

4. Training Requirements. To operate aerial lifts, employees first must complete Fall Protection—Authorized Person Level I or Authorized Person Level II and Aerial Lift Safety training. Employees must also become familiar with the specific aerial lifts that they will use through the Aerial Lift Safety training.

5. Equipment Requirements. The required PPE is based on the specific task(s) being completed:

a. Fall restraint or fall arrest with a lanyard of the appropriate length. If an employee is too tall or his/her lanyard is too long to prevent his/her center of gravity (which is generally the waist) from passing the top guardrail, he/she must use fall arrest. If the lift is not equipped with an anchor capable of fall arrest, another means of access should be exercised.

b. Safety glasses or goggles if there are any impact hazards or flying debris.

c. Gloves.

d. Safety shoes (appropriately rated for task).

e. Hard hat (when completing tasks involving a potential exposure to electrical hazards, wear a Class E (up to 20,000V) or G (up to 2,200V) hard hat).

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f. Hearing protection (as required in accordance with the ATO Hearing Conservation Program).

g. Other supplies that may be needed:

- (1) Vehicle's operator manual (mandatory).
- (2) Chocks (required where applicable per equipment design).
- (3) Tire gauge.
- (4) Materials to cordon off area (e.g., caution tape, safety cones, etc.).
- (5) Positive two-way communication (if immediate verbal communication is not possible because of distance or elevated noise levels).
- (6) Pulley system for raising and lowering tools (attach to structure, not aerial lift).
- (7) Mechanical fluids.

6. Worksite Evaluation.

a. Identify overhead lines and confirm that a safe approach distance can be maintained (see Table K-1 on following page).

b. Evaluate the terrain and slope in the area where the lift will be used.

c. Check the travel and work areas for hazards such as buried utilities, excavations, trenches, and soft ground.

d. Evaluate the work area for interference from vehicular and pedestrian traffic.

7. Pre-Operation Inspections.

a. Follow the manufacturer's recommendation for maintenance and pre-use inspections. This includes completing the annual safety inspection.

b. The equipment operator's manual must remain on the aerial lift at all times.

c. Check all tires for leaks, correct pressure, wear and "dry rot".

d. Check fuel, coolant, hydraulic fluid, and battery fluid levels. Always wear proper PPE when checking these fluids.

e. Inspect battery cables for wear and cracked or damaged insulation.

f. Inspect batteries for cracks/holes, leaking cells, and loose or clogged vent caps.

g. Inspect all connections for rust, leaks, corrosion, tightness and fit.

h. Inspect hydraulic lines and connections for leaking valves/connections, cracks, and fluid odors.

i. Inspect pivot pins for signs of wear or damage and for security of the locking device.

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- j.** Inspect weld seams for cracks and abnormalities, including attachment welds between the activating cylinders and the boom or pedestal.
- k.** Check guardrails for signs of wear or damage.
- l.** Inspect fall protection anchor point for cracks or abnormalities in the welds or bolts.
- m.** Ensure and observe the proper operation of all safety switches and interlocks.
- n.** Inspect and operate the secondary controls (at base) and observe normal functionality.
- o.** Conduct trial lifts with the platform empty and check for fluid leaks, abnormal operation, and unusual noises.
- p.** Inspect fall protection PPE before each use.
- q.** Warnings:
 - (1) Do not use the lift if any part of it is damaged or defective.
 - (2) Do not operate the lift in inclement weather, such as high winds, lightning, ice, snow, etc.
 - (3) Do not climb on, over, or through the guardrails and/or boom.
 - (4) Do not use additional ladders, planks, or other materials within the platform to achieve additional height.
 - (5) Do not exceed the manufacturer's rated load capacity (this includes the weight of worker(s), tools and materials) for the lift (a sign with the rated load capacity must be located on the equipment in an easily visible location).
 - (6) Do not exceed the manufacturer's occupancy limit for the equipment.
 - (7) Do not let the aerial lift, platform occupants, or tools approach energized conductors or facilities closer than the distances shown in Table K-1.
 - (8) Do not override hydraulic, mechanical or electrical safety devices.
 - (9) Do not put any part of your body outside the platform while raising and lowering the platform.

Table K-1. Minimum Clearance Distances.

Voltage	Minimum Distance
Aerial lift operations	
Up to 50 kV	10 feet
Above 50kV	10 feet plus 4 inches for every 10kV over 50kV
Aerial lift in transit with lift stowed	
Up to 50 kV	4 feet
Above 50kV	4 feet plus 4 inches for every 10kV over 50kV

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(10) Do not travel with the boom elevated unless the equipment is designed for this procedure and you are trained to use the equipment in this mode.

(11) Do not drive the lift unless the worker is facing in the direction of travel.

(12) Do not raise the platform on a slope or drive onto a slope when the platform is elevated.

(13) Do not throw objects to or from the platform. Use a pulley and rope (attached to an adjacent structure) to raise and lower objects.

(14) Do not use an aerial lift as a material handling device unless it is approved for material handling.

8. Safe Work Practices.

a. Cordon off the work area to restrict entry into the work zone.

b. Wear proper fall protection equipment when working from the lift platform. Attach the lanyard to the manufacturer's recommended attachment point.

c. Verify that any workers in the vicinity of the lift wear hardhats.

d. Always have a second person as a ground watch. The ground watch is responsible for ensuring that the lift remains a safe distance away from overhead obstructions and for summoning emergency assistance if needed. The ground person cannot have any other duties while the operator is in the lift.

e. Maintain positive, two-way communication between the lift occupant and the ground watch at all times.

f. The ground watch does not require fall protection training.

g. Ensure adequate ventilation when operating fossil fuel powered lifts indoors.

h. Set brakes and use wheel chocks where applicable.

i. When outriggers are present, extend them properly on a solid surface or outrigger pads before operating the lift.

j. Verify that the main unit of the lift is level.

k. Conduct another trial lift with the platform empty.

l. In accordance with the facility's lockout/tagout procedures, de-energize and lockout any equipment that will be worked on during the lift operations.

m. Maintain good housekeeping practices on the platform to prevent falls and tripping hazards.

n. Ensure the boom is properly cradled and the outriggers are in the stowed position before moving the aerial lift.

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Appendix L

Appendix L. Facility Fall Hazard Checklists

1. Overview. This appendix describes the Facility Fall Hazard Survey Checklist forms supporting this order.

a. Facility Fall Hazard Survey Checklist – A comprehensive survey checklist used to document each potential fall hazard an authorized person may be exposed. The survey shall consider fall hazards at the specific work area as well as fall hazards encountered while accessing the work area. The fall hazard survey shall be conducted by a competent person or a qualified person who is familiar with, and has access to, information about local work processes, environmental factors, policy and best industry practices, and who collects input from the authorized person conducting the work and the work team familiar with workplace activities. This checklist should be used the first time a facility is inspected for fall hazards and updated whenever there is a change to the task, process, structure, equipment or regulation that would render past surveys obsolete.

b. Facility Tower With Use Inspection – This checklist only includes questions related to the condition of the structure and fall protection system(s). Once the comprehensive fall hazard survey checklist as noted in paragraph 1.a above has been completed for a facility, this checklist may be used for condition checks prior to work at heights.

2. Checklist Forms. The electronic version of the forms can be found by navigating to the FPP link listed on the EOSH Services Group website.

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Appendix M. Document Feedback Information

1. Providing Document Feedback. Please submit all comments in written form and include specific feedback content such as recommendations for improving this document, suggestions for new related subjects, and content errors.

2. Document Feedback Recipient. Send all feedback for this document via e-mail to:

To: Document OPR: Catherine Apicella, AJW-231, catherine.apicella@faa.gov

Subject: FAA ATO Order JO3900.63A, ATO Fall Protection Program –Document
Feedback / Revision Suggestions

3. Document Feedback Content. When sending feedback to the OPR, please provide as much information as possible, using the following example as a model:

An error, procedural, or typographical item in paragraph _____ on page _____ should be changed to _____ (attach separate sheet as necessary).

In future revisions of this document, please include coverage on the following subject _____ (describe the specific language you want to add, include OSH regulatory references if applicable).

Include the following information for the OPR to respond appropriately:

- (1) Submitted by: _____.
- (2) Submission date: _____.
- (3) Telephone: _____.
- (4) Routing code: _____.
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ATTACHMENT NO. 2

FAA-C-1217H
November 5, 2018

SUPERSEDING
FAA-C-1217G
April 24, 2018



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

U.S. Department of Transportation

Federal Aviation Administration

Construction Specification

ELECTRICAL WORK, PREMISES WIRING

Foreword

1. This specification is approved for use by all departments of the Federal Aviation Administration (FAA).
2. This specification defines the minimum requirements for electrical work at FAA facilities. National and international codes such as the National Electric Code (NEC) primarily address safety. In particular, Paragraph 90.1(B) of the NEC states, "This *Code* contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance results in an installation that is essentially free from hazard, but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use." It is the intent of this specification to ensure that installations are not only free from hazard, but are efficient, and adequate for the FAA's mission needs. This specification does not supersede national codes, but augments them.
3. For instances where the NEC provides acceptable options, this specification may prescribe certain of these options and proscribe others.
4. Specific FAA facilities, e.g., Air Route Traffic Control Centers (ARTCC), Metroplex Control Facilities (MCF), Terminal Radar Control (TRACON), etc., may have requirements that are more stringent than these minimum requirements.
5. Comments, suggestions, or questions on this document should be addressed to:

Federal Aviation Administration
Power Services Group,
Systems Engineering Team, AJW-222
800 Independence Avenue, SW
Washington, DC 20591

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1 Scope

1.1 Scope

This specification covers the minimum requirements for electrical power work at FAA facilities. The requirements in this specification are based on performance and safety, and may exceed those of the NFPA 70™, National Electric Code® (NEC), which deals with safety only. National Airspace System (NAS) operations facilities, including Air Route Traffic Control Centers (ARTCCs), Metroplex Control Facilities (MCFs), and terminal radar control (TRACONs) may have performance requirements that exceed the requirements listed in this specification. This document does not specifically address communication wiring and grounding requirements.

FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, provides the minimum grounding requirements for facilities and equipment used in the NAS.

Where the phrase "unless otherwise indicated" or similar wording appears, it refers exclusively to other documents that are specific parts of electrical construction project contracts.

1.2 Change Record

Revision	Effective Date	Section Affected	Changes Made
H	July 2018	All	Initial release

2 Applicable Documents

2.1 General

The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification, or those recommended for additional information or as examples. Although every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government Documents

2.2.1 Specifications, standards, and handbooks.

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

2.2.1.1 Specifications

FAA-C-1391	Installation, Termination, Splicing, and Transient/Surge Protection of Underground Electrical Distribution System Power Cables
W C 596	General Specification for Electrical Power Connectors
A A 59544	Cable and Wire, Electrical (Power, Fixed Installation)
W C 375	Circuit Breakers, Molded Case; Branch Circuit and Service
W P 115	Panel, Power Distribution
A A 55810	Conduit, Metal, Flexible
A A 59551A	Wire, Electrical, (uninsulated)

2.2.1.2 Standards

FAA-STD-019	Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment
10 CFR 431	Energy Efficiency Program For Certain Commercial And Industrial Equipment

2.3 Non-Government publications

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

National Fire Protection Association (NFPA) publications

NFPA 70	National Electrical Code (NEC)
NFPA 101	Life Safety Code

Underwriters' Laboratories (UL) Inc. standards

UL 5	Standard for Surface Metal Raceways and Fittings
UL 50	Enclosures for Electrical Equipment
UL 486A-486B	Wire Connectors
UL 486C	Splicing Wire Connectors
UL 486E	Standard for Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

UL 514A	Metallic Outlet Boxes
UL 514B	Conduit, Tubing, and Cable Fittings
UL 651	Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL 797	Electrical Metallic Tubing - Steel
UL 870	Wireways, Auxiliary Gutters, and Associated Fittings
UL 924	Emergency Lighting and Power Equipment

Institute of Electrical and Electronics Engineers (IEEE) Inc. standards

STD C57.12.80	Standard Terminology for Power and Distribution Transformers
STD 141	Recommended Practice for Electric Power Distribution for Industrial Plants

National Electrical Manufacturers Association (NEMA) standards

MG-1	Standard for Motors and Generators
ST 20	Dry Type Transformers for General Applications
WD 1	General Requirements for Wiring Devices

Steel Structures Painting Council standards

SSPC-PS 10.01	Hot-Applied Coal Tar Enamel Painting System
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Telecommunications Industry Association./Electronic Industries Alliance

TIA/EIA 568-B	Commercial Building Telecommunications Cabling Standard
TIA/EIA 569-A	Commercial Building Standard for Telecommunication Pathways and Spaces

2.4 Order of precedence

FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, is the governing standard for the listed items, and takes precedence over this specification. In all other cases of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 Definitions

Definitions are derived from the NFPA 70, National Electric Code, except as noted.

Bonding Conductor or Jumper: A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected.

Disconnecting Means: A device, or group of devices, or other means by which the conductors of a circuit can be disconnect from their source of supply.

Electrical Metallic Tubing: An unthreaded thinwall raceway of circular cross-section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed using appropriate fittings. Within FAA practice, acceptable EMT is made of steel with protective coatings.

Equipment Grounding Conductor: The conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both. For FAA purposes, the Equipment Grounding Conductor (EGC) is to be green-insulated, solid or stranded, copper wire.

Flexible Metal Conduit: A raceway of circular cross-section made of helically wound, formed, interlocked ferrous metal (steel) strip.

Ground-Fault Circuit Interrupter (GFCI): A device intended for the protection of personnel that functions to deenergize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device, presently 6 mA or higher. Class A devices do not trip when the current to ground is less than 4 mA.

Grounded Conductor: A system or circuit conductor that is intentionally grounded.

Grounding Conductor: A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

Grounding Electrode Conductor: A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.

Intermediate Metal Conduit (IMC): A steel threadable raceway of circular cross-section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed with its integral or associated coupling and appropriate fittings.

Interrupting Capacity: The highest current at rated voltage that the device can interrupt. (IEEE Std 100 "IEEE Standard Dictionary of Electrical and Electronic Terms.")

Multioutlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors and receptacles, assembled in the field or at the factory.

Neutral Conductor: The conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

Neutral Point: The common point on a wye-connection in a polyphase system; the midpoint of a single-phase, 3-wire system; the midpoint of a single-phase portion of a 3-phase delta system; or the midpoint of a 3-wire, direct-current system. At the neutral point of the system, the vectorial sum of the nominal voltages from all other phases within the system that use the neutral, with respect to the neutral point, is zero potential.

Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits, designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support, and accessible only from the front.

Premises Wiring (System): Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes (a) wiring from the service point or power source to the outlets or (b) wiring from and including the power source to the outlets where there is no service point. Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment. Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.

Relocatable Power Tap (RPT): A UL-1363 listed device that is a factory assembled, multiple outlet unit with a cord and plug, and may also include fuses, circuit breakers, switches and/or lights. RPTs are intended to be directly connected to a permanently installed receptacle. RPTs are also referred to as Temporary Power Tap (TPT) and power strips.

Rigid Metal Conduit (RMC): A threadable raceway of circular cross-section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed with its integral or associated coupling and appropriate fittings. RMC is generally made of steel (ferrous) with protective coatings or aluminum (nonferrous). Within FAA practice, acceptable RMC is galvanized (zinc-coated) steel.

Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

Service Point: The point of connection between the facilities of the serving utility and the premises wiring.

Switchboard. A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

4 General Requirements

4.1 General

The orders, standards, rules, regulations, and reference specifications enumerated herein are considered minimum requirements. FAA installations shall meet or exceed the requirements of NFPA 70, National Electric Code (NEC). Where the NEC provides for multiple options, this specification may prescribe some options and proscribe others. Contractors shall furnish and install higher grades of materials and workmanship required by this specification in addition to adhering to other commercial standards.

Facility design and construction standards for specific NAS facilities may have detailed requirements for use of a particular wiring method. Subsection 4.9 includes some of these requirements. This specification for general electrical work at FAA facilities does not supersede any facility-specific standard. In no event shall electrical codes be violated.

Unscheduled interruptions of the electrical service to FAA facilities may cause aircraft accidents and loss of life. Work requiring a temporary or permanent energizing and/or deenergizing of equipment shall be scheduled in writing with the onsite FAA maintenance personnel. Only onsite FAA maintenance personnel are authorized to energize equipment, deenergize equipment, or operate a circuit breaker, switch, or fuse in an FAA facility. Work procedures shall include lock-out/tag-out procedures in accordance with FAA Order 3900.64 and NFPA 70E.

4.2 Grounding

All grounding shall be in accordance with FAA-STD-019, current revision, and the FAA-accepted version NEC, unless otherwise stated in Section 5, Detailed Requirements.

Each overcurrent device shall have its own equipment grounding conductor, i.e.: a single-pole single-phase overcurrent device shall be supplied with an equipment grounding conductor; a two-pole, single-phase overcurrent device shall be supplied with its own equipment grounding conductor; and a three-pole, three-phase overcurrent device shall be supplied with its own 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. Metal conduit housing the equipment grounding conductor shall be electrically continuous, forming a parallel path to the equipment grounding conductor, except as allowed by the NEC. Where parallel feeders are installed in more than one raceway, a full-sized equipment grounding conductor shall be installed in each raceway.

4.3 Safe Work Practices

To the greatest extent possible, all electrical work shall be performed on deenergized material and equipment using appropriate lock-out/tag-out (LOTO) procedures, per FAA and OSHA requirements. Work on energized systems shall be approved by the local FAA Safety & Environmental Compliance Manager (SECM).

All persons working on energized electrical equipment shall wear appropriate personal protective equipment (PPE) and follow safe electrical work practices of FAA Order 3900.64 and the latest version of NFPA 70E. For all energized work, a minimum of two persons are required to be working, to ensure the safety of each.

4.4 Power Systems Analyses

The distribution system and all component parts, when installed or as modified, must include a load flow analysis, short circuit analysis, a protective device coordination analysis, and an arc flash risk assessment, in accordance with the current versions of (1) FAA Order 6950.27, (2) NFPA 70E, (3) IEEE 1584, and (4) other PSG guidance. Arc flash labels are installed as part of the arc flash study in accordance with FAA Order 3900.64, and current version of NFPA 70E.

4.5 Lightning Protection, Grounding, Bonding, and Shielding

FAA grounding requirements exceed those of the NEC. These requirements are considered the minimum necessary to adequately provide for the needs of the FAA missions – to prevent delay or loss of service, to minimize or preclude outages, and to enhance personnel safety. Further, the requirements in the document have been coordinated with industry standards, and in some cases exceed industry standards where necessary to meet the FAA missions. Refer to FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, when installing all NAS equipment.

All surge protective devices shall be installed in accordance with the latest revision of FAA-STD-019.

4.6 Harmonics Control

The distribution system and all component parts, when installed or as modified, shall be in accordance with IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control.

4.7 Quality Assurance Requirements

All design of new facilities and modifications to existing facilities shall be subject to the scrutiny of the Joint Acceptance Inspection (JAI).

4.8 Tests

4.8.1 General

Unless otherwise indicated, the contractor shall furnish all test instruments, materials, and labor necessary to perform the following tests. All tests shall be performed in the presence of the Contracting Officer's designated representative. All instruments shall have been calibrated within a period of one year preceding testing. Calibrations shall be traceable to applicable industry recognized standards.

4.8.2 Insulation resistance

Cables, conductors, and wires shall be tested prior to energization. Intrafacility wiring/cabling may be tested with a standard ohmmeter set to the highest scale, measuring between phases, phase and neutral, phase and ground. A reading of infinite resistance indicates an acceptable installation. All testing shall be accomplished before connection is made to any existing equipment.

Intrafacility wiring/cabling, feeder, and branch circuit insulation tests shall be performed after installation, but before connection to fixtures or appliances. Motors shall be tested for grounds or short circuits after installation but before start-up. Testing should be performed using a 500-volt dc insulation resistance tester, but may be done with a standard ohmmeter set to the highest scale, measuring between phases, phase and neutral, phase and ground. Using the 500-volt DC meter method, a resistance of 30 megohms or greater indicates an acceptable installation. Using the standard ohmmeter method, a reading of infinite resistance indicates an acceptable installation. All conductors shall test free of short circuits and grounds.

4.8.3 Ground-fault Performance Testing

The ground-fault protection system shall be tested in accordance with the NEC and set as appropriate.

4.8.4 Load balancing

All polyphase electrical distribution systems shall be balanced to the greatest extent possible. Current readings with a true RMS ammeter will be taken for the purpose of load balancing. These readings shall be taken at the service entrance, each feeder panelboard, each branch panelboard, and each separately derived source. Single-phase loads must be redistributed where there is a greater than 20% difference between readings in any two phases.

4.9 Facility-Specific Requirements

For Air Route Traffic Control Centers (ARTCC), Metroplex Control Facilities (MCF), and Large Terminal Radar Approach Control Facilities (TRACON), zinc-coated ferrous rigid metal conduit (RMC) or intermediate metal conduit (IMC) shall be used for all distribution panel feeders, transformer feeders, motor control center feeders and distribution switchboards. Electrical metallic tubing (EMT) may be used for communication, lighting and branch circuits.

5 Detailed Requirements

5.1 Electrical Surge Protection

All electrical surge protective devices shall be installed in accordance with the latest revision of FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment.

5.2 Wiring methods

5.2.1 General

All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.

5.2.1.1 Conductor routing

Panelboards, surge protective devices, disconnect switches, etc., shall not be used as raceways for conductor routing other than conductors that originate or terminate in these enclosures. Per the NEC, grounding conductors for isolated ground receptacles will be allowed to pass through these enclosures as required.

5.2.1.2 Conductor separation

Power conductors such as branch-circuit and feeder conductors shall be routed separately from all non-power (e.g., signal, communication, etc. conductor types. This may be accomplished by routing power conductors and other conductors in separate raceways. Rated partitions in a common raceway may be used with documented FAA engineering approval.

5.2.2 Neutral conductor

Shared/common neutral conductors 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.

5.2.3 Raceway systems

5.2.3.1 General

Conduit interiors shall be visibly clean of debris, and swabbed if necessary, before conductors are installed. Ends of raceway systems not terminated in boxes or cabinets shall be capped. Exposed raceways shall be installed parallel to or at right angles with the lines of the structure, with exceptions as approved by the Contracting Officer's Representative (COR). Crushed or deformed raceways shall not be installed. A pull wire shall be installed in all empty tubing and conduit systems in which wiring is to be installed by others. The pull wire shall be 14 AWG zinc-coated steel, or plastic having a minimum 200-pound tensile strength. A minimum of ten (10) inches of slack shall be left at each end of the pull wire. MULETAPE® of minimum 200-pound pull strength may also be used, with 36 inches left at each end of the wire pull. Sections of raceways that pass through to damp, concealed, or underground locations shall be of a type allowed for such locations by NEC, and shall extend a minimum of 12 inches beyond the damp, concealed, or underground area. Where raceway has to be cut in the field, it shall be cut square and burrs and sharp edges removed. Where conduits penetrate walls or floors separating the building interior from the exterior, they shall be sealed to prevent moisture and rodent entry and to deter air transfer. In addition, where conduits penetrate walls separating individually controlled temperature or humidity controlled areas, they shall be sealed to prevent air circulation. Sealing methods and sealants shall be in accordance with NEC. Where

conduits penetrate fire-resistant-rated walls, partitions, floors, or ceilings, the conduit and openings shall be fire stopped using approved methods to maintain the fire resistance rating.

5.2.3.2 Conduit

5.2.3.2.1 General

Minimum conduit size for power distribution shall be ½ inch unless otherwise specified. Conduit for telephone and signal systems shall be allowed to be ½ inch.

Equipment such as Heating, Ventilating, and Air-Conditioning (HVAC) Direct Digital Control (DDC) systems, fire alarm control panels, light fixtures, etc. are often furnished with ½-inch knock-outs. Trade size ½-inch conduit will be permitted for final connection to this equipment. Reducing bushings shall be used as necessary.

Where threads have to be cut on a 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.

5.2.3.2.2 Rigid Metal Conduit

Galvanized ferrous rigid metal conduit (RMC) shall conform to UL 6. Ferrous RMC may be used in all locations above and below grade, and shall be used for all underground service conductors. All RMC shall be galvanized RMC or PVC coated galvanized RMC. When used in corrosive environments, RMC shall have a protective coating of PVC. The conduit shall extend at least 18 inches above grade or into the enclosure.

Elbows, couplings, and fittings used underground shall be protected as specified for conduit, or shall be field wrapped with 0.01-inch-thick pipe wrapping plastic tape applied with 50% overlap. All fittings used with ferrous rigid metal conduit shall be the threaded type, of the same material as the conduit. Where conduits enter/exit exterior junction boxes from the top, a water-tight hub such as MyersTM hub or equivalent connector shall be used. Where conduits enter enclosures without threaded hubs, double locknuts (one on each side of the enclosure wall) shall be used to securely bond the conduit to the enclosure. In addition, a grounding bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation.

5.2.3.2.3 Intermediate Metal Conduit

Intermediate metal conduit (IMC) shall be zinc-coated steel, shall conform to UL Standard 1242, and shall bear the UL label. Ferrous IMC may be used in all locations above grade and below grade. When used in corrosive environments, IMC shall have a protective coating of (1) Steel Structures Painting Council Standard (SSPC-PS) 10.01, Hot-Applied Coal Tar Enamel Painting System; or (2) PVC. The conduit shall extend at least 18 inches above grade or into the enclosure.

Elbows, couplings, and fittings used underground shall be protected as specified for conduit, or shall be field wrapped with 0.01-inch-thick pipe wrapping plastic tape applied with 50% overlap. Where it is necessary to fabricate IMC bends in the field, the tooling required to fabricate those bends shall be specifically designed for IMC. All fittings shall be of the threaded type, of the same material as the conduit. Where conduits enter/exit exterior junction boxes from the top, a water-tight hub such as MyersTM hub or equivalent connector shall be used. Where conduits enter enclosures without threaded hubs, double locknuts (one on each side of the enclosure wall) shall be used to securely bond the conduit to the enclosure. In addition, a grounding bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation.

5.2.3.2.4 Electrical Metallic Tubing

Electrical metallic tubing (EMT) shall be steel and otherwise conform to UL 797. EMT may be used only in dry interior locations, and where not subject to physical damage. EMT shall not be used on circuits above 600 volts. The maximum size of EMT shall be trade size 4 (metric designator 103). Previous versions of this document limited EMT to trade size 3 (metric designator 78) due to structural integrity issues. Fittings used with EMT shall be standard compression-type fittings designed for this type of EMT, unless otherwise indicated. Set-screw-type fittings are not acceptable. Where EMT enters enclosures without threaded hubs, an appropriate connector with threads and cast or machined (not sheet metal) locknut shall be used to securely bond the conduit to the enclosure. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure. In addition, the connectors shall have an insulated-throat, smooth bell-shaped end, or a grounding bushing.

5.2.3.2.5 Rigid Aluminum conduit

Aluminum conduit shall not be used for any installation except by special permission. Nonferrous Condulets™ are acceptable.

5.2.3.2.6 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall conform to UL 651. Rigid nonmetallic conduit used to protect electrical power conductors may only be used underground, or in concrete, or as a vertical riser to 6 inches above grade or floor surface for connection to metal conduit, and only when required by the contract drawings or specific job specifications. PVC fittings shall be used with PVC conduit and shall be assembled in accordance with manufacturer's instructions. A PVC threaded fitting with locknut and plastic bushing shall be used to connect PVC conduit to boxes or cabinets without threaded hubs. Rigid nonmetallic conduit may also be used to protect lightning protection system conductors and grounding conductors in accordance with FAA-STD-019.

Sweeps and elbows in underground installations shall be RMC or IMC.

5.2.3.2.7 Flexible metal conduit, including liquid-tight

Flexible metal conduit shall be ferrous and conform to Federal Specification A-A-55810. Flexible metal conduit shall be used for terminal connections to motors or motor driven equipment, and in lengths only up to six (6) feet for other applications permitted by the NEC. A copper equipment grounding conductor (wire) shall be run with the circuit conductors; the conduit is not to be used as the equipment grounding conductor.

Liquid-tight flexible metal conduit shall be used outdoors and in wet locations.

Flexible metal conduit may be used under raised floor for branch circuits in lengths longer than six (6) feet in locations that meet all the requirements of Article 645 of the NEC. Conduit, fittings, and junction boxes installed under the raised floor shall be liquid-tight types.

5.2.3.2.8 Flexible nonmetallic conduit

Flexible nonmetallic conduit shall not be used.

5.2.3.2.9 Surface raceways

Nonmetallic surface raceways shall not be used. Surface metal raceways shall conform to UL 5. Surface metal raceways shall be installed only in exposed, dry locations not subject to physical damage. Surface metal raceways shall meet NEC requirements; however, they shall not be used for circuits above 600 volts.

5.2.3.3 Wireways

Wireways shall conform to UL 870. Wireways shall only be installed in accessible locations. Wireways installed in wet or outdoor locations shall be rated for these locations.

5.2.3.4 Cable rack systems

5.2.3.4.1 General

Cable rack systems shall be of the ladder or ventilated trough type conforming to NEMA VE 1 unless otherwise indicated. All components for each cable rack system shall be fabricated with commercial off the shelf (COTS) components from a single manufacturer. Cable rack support spacing shall be as recommended by the manufacturer except that in no case shall spacing of supports exceed 6 feet. Cable racks shall be supported from structural members only.

5.2.3.4.2 Dimensions

Straight sections, bends, tees, offsets, reducers, etc., for ladder-type cable rack systems shall consist of 3-inch minimum side channels with suitable cross-channels (rungs) installed on 6-inch centers unless otherwise indicated. Straight sections, fittings, etc., for ventilated-type cable rack systems shall have 3-inch minimum high sides and a ventilated bottom with cross-pieces 2 inches (maximum) wide on 3-inch (maximum) centers and openings 2 inches (maximum) wide. Cable rack widths shall be as shown on the drawings.

5.2.4 Raceway support systems

5.2.4.1 General

Raceways shall be securely supported at intervals specified in the NEC Article 300.11, "Securing and Supporting," and fastened in place with pipe straps, wall brackets, hangers, or ceiling trapezes. Fastenings shall be by wood screws, nails, or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, or spring tension clamps on steel work. Nail-type nylon anchors or threaded studs driven by a power charge and provided with lock washers and nuts may be used in lieu of expansion bolts, machine screws, or wood screws. Threaded C clamps with retainers may be used. Raceways or pipe straps with a depth of more than 1 ½ inch in reinforced concrete beams, or with a depth of more than ¾ inch in reinforced concrete joists, shall not cut the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported from sheet-metal roof decks. In suspended-ceiling construction, raceways shall not be fastened to the suspended-ceiling supports.

5.2.4.2 Telecommunication raceways

Telecommunication system raceways shall be installed in accordance with the previous requirements for conduit and tubing, with the additional requirements that no length of run shall exceed 50 feet for ½ inch and ¾ inch sizes, or 100 feet for 1-inch or larger sizes; and shall not contain more than two 90-degree bends or the equivalent. Pull or junction boxes shall be installed to comply with these limitations, whether or not indicated on the drawings. Bends in conduit of 1 inch and larger shall have minimum inside radii of 12 times the nominal conduit diameter.

5.2.5 Conductors

5.2.5.1 Uninsulated conductors

Uninsulated conductors shall be copper and in accordance with Federal Specification A-A-59551A.

5.2.5.2 Insulated conductors

Unless otherwise indicated, insulated conductors shall be copper with thermoplastic or thermosetting insulation, type THW, THWN, and XHHW for general use, or type THHN for use in dry and damp locations only, all insulated for 600 volts in accordance with Federal Specification A-A-59544.

Conductors sized 12 AWG and smaller for general use shall be solid. Stranded 12 AWG and smaller conductors are permitted when required for specific equipment installations. Conductors 10 AWG and larger may be stranded. Stranded conductors shall be UL Listed Class B. Minimum branch circuit conductor size shall be 14 AWG. If required for specific equipment installations, stranded conductors finer than Class B may be used. Minimum control wire size shall be 14 AWG unless otherwise required by manufacturer or noted on the drawings. Conductors 12 AWG and smaller are permitted to be stranded in applications where vibration and flexing may be encountered, with compression fittings installed at appropriate ends.

5.2.5.2.1 Fixture wiring

Fixture wiring shall be thermoplastic insulated copper, rated for 600 volts, in accordance with Federal Specification A-A-59544 and the NEC.

5.2.5.2.2 Conductor identification

All feeder and branch circuits, including neutral conductors, shall be identified at both ends of the conductor with panel and circuit number indicated. This shall be accomplished using vinyl self-laminating wraparound labels or shrink-embossed labels. Equipment grounding conductors shall be color coded green. Conductors covered with green insulation with yellow, orange, violet, or red tracers shall be used for other grounding systems. Neutral conductors shall be white insulated for 208Y/120 and 120/240 volt systems, and gray insulated for 480Y/277 volt systems. For conductors 4 AWG and larger, and where appropriate insulation color is not available, use color-coded tape, half lapped for a minimum length of 3 inches. Switch-leg conductors shall be consistently identified within a facility. All conductor color codes including reidentified conductors shall be visible at all junction boxes, pull boxes, panelboards, outlets, switches, at access locations in closed raceways, every three (3) feet in open raceways, under all raised floors, and at all terminations.

5.2.5.2.3 Color Coding for Ungrounded Conductors

5.2.5.2.3.1 120, 120/240, 208Δ, 208Y/120 Voltage Systems

Standard practice for FAA installations is (1) black for 120 volt systems; (2) black and red for 120/240 volt systems; (3) black (phase A), red (phase B), and blue (phase C) for 208Δ and 208Y/120 volt 3-phase systems. This color scheme is generally used within the United States. Phase conductor color coding shall be continuous throughout the facility on each phase conductor to its point of use so that the conductor phase connection is readily identifiable.

5.2.5.2.3.2 480Δ, 480Y/277 Voltage Systems

To ensure safety and proper operation of equipment, only one system shall be used within a facility. For work at an existing facility, the color coding to be used shall match the existing facility color code. For new FAA facilities, the FAA historical practice of yellow-brown-orange for phase A, B, C is preferred; local practice brown-orange-yellow for phase A, B, C is permitted. Phase conductor color coding shall be continuous throughout the facility on each phase conductor to its point of use so that the conductor phase connection is readily identifiable.

5.2.5.2.3.3 Direct Current Systems

Standard use in the electrical, automotive, and nautical arenas, including the approved National DC Bus System equipment, is red for dc positive and black for dc negative. These standard colors shall be used for all FAA installations.

5.2.5.3 Connectors and Splices

Splices shall be made only at outlets, junction boxes, or accessible raceways. Splicing of ungrounded conductors in panelboards is not permitted. All splices shall be accessible. Splices shall be made with solderless connectors conforming to UL 486A-486B, UL 486C, and UL 486E. Insulated twist-on wire connectors may only be used to splice conductors sized 10 AWG and smaller. Compression connectors shall be used to splice conductors 8 AWG and larger. All splices, including those made with insulated twist-on wire connectors, shall be insulated with electrical tape or shrink tubing to a level equal to that of the factory insulated conductors. All underground splicing shall be accomplished in accordance with FAA-C-1391. To increase the reliability of power for NAS critical services, new feeder and branch conductors supporting these services shall not be spliced. Splices are not recommended, but may be used for modification work on existing systems. Where splices are used in other systems, such splices shall be approved by FAA in advance, and documented on facility drawings.

Connectors shall be listed for use with the conductors. Connectors for use with Class C and finer stranding shall be wire compression connectors or a pressure washer type lug; lugs with screw only compression are not allowed. Consult manufacturer for specific recommendations for termination of fine stranded wire.

When twist-on wire connectors are used, wires must be pre-twisted.

5.2.6 Metal-Clad Cable: Type MC

The installation of Metal-Clad Cable: Type (MC) installation must comply with the NEC. All metal-clad cable shall be UL listed with a steel sheath. Aluminum sheathing is not allowed. Both ends of the cable shall be terminated using UL-listed saddle or stirrup type fittings. Metal-Clad Cable shall include a separate internal equipment grounding conductor (wire); the metallic sheath is not to be used as the equipment grounding conductor.

5.2.6.1 Type MC installed in cable tray

When installed in cable tray, the following conditions must also be met:

- a. Type MC Cable shall be installed in metallic cable tray.
- b. MC Cable shall be separated from communication, signal, and control cables per ANSI/TIA/EIA 569, Table 3.
- c. The bend radius of Type MC Cable shall comply with applicable code and manufacturer guidance.
- d. MC cable can be run with other power conductors in accordance with code.

5.2.6.2 Type MC installed in other than cable tray

When installed in other than cable tray, or freely supported as allowed by code, MC cable shall be:

- a. Used only in existing construction, or as otherwise permitted in writing for a specific use.
- b. Used only for branch circuits.

- c. Used for essential and nonessential loads only, when installed in areas that are not readily accessible such as wall cavities or ceilings, except as otherwise permitted in writing for a specific use.
- d. Permitted for specialized installations with proper engineering justification.

5.3 Boxes

Boxes shall be either the cast-metal threaded-hub type conforming to UL 514A and UL514B, galvanized steel type conforming to UL 514A and UL 514B, or metal outlet boxes conforming to NEMA OS 1. All enclosures shall conform to NEMA standards.

5.3.1 Applications

Boxes shall be provided in the wiring or raceway system for pulling wires, making connections, and mounting devices or fixtures. All outdoor boxes shall be rated suitable for the environment. In hazardous areas, boxes shall be rated suitable for the hazardous locations. Each electrical outlet box shall have a machine screw that fits into a tapped hole in the box for the ground connection. Boxes shall be sized in accordance with the NEC. Boxes for mounting lighting fixtures shall not be less than 4 inches square. 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. Boxes for use in masonry-block or tile walls shall be square-cornered tile-type, or standard boxes having square-cornered tile-type covers. Cast-metal boxes installed in wet locations and boxes installed flush with exterior surfaces shall be gasketed. Separate boxes shall be provided for flush or recessed fixtures where required by the fixture terminal operating temperature. Fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided. Boxes for fixtures on suspended ceilings shall be supported independently of the ceiling supports. Boxes shall not be supported from sheet-metal roof decks. Nonmetallic boxes may be used only with nonmetallic raceway systems.

5.3.2 Supports

Boxes and supports shall be securely fastened to wood with wood screws, nails, screw-type nails, carriage bolts, or lag screws of equal holding strength, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Support systems shall be capable of carrying the weight of the box and its contents. Threaded studs driven by powder charge and provided with lock washers and nuts, or nail-type nylon anchors, may be used in lieu of expansion shields or machine screws. In open overhead spaces, cast-metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast-metal boxes having threadless connectors and sheet-metal boxes shall be supported directly from the building structure or by bar hangers. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved fastener not more than 24 inches from the box. Penetration shall be no more than 1-1/2 inches into reinforced concrete beams or more than 3/4-inch into reinforced concrete joists. Main reinforcing steel shall not be cut.

5.4 Wiring devices

5.4.1 Receptacles

All receptacles shall be Federal Specification grade in accordance with W-C-596. Unless otherwise indicated, general-purpose duplex receptacles shall be Federal Specification grade, grounding type NEMA 5-15R or NEMA 5-20R. Receptacles with push-in connections or a combination of screw-type and push-in connectors are not acceptable. Unless noted otherwise, receptacles shall be installed

12 inches above finished floor. All receptacles, unless they are of the isolated-ground type, shall be grounded by the installation of a green grounding pigtail from the receptacle grounding screw directly to the grounding screw on the outlet box where the green equipment grounding conductor is terminated.

NOTE: For all critical power circuits, the receptacles shall be twist lock type except where the receptacles are not subject to be kicked or bumped (e.g., receptacles mounted inside an equipment rack). Electronic equipment installations often use plug strips that do not have twist locks. These are typically connected into a PDU, which is then plugged into a twist lock.

5.4.1.1 Ground Fault Circuit-Interrupter receptacles

Ground fault circuit-interrupter (GFCI) receptacles shall be 125-volt, duplex, UL Group I, Class A, rated for 15 amperes minimum.

5.4.1.2 Multioutlet Assemblies

5.4.1.2.1 General

Fixed multioutlet assemblies shall consist of a surface metal raceway with grounding type receptacles. Phase and neutral conductors shall not be smaller than 12 AWG and shall have the type of insulation specified for branch circuit conductors. In addition, a 12 AWG or larger green insulated equipment grounding conductor having the same insulation as the phase conductors shall be installed. This grounding conductor shall connect all receptacle ground terminals and each section of the surface metal raceway, and shall be securely connected to the equipment grounding conductor from the branch power panel. Where more than one circuit is indicated as serving a group of similar receptacles in a common raceway, adjacent receptacles shall not be connected to the same circuit.

NOTE: Relocatable Power Taps / Temporary Power Taps are not covered by this specification.

5.4.1.2.2 Associated hardware

Surface metal raceways shall be provided with snap-on blank covers and/or snap-on receptacle covers for the receptacles furnished, all manufactured by the raceway manufacturer. They shall be installed to prevent open cracks. Where industry standard device plates are to be installed on raceways, snap-on blank covers shall be accurately cut to avoid open cracks. Fittings, elbows, clips, mounting straps, connection blocks, and insulators, shall be provided as required for a complete installation.

5.4.1.3 Emergency light receptacles

Emergency light receptacles shall be grounding type single receptacles in accordance with NEMA WD 1.

5.4.2 Wall switches

Switching devices, such as single-pole, three-way, and four-way wall switches shall be Federal Specification grade, rated 120/277 volts, and shall be fully rated 20 amperes, ac only. Wiring 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 equipped with grounding terminals and shall be grounded with a green grounding pigtail connected from the switch grounding screw directly to the grounding lug or screw on the outlet box where the green equipment grounding conductor is terminated. Switches shall be the quiet-operating type. Not more than one switch shall be installed in a single gang position.

5.4.3 Device plates

Plates of the one-piece type shall be provided for all outlets and fittings to suit the devices installed. Plate screws shall be of metal with countersunk heads, in a color to match the finish of the plate. Telephone and communication outlets shall be provided with a blank cover plate unless otherwise indicated. Plates shall be installed with all four edges in continuous contact with finished wall surfaces with the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed. Device plates for telephone and intercommunication outlets shall have a 3/8-inch bushed opening in the center or a dome-shaped grommet on the side.

5.5 Service equipment

5.5.1 Power

Service entrance equipment and installation for power shall be in accordance with the regulations of the local utility providing service and NEC Article 230.

5.5.1.1 Service conduits

Service conduits shall be installed as shown on the drawings and shall be zinc-coated ferrous rigid metal conduit unless otherwise indicated. Grounding bushings shall be installed on both ends of the service conduit.

5.5.1.1.1 Underground service

Underground service conduits shall be installed a minimum of 2 feet below finished grade. The conduit shall be bonded to the GES.

5.5.1.1.2 Aerial service

A minimum of 4 feet of slack in all service conductors shall be extended from an appropriate weatherproof entrance fitting to permit connection to the service drop. Conduit shall be concealed within the building where possible and conduit penetrations into the building shall be caulked with sealing compound.

5.5.1.2 Service disconnecting means

Service equipment shall be a fused disconnect switch, separately mounted circuit breaker, or main circuit breaker in the main distribution panel. All switches and circuit breakers used as service entrance disconnecting means shall be UL rated for service equipment.

5.5.2 Ground fault protection

Ground-fault protection of equipment shall be provided for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 600 volts phase-to-phase for each service disconnect rated 1000 amperes or more, where required per NEC Article 230, VII Service Equipment — Overcurrent Protection.

5.6 Panelboards

5.6.1 General

Panelboards shall be dead-front type, shall conform to Federal Specification W-P-115, Type I, Class 1, and shall be listed by UL except for installations which require special panelboards to incorporate items not available as UL listed. Unless otherwise specified, panelboards shall have a full continuous piano hinged front cover, with a hinged door in that cover for access to circuit breaker switches. The cover, when open, provides access to the panel interior, conductors, and wiring terminals. Doors

shall have flush type cylinder locks and catches. Doors over 48 inches in height shall have auxiliary fasteners on top and bottom. All locks in a project shall be keyed alike, and two keys shall be furnished with each lock. Directories shall be type written to indicate the load served by each circuit and shall be mounted on the inside of the door in a holder with a protective covering. Circuits shall be connected as indicated on the drawing. The directory shall be arranged so that the typed entries simulate circuit breaker positions in the panelboard.

5.6.2 Wiring gutters

The minimum size of side wiring gutters shall be 4 inches for power feeders up to and including 100 amperes, 6 inches for power feeders over 100 amperes and up to 225 amperes, and 8 inches for power feeders over 225 amperes and up to 600 amperes.

5.6.3 Circuit breakers

Circuit breaker ratings shall be in accordance with the current version of FAA Order 6950.27. All circuit breakers shall be UL listed thermal magnetic type or electronic solid state type, as described herein, and with a minimum interrupting rating of 10,000 AIC. Circuit breakers shall also have ampere ratings, voltage ratings, and number of poles as defined on the drawings. All circuit breakers shall have a trip indicating feature. Single-pole breakers shall be full-size modules. Two-pole and three-pole breakers shall be physically sized in even multiples of a single-pole breaker. Breakers shall be sized so that two single-pole breakers cannot fit in a single housing. Multipole circuit breakers shall have an UL-approved common trip mechanism. All circuit breakers and the panelboards in which the breakers are installed shall be products of the same manufacturer. Plug-in type load centers and/or plug-in type branch or feeder circuit breakers shall not be used. Positive integral locking plug-in circuit breakers, and associated panelboards, may be used.

5.6.3.1 Thermal magnetic

All thermal magnetic breakers shall be quick-make, quick-break type conforming to Federal specification W-C-375. Adjustable breakers shall have setting adjustments that are accessible. Where the circuit breaker ratings and settings are rendered not readily accessible for inspection, the information shall be recorded and attached to the panel.

5.6.3.2 Solid state

Adjustable solid-state or microprocessor-controlled circuit breakers shall have adjustments that are accessible. Where the circuit breaker ratings and settings are rendered not readily accessible for inspection, the information shall be recorded and attached to the panel.

5.6.3.3 Self-enclosed circuit breakers

5.6.3.3.1 General

Circuit breakers shall be UL-listed thermal magnetic type or electronic solid-state type, as described herein. Multiple circuit breakers shall have a UL-approved common trip mechanism. Circuit breakers shall comply with Federal Specification W-C-375.

5.6.3.3.2 Thermal magnetic

These circuit breakers shall be of the molded-case type, 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 a bimetallic thermal element releasing the mechanism latch. In addition, 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.

5.6.3.3.3 Solid state/microprocessor

These circuit breakers may be used providing they meet or exceed the performance characteristics given by paragraph 5.7.3.3.2 above.

5.6.4 Bus bars

All phase bus bars shall be copper or plated copper. Neutral and ground bus bars shall be copper or plated copper. Bus capacity shall be as indicated on the drawings. Where bus capacity is not indicated on the drawings, the capacity shall be equal to or greater than the panelboard feeder overcurrent protective device. Except as indicated in paragraph 5.7.3, circuit breaker current-carrying connections shall be bolted. Bus bar connections to branch circuit breakers shall be of the sequence phase type. The neutral bus shall be insulated from all panelboards except where the panelboard is used as the service disconnecting means. Where "provisions for," "future," or "space" is noted on the drawings, the panelboard shall be equipped with bus connections for the future installation of circuit breakers.

5.6.4.1 Ground bus

All panelboards shall have one or more uninsulated ground bus bars that are separate from the neutral bus. The ground bus bars shall be securely bonded to the cabinet and adequately sized for the panelboard capacity. The number of available grounding conductor terminations shall be equal to the total number of single-wire and multiwire circuits plus the number of unequipped spaces. Although generally done for electrical safety only, the effective grounding of electronic equipment does not allow terminating multiple grounding wires under one termination, even if the termination is so rated. The ground bus shall only be bonded to the neutral bus at the service disconnecting means and at the first disconnect means after a separately derived source, the point of origin (X0 bond) of a separately derived system. The ground bus bars shall be structurally integral to the panelboard or, at a minimum, attached to the panelboard following manufacturer's recommendations. If the ground bus bar is mounted to the enclosures with screw threads only (i.e., tapped blind hole), a separate, bolted ground lug shall be installed on the panelboard and bonded to the ground bus bar. The bond conductor shall have the same current carrying capacity as the largest equipment grounding conductor terminated to the ground bus bar.

For panels requiring more than one ground bus bar, the ground bus bars shall be connected in a star configuration. To ensure higher reliability, daisy-chaining of the multiple ground bus bars is not permitted. The conductors connecting the multiple ground bus bars shall be parity sized with the panel equipment grounding conductor. The panel equipment grounding conductor shall be connected to the center point of the star.

5.7 Safety switches

Safety switches shall be NEMA KS 1 type "HD", heavy-duty locking type unless otherwise indicated. Switches mounted in dry locations shall be NEMA type 1 enclosures. Switches installed outdoors, or in damp locations shall be mounted in NEMA type 3R enclosures. Switches shall be of the voltage and current ratings indicated on the drawings. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, all 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. When used for motors, a safety switch shall be sized in accordance with the NEC. Switches shall disconnect all ungrounded conductors.

Safety switches shall be readily accessible.

5.8 Cabinets

Telephone and signal systems cabinets shall be constructed of zinc-coated sheet steel in accordance with the NEC, and shall meet the requirements of UL 50. Cabinets shall be constructed with interior dimensions not less than those indicated on the drawings. A locking catch and two keys shall be provided with each cabinet unless otherwise indicated. All locks in a project shall be keyed alike. Cabinets shall also be provided with a 5/8-inch Class A fire-rated, treated-plywood backboard unless otherwise indicated. The rating stamp shall remain visible after any painting.

5.9 Motors and controls

5.9.1 Motors

Motors furnished under this specification shall be of sufficient size for the duty to be performed, and shall not exceed the full-load rating when the driven equipment is operating at specified capacity. Motors shall be rated for the voltage of the system to which they are to be connected. Unless otherwise indicated, all motors shall have open frames, and continuous-duty classifications. Polyphase motors shall conform to NEMA MG-1, and shall be type II, class 3, minimum insulation class B, squirrel-cage type, having normal starting-torque and low-starting-current characteristics, unless otherwise specified. When motor horsepower ratings are indicated on electrical drawings, these ratings are only approximate. Higher ratings may be required to adequately power driven equipment selected by the contractor for the duty to be performed. Motors shall be premium efficiency conforming to the DOE "Energy Conservation Program: Energy Conservation Standards for Small Electric Motors," in the Federal Register (10 CFR Part 431).

5.9.2 Motor controls

Each motor, 1/8 horsepower or larger, shall have overload protection in each phase, or other equally rated method in accordance with the NEC. The overload-protection device shall be provided either integral with the motor, or with the control, or shall be mounted in a separate enclosure. In any case the reset button shall be in an accessible location. Unless otherwise indicated, the protective device shall be of the manual reset type. Single or double-pole tumbler switches specifically designed for AC operation may be used as manual controllers for single-phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats and float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic control device operates the motor directly, a double-throw, three-position tumbler or rotary switch shall be provided for manual control.

5.9.2.1 Reduced-voltage controllers

Reduced voltage starting methods, when required, shall be as indicated on the drawings. Reduced-voltage starters, when indicated, shall be single-step, closed-transition autotransformer solid-state type, or as indicated, and shall have adjustable time interval between application of reduced and full voltages to motors.

5.9.3 Motor disconnecting means

Each motor shall be provided with a disconnecting means and a manually operated switch as shown on the drawings or when required by the NEC. Motor disconnecting means shall be located within line of sight of the motor for LOTO unless a circuit has a lockable breaker or disconnecting means upstream of the motor. For single-phase motors, a single-pole or double-pole toggle switch, rated only for AC, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the

switch is at least 125 percent of the motor full load amperages (FLA). Enclosed safety switches shall conform to paragraph 5.8 above.

5.10 Dry-type transformers

5.10.1 General

Dry-type transformers shall be of the sizes and characteristics shown on drawings. Unless otherwise indicated, the design, manufacture, and testing of dry-type transformers, and the methods of conducting tests and preparing reports shall be in accordance with NEMA ST 20, and UL standards. These transformers shall be dry-type self-cooled (Class AA) as defined by IEEE C57.12.80. Unless otherwise indicated, minimum Basic Insulation Levels (BIL) shall be in accordance with IEEE STD 141. Transformer efficiency shall not be less than that specified in 10 CFR Part 431 and NEMA Class 1 efficiency as defined by NEMA TP 1. K rated transformers shall be used for electronic loads and elsewhere as required or where justified. Inrush current shall not adversely impact normal operation of the facility.

5.10.2 Windings and taps

Dry-type transformers shall be provided with separate primary and separate secondary windings for each phase. Unless otherwise indicated, each primary winding of each transformer rated 15 kVA and greater shall be provided with four taps, two of which shall provide 2½ percent increments above full rated voltage and two of which shall provide 2½ percent increments below full rated voltage. Each primary winding of each transformer rated below 15 kVA shall be provided with not less than two taps, each providing a 5 percent increment above and below full rated voltage.

5.10.3 Insulation

General-purpose transformer insulation rating shall be Class 220. Allowable transformer ratings, i.e. average winding temperature rise, are 80°C rise, 115°C rise, and 150°C rise. Encapsulated or resin-filled transformers shall have Class 180 transformer insulation rating.

5.10.4 Terminal compartments

Each dry-type transformer shall be provided with a suitable terminal compartment to accommodate the required primary and secondary wiring connections, and side or bottom conduit entrance. Transformers having ratings not exceeding 25 kVA shall be provided with terminal leads equipped with factory installed and supported connectors. Transformers rated greater than 25 kVA shall have terminal boards equipped with factory installed clamp-type connectors. The terminal compartment temperature shall not exceed 75°C when the transformer is operating continuously at rated load with an ambient temperature of 40°C.

5.10.5 Sound pressure levels and vibration isolation

Sound pressure levels dry-type transformers shall be determined in accordance with NEMA ST 20. Levels shall not exceed 40 dB for transformers rated at 9 kVA or less; 45 dB for transformers rated over 9 kVA but not over 50 kVA; and 50 dB for transformers rated over 50 kVA but not over 150 kVA. All dry-type transformers 45 kVA and greater shall have integral vibration isolation supports between the core and coil assembly and the transformer enclosure. Transformers of lesser rating shall have either integral or external vibration isolation supports. Conduit connections to transformers shall be made with flexible metal conduit, nominally 12 inches, but not more than 36 inches, in length.

5.10.6 Enclosures

Single-phase transformers larger than 25 kVA and three-phase transformers larger than 15 kVA shall be fully encased in steel enclosures. Transformers smaller than 15 kVA shall be fully encased in steel

enclosures with or without compound fill, or shall have exposed cores, impregnated windings, and steel enclosures encircling all live parts. Enclosures shall be bonded to the grounding system. The surface temperature of the transformer shall not exceed 65°C when the transformer is operating continuously at rated load with an ambient temperature of 40°C.

5.10.7 Mounting

Transformers shall be mounted to allow for adequate ventilation. Unless otherwise indicated on drawings, dry-type transformers having ratings not exceeding 45 kVA shall be suitable for wall mounting. Shop drawings of wall brackets and platforms for transformers shall be submitted for approval.

5.11 Equipment Identification

Equipment shall be identified with a name plate showing the functional name of the unit, voltage used, the number of phases, and other pertinent formation. Switches for local lighting need not be identified. Equipment that shall be identified includes, but is not limited to, the following:

- a) Panelboards, electrical cabinets, and enclosures.
- b) Access doors and panels for concealed electrical items.
- c) Electrical switchboards.
- d) Motor starters.
- e) Push-button stations.
- f) Variable frequency drives (VFD).
- g) Contactors.
- h) Remote-controlled switches.
- i) Power disconnect switches.
- j) Control devices (including HVAC DDC).
- k) Transformers.
- l) Automatic transfer switch.
- m) Power-generating units.
- n) Telephone switching equipment.
- o) Fire alarm master station or control panel.
- p) Security monitoring master station or control panel.
- q) Lighting/dimming control panel.
- r) Load banks.
- s) Static transfer switch.
- t) Other equipment called for on-project drawings.

Nameplates shall be non-ferrous metal or rigid plastic, stamped, embossed or engraved with 3/8-inch minimum height characters, or as specified by FAA-issued drawings. Engraved nameplates shall

have white letters on black face. Nameplates shall be secured to the equipment with a weather-proof bonding material (glue), double-sided tape, or a minimum of two screws.

5.12 Fuses

A complete set of fuses shall be installed and one set of spares shall be furnished for each fusible device. Sizing and selection of fuses serving motors or connected in series with circuit breakers shall be determined by electrical power calculations, including Load Flow, Short Circuit Analysis and Protective Device Coordination Analysis, and Arc Flash Hazard Analysis. Fuses shall have a voltage rating not less than the circuit voltage. Fuses shall have an interrupting capacity equal or greater than the maximum available short circuit current at the point of application.

5.13 Lamps and lighting fixtures

5.13.1 General

Lamps and lighting fixtures shall be of types indicated on the drawings. All lighting fixtures shall be UL approved and shall bear the UL label. Flexible metal conduit, minimum 3/8 inch nominal trade size, is permitted. External bonding jumpers are not required across the lighting fixture flexible conduit. All luminaries shall be appropriately selected based on the expected application. Lighting fixtures shall be sized based on photometric calculations and shall meet an accepted design criteria. Luminaries may be recessed, pendant, or surface mounted. Indirect/direct luminaries should have a minimum 2 percent indirect component and a maximum 50 percent direct component. Luminaries should have a minimum lumen efficiency of 65 percent.

5.13.2 Fluorescent fixtures

Ballasts for fluorescent fixtures should be NEMA Premium[®] when applicable. Ballasts for other types of linear and compact fluorescent lamps and LED fixture drivers shall be electronic with a minimum power factor (PF) of 0.95 and a maximum current total harmonic distortion (THD) of 10 percent. Programmed start ballasts shall be specified for use in linear fixtures that are frequently switched on and off, such as with occupancy controls. Continuous dimming or step-dimming ballasts may be used in special application situations. Tandem wiring should be implemented to reduce the number of ballasts, where applicable. Electronic ballasts should be used wherever possible and have a sound rating of "A." EM ballasts used in special applications shall have a sound rating of "A" for 430 mA (standard output) lamps; "B" for 800 mA lamps; and "C" for 1,500 mA lamps. Special consideration shall be given to the ballast types in the FAA facilities to confirm compatibility of application.

Fluorescent fixtures used in communication areas shall be equipped with radio frequency interference (RFI) filters.

Unless otherwise indicated, fluorescent fixture lenses shall be the prismatic type made of virgin acrylic. Where parabolic luminaries are used, louvers shall be semispecular or diffuse finishes; specular finishes shall not be used.

5.13.2.1 Recessed lighting

Recessed lighting fixtures shall conform to NEC Article 410, Parts XI and XII, and shall be installed in suspended ceiling openings. These fixtures shall have adjustable fittings to permit alignment with ceiling panels. All recessed downlights shall use compact fluorescent lamps (CFL), LED, halogen, or ceramic metal halide lamps. LED or halogen downlights with appropriate light distributions may be substituted for CFL or ceramic metal halide where appropriate. LED lamps should not be used in fixtures not designed for their application.

5.13.2.2 Suspended fluorescent fixtures

Pendant-mount fluorescent fixtures shall be of the types indicated on the drawings. Single-unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple-unit or continuous-row fluorescent units shall have tubing or a stem for wiring at one point, and tubing or a stem suspension provided for each unit length of chassis, including one at each end.

5.13.3 Suspended incandescent fixtures

Pendant-mounted incandescent fixtures shall be provided with swivel hangers to ensure a plumb installation.

5.13.4 Emergency lights

Emergency lighting units shall be completely assembled with wiring and mounting devices, ready for installation at the locations indicated. The emergency lighting fixtures shall be equipped with lamps. Emergency lighting units shall be inspected to ensure they are suitable for operation on the AC supply circuit to which they are to be electrically connected. Emergency lighting units shall conform to UL 924 and NFPA 101.

Provide each unit with an automatic power failure device, test switch, pilot light, and fully automatic high/low trickle charger in a self-contained, solid-state, temperature-compensated power pack.

5.13.5 Lamps

Fluorescent lamps shall be rapid start, cool white unless otherwise indicated. Fluorescent lamps shall be Super T8 or T5, low-mercury lamps with efficacies above 90 lumens/watt. The maximum lumen depreciation shall be 5%. Lamps shall have a Color Rendering Index (CRI) greater than or equal to 85. The minimum rated lamp life shall be 20,000 hours. All CFLs shall have minimum efficacies of 60 lumens/watt and a maximum lumen depreciation of 15 percent. The minimum rated lamp life shall be 10,000 hours. The lamp color and CRI shall be consistent with the linear fluorescent lamps. All ceramic metal halide lamps used in finished spaces shall have a CRI greater than or equal to 80. LED replacement modules shall not be used in an existing luminary designed for an incandescent, CFL, or high-intensity discharge (HID) luminary unless tested for that specified luminary due to poor heat transfer.

LED lamps shall comply with the requirements of FAA-G-2100 regarding harmonics and electromagnetic interference.

High-efficiency halogen lamps and HIR lamps may be used in all incandescent fixtures.

5.14 Signal and communications

5.14.1 Entrance conduits

Entrance conduits shall comply with the requirements of FAA-STD-019 section 5.4.3.1. Conduits installed for future use by others, such as for telephone, communications, electronic signals, etc., shall have both ends capped.

5.14.2 Transient protection demarcation box for electronic landlines

A metallic, appropriately rated NEMA-listed junction box shall be installed where electronic landlines or conduits enter the facility. This box will house antenna bulkhead ground plate, terminal boards, cables, and circuit transient protectors as shown on the contract drawings.

5.14.3 Fiber optics

The use of fiber optics is recommended to replace metallic control cables. Using fiber optics will reduce frequency of outages and loss of service due to lightning strikes.

6 Notes

6.1 Intended use

This specification is to be used for all electrical work at FAA facilities as part of the contract documentation for construction and facility modification projects.

6.2 Tailoring guidance

To ensure proper application of this specification, invitation for bids, requests for proposals and contractual statements of work shall tailor the requirements in sections 4 and 5 of this specification to exclude any unnecessary requirements. Any proposal request using this document shall contain the following provisions:

"Prospective contractors shall, as part of their proposals, enumerate, identify, and list conflicts that exist between (1) the contract documents; and (2) the rules, regulations, and codes of the local utility company and of the local, county, or state governing bodies."

Appendix A Acronyms and Abbreviations

°C	Degrees Centigrade
ac	Alternating Current
AFCI	Arc-Fault Circuit Interrupter
AIC	Amperes Interrupting Capacity
ANSI	American National Standards Institute
ARTCC	Air Route Traffic Control Center
ATO	Air Traffic Organization (FAA)
AWG	American Wire Gauge
BIL	Basic Insulation Level
CFL	Compact Fluorescent Light
CFR	Code of Federal Regulations
CHG	Change
COR	Contracting Officer's Representative (FAA)
COTS	Commercial Off the Shelf
CRI	Color Rendering Index
dB	Decibel(s)
dc	Direct Current
DDC	Direct Digital Control
DOE	Department of Energy
EGC	Equipment Grounding Conductor
EIA	Electronic Industries Alliance
EM	Electromagnetic
EMT	Electrical Metallic Tubing
FLA	Full Load Amperage
GES	Ground Electrode System
GFCI	Ground-Fault Circuit Interrupter
HD	Heavy Duty
HID	High-Intensity Discharge
HVAC	Heating, Ventilating, and Air Conditioning
IEEE	Institute of Electrical and Electronics Engineers
IMC	Intermediate Metal Conduit
JAI	Joint Acceptance Inspection
K	Degrees Kelvin
kVA	Kilovolt-Ampere(s)
LED	Light Emitting Diode
LOTO	Lock-Out/Tag-Out
mA	milliampere(s)
MC	Metal Clad (cable)
MCF	Metroplex Control Facility
MG	Motors and Generators
NAS	National Airspace System
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association

NFPA	National Fire Protection Association
OSD	Operational Suitability Demonstration
OSHA	Occupational Safety and health Administration
PDU	Power Distribution Unit
PF	Power Factor
PPE	Personal Protective Equipment
PSG	Power Services Group (FAA AJW-22)
PVC	Polyvinyl Chloride
RFI	Radio Frequency Interference
RMC	Rigid Metal Conduit
rms	Root Mean Square
RPT	Relocatable Power Tap
SECM	Safety and Environmental Compliance Manager (FAA)
SSPC	Steel Structures Painting Council
ST	Dry-Type Transformer
STD	Standard
THD	Total Harmonic Distortion
THHN	Thermoplastic High Heat Resistant Nylon Coated Insulated Wire
THW	Thermoplastic Heat and Water Resistant Insulated Wire
THWN	Thermoplastic Heat and Water Resistant Nylon Coated Insulated Wire
TIA	Telecommunications Industry Association
TPT	Temporary Power Tap
TRACON	Terminal Radar Control
UL	Underwriters Laboratories
VFD	Variable Frequency Drive
WD	Wiring Device
XHHW	Cross-Linked High heat and Water Resistant insulated Wire

Appendix B Using Twist-on Wire Connectors

What Are Twist-on Wire Connectors?

Twist-on wire connectors are a type of electrical connector used to connect two or more wires together. They are often referred to by the trade-marked name Wire-Nut™. They come in different styles, under different trade-marked names. Twist-on connectors are available in different sizes and are listed for various combinations of wire quantities and sizes. This paper does not go into the details of proper sizing, other than to state that all twist-on connectors shall be properly rated and listed for their desired application.

Twist-on wire connectors are generally easy to apply, but they are not always installed correctly.

FAA-C-1217 permits the use of twist-on wire connectors for connection of certain conductors, as stated in section 5.2.5.3, Connectors and Splices

... Splices shall be made with solderless connectors conforming to UL 486A-486B, UL 486C, and UL 486E. Insulated wire nuts [sic] may only be used to splice conductors sized 10 AWG and smaller. ... All splices, including those made with insulated wire nuts [sic], shall be insulated with electrical tape or shrink tubing to a level equal to that of the factory insulated conductors.

At first glance, connecting two wires with a twist-on wire connector seems easy. Strip off the ends of the wires, put them together, push them into a connector, and twist. However, simply inserting the stripped ends into the connector and twisting a bit is not adequate.

Connector Installation

Twist-on connectors have a coiled hard-metal tapered interior that acts as a die for cutting into the bare conductor(s), the taper allowing the connector to “jam” on the conductor(s). The connector thus provides secure electrical connectivity and some mechanical connectivity.

As might be expected, this cutting into the bare copper requires some effort. Some types of twist-on connectors provide wings to allow greater force and torque as needed. Some manufacturers provide a “nut-driver” tool. Side-cutting or “lineman’s” pliers are also conveniently used.

Although the connector provides some mechanical connectivity, the assembly does not provide much in the way of strain relief. Strain relief can be improved by twisting the insulated part of the conductors, such that approximately one and one-half (1½) twists remain be outside the connector. While not stated in the present FAA-C-1217, it is desired that the twists be readily visible beyond the required taping. It is possible that 1½ twists recommended might not be enough for this purpose.

There are two generally accepted methods to providing these extra twists. One method involves pre-twisting the wires before insertion into the connector. The other method involves inserting the wires into the connector and continuing to twist as needed. Many manufacturers state that pre-twisting wires is acceptable, but not required. At least one manufacturer advises against pre-twisting wires.

This paper explains these two methods and their proper FAA use.

Method of Pre-Twisting:

The pre-twist method involves twisting the wires before applying of the connector so that the insulated portions of the wires are twisted to some extent, approximately one and one-half (1½) twists. Using

this method, the twisting force is applied directly to the wire, best accomplished with “lineman’s” or side-cutting pliers. Twisting the wires together in this fashion provides mechanical integrity, keeping the wires together even if the connector fails. The stress on the connector is limited to that needed for cutting into the bare wire(s).

1. Turn off all power before installing or removing the connectors.
2. Strip wires longer than the recommended strip length.
3. Align the insulation of the conductors.
4. Using pliers, grip the ends of the bare wires and twist.
5. Twist conductors together until approximately one and one-half ($1\frac{1}{2}$) twists are visible in the wire outside the connector.
6. Trim bare ends to the recommended length.
7. Insert wires into the connector, and screw it on.
8. Pull on the connector to ensure that it is secure.
9. Tape the wire and open end of the connector.

Method of Not Pre-Twisting:

The method of no pre-twist simply puts the bare conductor(s) into the connector, twisting the connector on, and continuing to twist the connection until approximately one and one-half ($1\frac{1}{2}$) twists are visible. A negative feature of this method is that the connector becomes the tool to apply the twisting. The connector may or may not adequately convey this torque. As with the pre-twist method, the use of pliers or specialized tools should be considered, or the use of connectors that allow such tightening by hand.

1. Turn off all power before installing or removing the connectors.
2. Strip wires to the recommended strip length.
3. Align the bare ends of the conductors.
4. Hold the stripped wires together with the insulation even.
5. Insert the wires into the connector and screw it on until approximately one and one-half ($1\frac{1}{2}$) twists are visible in wire outside connector.
6. Pull on the connector to ensure that it is secure.
7. Tape the wire and open end of the connector.

Step-by-Step Guidance for Pre-twist.

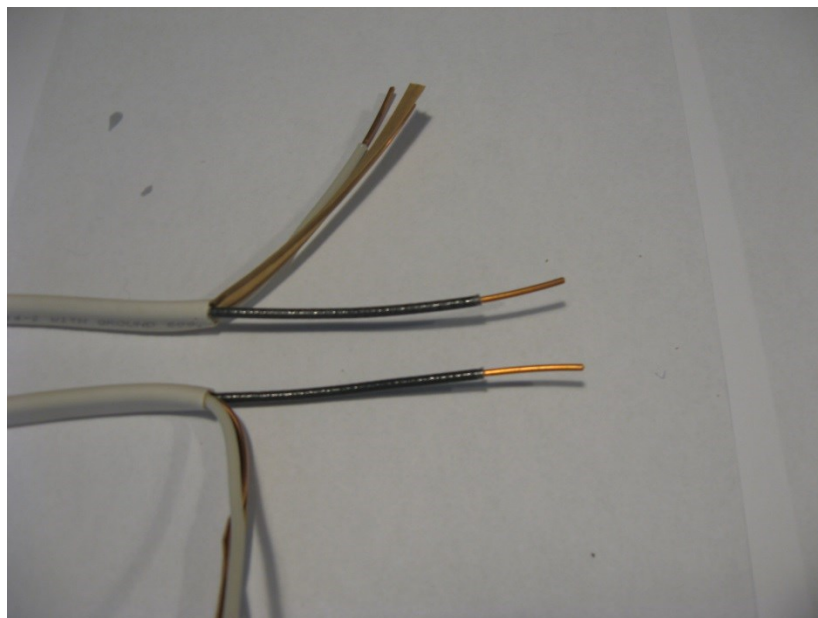


Figure 1. Wires to be connected.

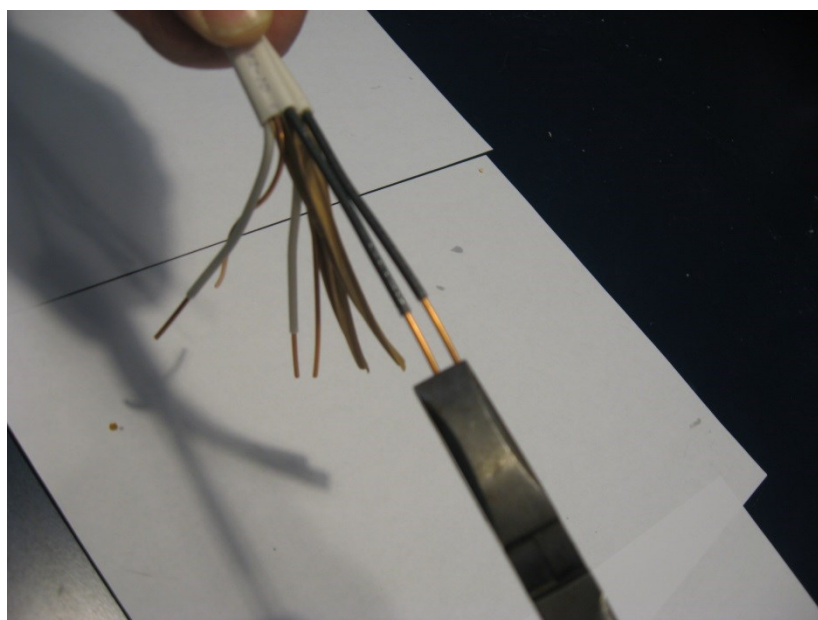


Figure 2. Using pliers, twist wires together 2-3 times. Twisting provides mechanical connectivity.



Figure 3. Trim ends of wires to (approximate) same length.

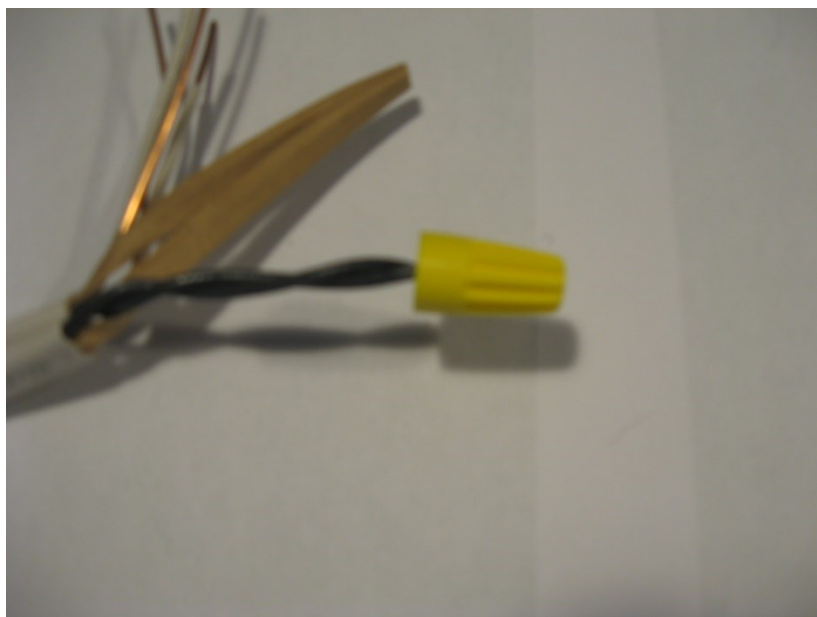


Figure 4. Apply wire nut per manufacturer's recommendations. Note the extra twists in the wire as a result of ensuring a tight and secure connection.

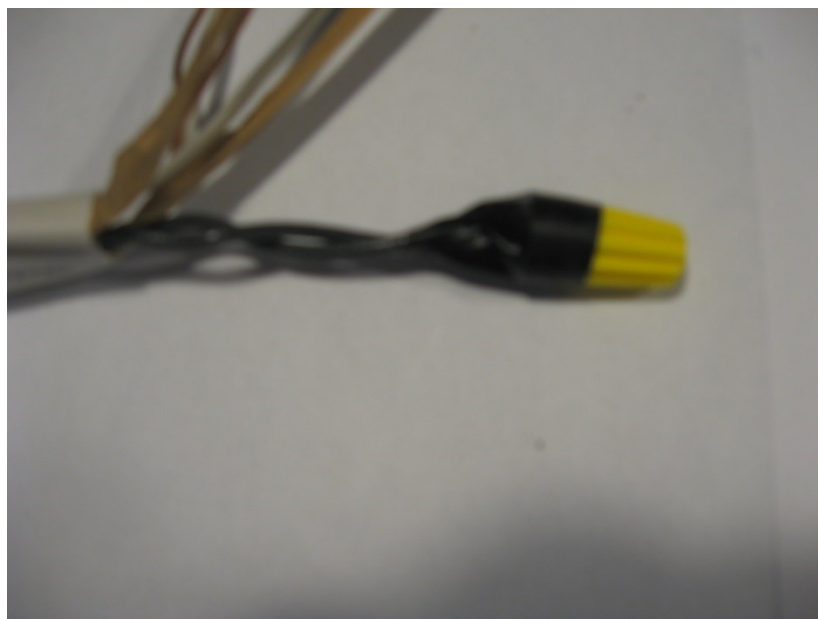


Figure 5. Apply electrical tape to cover the base of the wire nut and the insulated wires.

Step-by-Step Guidance for No Pre-twist.

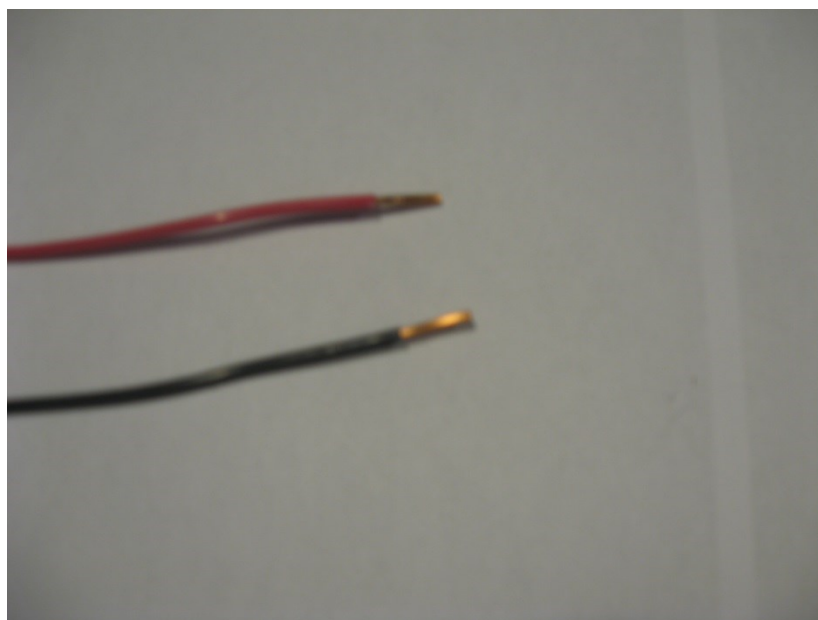


Figure 1. Wires to be connected.

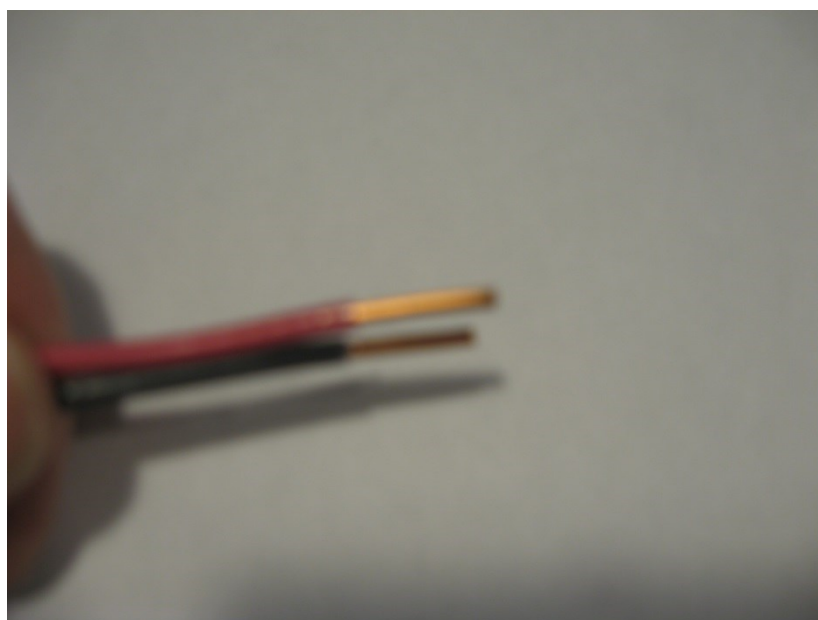


Figure 2. Align the bare ends of the conductors

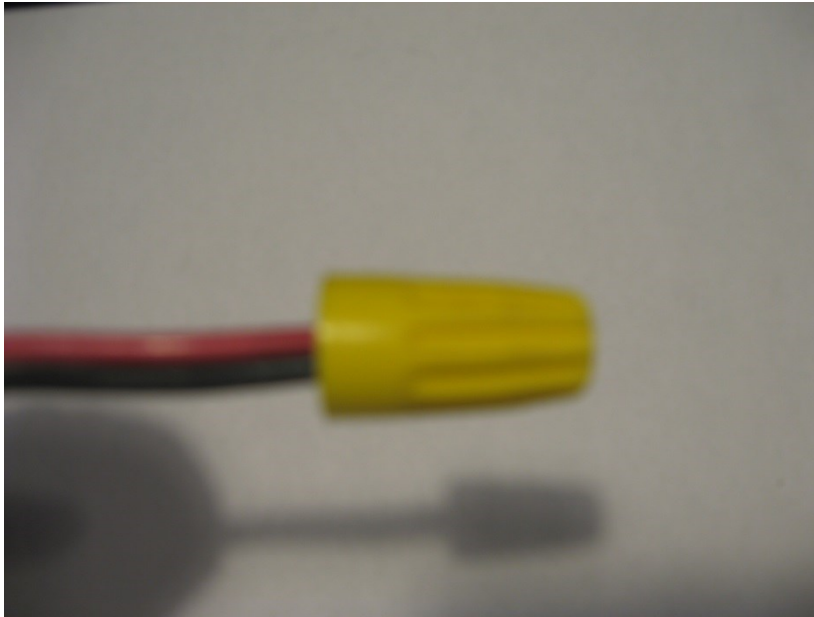


Figure 3. Apply wire nut per manufacturer's recommendations. Note the extra twists in the wire as a result of ensuring a tight and secure connection.

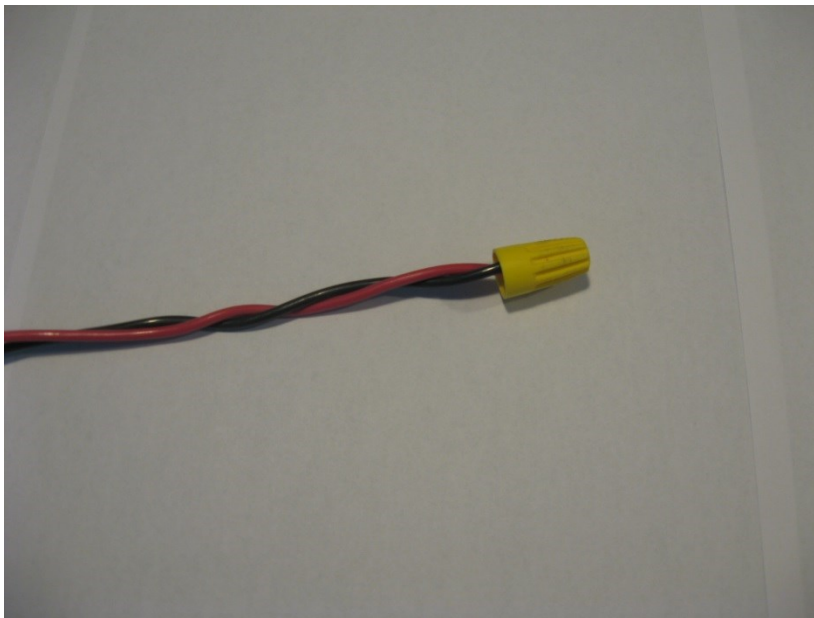


Figure 4. Extra twists in the wire as a result of ensuring a tight and secure connection.

ATTACHMENT NO. 3

FAA-STD-019f
October 18, 2017



DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
STANDARD

**LIGHTNING AND SURGE PROTECTION,
GROUNDING, BONDING, AND SHIELDING
REQUIREMENTS FOR
FACILITIES AND ELECTRONIC EQUIPMENT**

FAA-STD-019f

FOREWORD

1. Construction of Federal Aviation Administration (FAA) operational facilities and the electronic equipment installed therein shall conform to this standard. This standard defines minimum requirements for FAA facilities. When specific needs of a facility exceed these minimum requirements, the facility design and construction shall meet the specific needs. The equipment type, configuration, and location along with the configuration of site structures and environmental/weather conditions influence these needs.
2. The requirements herein reflect lessons learned from investigation and resolution of malfunctions and failures experienced at field locations. The FAA thus considers these requirements the minimum necessary to harden sites sufficiently for the FAA missions – to prevent delay or loss of service, to minimize or preclude outages, and to enhance personnel safety. Further, the requirements herein are coordinated with industry standards, and in some cases exceed industry standards where necessary to meet the FAA missions.
3. The use of “shall” or verbs such as “provide,” “construct,” “weld,” or “connect” indicates mandatory compliance. Deviations are permissible in cases when implementation of certain requirements is not technically feasible, and in such cases, the FAA shall submit a National Airspace System (NAS) Change Proposal (NCP) with justification and technical documentation, and receive approval by the NAS Configuration Control Board (CCB).
4. The format and content requirements of this standard are in accordance with FAA-STD-068, and the grammar and style are in accordance with the Government Printing Office (GPO) Style Manual.

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Note. Colors in figure illustrations distinguish the fundamental elements of the grounding system concept and do not represent color-coding or labeling requirements of this standard.

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1 SCOPE

This standard establishes design, procurement, installation, construction, and evaluation standards for lightning protection, transient surge protection, grounding, bonding, shielding configurations and procedures, and control of electrostatic discharge (ESD).

1.1 Applications

The requirements of this standard are mandatory for both new facilities and modifications and upgrades to existing facilities, new equipment installations, and new electronic equipment procurement used in the National Airspace System (NAS) facilities.

The use of the term “facilities” herein can differ from the manner in which it is frequently used in other Federal Aviation Administration (FAA) documents. In this standard, facilities may refer to an entire building, tower, interior or exterior system(s), or portions thereof which support the NAS and its operation. The physical proximity of the system(s) or equipment typically defines a single facility, while significant physical separation of the system or equipment defines separate facilities.

This standard covers government owned or leased property and “facilities.”

- a. Contractor-Owned Equipment Interface. The interface between contractor-owned equipment or electronic equipment not used for operational purposes, such as administrative local area network (LAN), administrative telephone, and the operational NAS facilities shall be in accordance with this standard.

1.2 Tailoring of Mandatory Requirements

The FAA recommends that the Office of Primary Responsibility (OPR) is contacted to obtain technical guidance on the applicability of requirements herein for modifications, upgrades, and new equipment installations in existing facilities.

- a. Application for Previously Funded Programs. This standard is not mandatory for programs funded prior to the issue date of this standard, nor is it mandatory for construction contracts associated with programs funded prior to the issue of the standard. Application of this standard is at the discretion of the user for programs funded prior to the issue of the standard.
- b. Mandatory Applications. The OPR can mandate the use of this standard for programs started before the issue date of this standard, if funding is provided.




1.3 Purpose

The requirements of this standard provide a systematic approach to minimize electrical hazards to personnel, and minimize electromagnetic interference (EMI) that can cause damage to facilities and electronic equipment from lightning, transients, ESD, and power faults.



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1.4 Content Organization

The standard is organized in accordance with FAA-STD-068.

FAA-STD-019F Content Arrangement		
FOREWORD		Normative Process Information
1 SCOPE		<p>This chapter contains:</p> <ul style="list-style-type: none"> a. Scope Statement b. Applicability Statement for mandatory compliance with requirements c. Procedure for Tailoring of Mandatory Requirements
2 APPLICABLE DOCUMENTS		This chapter includes technical documents used in this standard.
3 DEFINITIONS		This chapter contains definitions essential to the understanding and application of this standard. It is not intended to include commonly defined general or technical terms from building codes or industry standards.
4 GENERAL REQUIREMENTS		<p>This chapter addresses the general grounding system requirements commonly included in building codes and industry standards, and covers the general common requirements and standard practice for the overall design, installation, construction, and evaluation for FAA installations.</p> <p>The general requirements of industry codes and standards are often too general for many FAA applications. This chapter is organized to define and build upon the requirements of general industry standards and building codes as they relate to FAA applications.</p> <p>This chapter includes the following parts:</p> <ul style="list-style-type: none"> a. Bonding Requirements b. Lightning Protection System Requirements c. Earth Electrode System Requirements d. National Electrical Code Power Distribution System Grounding Compliance e. Surge Protective Device Requirements f. Grounding and Bonding Requirements for NAS Electronic Equipment Areas g. Shielding Requirements h. Electrostatic Discharge Requirements

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FAA-STD-019F Content Arrangement (continued)		
5 DETAILED REQUIREMENTS		<p>This chapter describes detailed performance requirements, which are specific to FAA facility applications, organized by facility special conditions and equipment as follows:</p> <ul style="list-style-type: none"> a. Airport Traffic Control Tower Facilities b. Lightning Protection System – Special Conditions c. Facility Transient Protection – Special Conditions d. Single Point Ground System (SPG) – Special Conditions e. NAS Electronic Equipment – Interface and Procurement Requirements f. Surge Protective Device (SPD) – Procurement Requirements g. Electrostatic Discharge Equipment – Interface and Specification Requirements h. Electromagnetic Compatibility Requirements
6 NOTES		<p>This chapter includes:</p> <ul style="list-style-type: none"> a. Acronyms and Abbreviations b. Guidelines and References Notes c. Version Cross-Reference d. Bibliography <p>Document conventions:</p> <p>Designations indicated with brackets, e.g., " [A1] " preceding a section or paragraph title denote that explanatory material is provided in section 6.2.</p> <p>Designations indicated with brackets, e.g., " [B1] " preceding a section or paragraph title indicates that bibliography reference material is provided in section 6.4.</p>

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2 APPLICABLE DOCUMENTS**2.1 General**

Documents listed in this chapter are government and non-government reference documents that form a part of this standard and are applicable to the extent specified herein. While every effort has been made to ensure the completeness of this list, document users are cautioned that they shall meet all specified requirements of documents cited in Chapters 3, 4, and 5 of this standard, and national safety standards, whether or not they are listed.

- a. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard takes precedence. Nothing in this standard shall supersede applicable laws and regulations unless a specific exemption has been obtained.
- b. Bibliography and reference source material is included in Chapter 6.

2.2 Government Documents

Due to periodic updating of government documents, the Contracting Officer and/or the Implementation Engineer shall specify the current version for project design or at contract award.

2.2.1 FAA Specifications

FAA-C-1217	Electrical Work, Interior
FAA-G-2100	Electronic Equipment, General Requirements
FAA-STD-012	Paint Systems for Equipment

2.2.2 FAA Orders and Handbooks

FAA-HDBK-010	Recommended Practices and Procedures for Lightning and Surge Protection, Grounding, Bonding, and Shielding Implementation
FAA-HDBK-011	Fundamental Considerations of Lightning Protection and Surge Protection, Grounding, Bonding, and Shielding

Copies of FAA specifications, standards, orders, and other applicable documents may be obtained from the Contracting Officer issuing the invitation-for-bid or request-for-proposal. Requests for this material should identify the material desired, for example, the specifications, standards, amendments, drawing numbers and dates. Requests should cite the use for the material, invitation-for-bid, request-for-proposal, the contract number, or other intended use.

2.2.3 Military Documents

MIL-HDBK-232	Revision A Red/Black Engineering-Installation Guidelines
MIL-HDBK-237	Electromagnetic Compatibility Management Guide for Platforms, Systems and Equipment
DOD/MIL-HDBK-263	Electrostatic Discharge Control Handbook
DOD-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices)
MIL-HDBK-419	Grounding, Bonding, and Shielding for Electronic Equipment and Facilities

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MIL-PRF-87893	Performance Specification, Workstation, Electrostatic Discharge Control
MIL-W-87893	Military Specification Workstation, Electrostatic Discharge (ESD) Control
MIL-STD-461	The Control of Electromagnetic Interference Emissions and Susceptibility
MIL-STD-889	Dissimilar Metals
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies, and Equipment (Excluding Electrically Initiated Explosive Devices)
NACSIM 5203	Guidelines for Facility Design and Red/Black Installation (Confidential Document)
<p>Single copies of Military specifications, standards, and handbooks are available by mail or telephone from Document Automation and Production Service Customer Service, Standardization Documents Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094. http://quicksearch.dla.mil/</p> <p>Not more than five items may be ordered on a single request and all requests must contain the document number. Only the latest revisions (complete with latest amendments) are available. Slash sheets must be individually requested. The Invitation for Bid or Contract Number should be cited where applicable.</p>	

2.3 Non-Government Documents

Due to periodic updating of non-government documents, the Contracting Officer and/or the Implementation Engineer must specify the current version for project design or at contract award unless a specific version is identified in this standard. These documents form a part of this standard and are applicable to the extent specified herein. While this standard may exceed the requirements of the following documents, building codes and industry standards always shall be followed as a minimum.

2.3.1 Electronic Industries Alliance (EIA)

JEDEC Standard JESD625	Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices
<p>Copies of EIA Standards are available from JEDEC Solid State Technology Association, Mailing Address: 3103 North 10th Street, Suite 240-S, Arlington, VA 22201-2107. https://www.jedec.org/</p>	

2.3.2 National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code (NEC)
NFPA 77	Recommended Practice on Static Electricity
NFPA 780	Standard for the Installation of Lightning Protection Systems
<p>Copies of NFPA documents are available from the National Fire Protection Association, One Batterymarch Park, Quincy, MA 02269. www.nfpa.org</p>	

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2.3.3 Underwriters Laboratories (UL)

UL 96	Lightning Protection Components
UL 96A	Installation Requirements for Lightning Protection Systems
UL 779 (ANSI-A148.1)	Electrically Conductive Floorings
UL 1449	Standard for Surge Protective Devices
Copies of UL documents are available from Global Engineering Documents, 1500 Inverness Way, East Englewood, CO 80112. Telephone 303-397-7945, 800-854-7179. www.ul.com	

2.3.4 Institute of Electrical and Electronic Engineers (IEEE)

ANSI/IEEE C62.41.2	Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
ANSI/IEEE C62.45	Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
ANSI/IEEE 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book)
Copies of IEEE documents are available from Institute of Electrical and Electronic Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-9916. www.ieee.org	

2.3.5 Electrostatic Discharge (ESD) Association Documents

ESD ADV1.0	Electrostatic Discharge Terminology - Glossary
ESD ADV53.1	ESD Protective Workstations
ESD S4.1	Worksurfaces Resistance Measurements
ANSI/ESD S8.1	Symbols - ESD Awareness
ANSI/ESD S20.20	Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment
ANSI/ESD STM 7.1	Floor Materials - Resistive Characterization of Materials
ANSI/ESD STM 11.11	Surface Resistance Measurement of Static Dissipative Planar Materials
ANSI/ESD STM 12.1	Seating - Resistive Measurement
ESD TR20.20	Handbook for the Development of an Electrostatic Discharge Control Program for the Protection of Electronic Parts, Assemblies and Equipment
ANSI/ESDA/JEDEC JS-001	ESDA/JEDEC Joint Standard for Electrostatic Discharge Sensitivity Testing - Human Body Model (HBM) - Component Level
Copies of ESD Association documents are available from the EOS/ESD Association, Inc. 7900 Turin Road, Building 3, Rome, NY 13440-2069. Telephone 315-339-6937. www.esda.org	

2.3.6 Telecommunication Industry Association (TIA) Documents

TIA-222	Structural Standard for Antenna Supporting Structures and Antennas
Copies of TIA documents are available from the Telecommunications Industry Association, 1320 North Courthouse Road, Suite 200, Arlington, VA 22201. Telephone 703-907-7700. www.tiaonline.org/standards/	

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3 DEFINITIONS

A	
Access Well	A covered opening in the earth using concrete or other cementitious material to provide access to an EES connection.
Armored Cable	Power, signal, control, or data cable having an overall armor or covering constructed of ferrous (steel) material that provides both structural protection and electromagnetic shielding for direct buried cables.
Arrester	Components, devices, and circuits used to attenuate, suppress, limit, or divert adverse electrical surge and transient energy. The terms arrester, suppressor, and protector are used interchangeably, except the term "arrester" is used herein for components, devices, and circuits installed on the primary side of FAA-owned distribution transformers.
B	
Bond	The electrical connection between two metallic surfaces used to provide a low-resistance path between them.
Bond, Direct	An electrical connection utilizing continuous metal-to-metal contact between the members being joined.
Bond, Indirect	An electrical connection employing an intermediate electrical conductor between the bonded members.
Bonding	The joining of metallic parts to form an electrically conductive path to ensure electrical continuity and the capacity to conduct current imposed between the metallic parts.
Bonding Jumper	A conductor installed to ensure electrical conductivity between metal parts required to be electrically connected.
Bonding Jumper, for NEC Compliance	See NEC definitions for power distribution wiring terms such as "Equipment", "Main", or "System" bonding jumper.
Branch Circuit	The circuit conductors between the final overcurrent protective device and the load.
Building "Structural" Steel	The main building structural steel members consisting of columns and beams or girders. Concrete-encased reinforcing steel rebars may be considered structural steel, depending on location.
Bulkhead Ground Plate	A metallic plate located where conduits, conductors, cables, waveguides, etc, enter the facility from the exterior. The bulkhead plate provides a central point for the grounding of these services to minimize external transients from entering the facility or structure.
Bushing	An insulated device that allows an electrical conductor to pass safely through a grounded conducting barrier such as the case of a panel, transformer, etc. The primary purpose is to prevent chafing of the conductors.
Bushing, Grounding or Bonding	An insulated device that allows for a grounding method at the end of the conduit. Also known as grounding-type bonding bushing or bonding bushing.
C	
Cabinet	An enclosure designed either for surface mounting or flush mounting that is provided with a frame, mat, or trim in which a swinging door or doors are, or can be, supported.
Cable	A fabricated assembly of one or more conductors in a single outer insulation. Types include axial, armored, and shielded.

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Cable, AC	A fabricated assembly of insulated conductors in a flexible metallic enclosure. Type armored-cable (AC) cable is not the same as DEB cable.
Cable, Axial	Cable where all conductors are oriented on a single axis, such as coaxial, biaxial, and tri-axial cables.
Cable, Direct Buried	Cable with construction suitable for use in direct buried, underground installations without any form of conduit. Type direct buried cable is not the same as DEB cable.
Cable, Direct Earth Burial (DEB)	Cable with a ferrous shield designed to provide both physical and electromagnetic protection to the conductors.
Cable, MC	Metal-Clad Cable, Type MC. A factory assembly of one or more insulated circuit conductors with or without optical fiber members enclosed in an armor of interlocking metal tape, or a smooth or corrugated metallic sheath. See NEC. <u>Note:</u> For the purpose of this standard, MC cable is only permitted when installed in accordance with FAA-C-1217.
Cable, Shielded	Cable with a metalized or braid shield to improve resistance to electromagnetic interference (EMI).
Case	A protective housing for a unit or piece of electrical or electronic equipment.
Chassis	The metal structure that supports the electrical or electronic components which make up the unit or system.
Conductor, Bare	An electrical conductor that has no covering or electrical insulation.
Conductor, Insulated	An electrical conductor encased within material of composition and thickness recognized by the NEC as electrical insulation.
Conductor, Lightning Bonding (Secondary)	An electrical conductor used to bond a metal object, within the zone of protection and subject to currents induced by lightning strikes, to the lightning protection system.
Conductor, Lightning Down	The down conductor serves as the path to the EES from the roof system of air terminals and roof conductors or from an overhead ground wire.
Conductor, Lightning Main	Conductors intended to carry lightning currents between air terminals and the EES. These can be conductors interconnecting air terminals on the roof, conductors connecting a metal object on or above the roof level that is subject to a direct lightning strike to the lightning protection system, or the down conductor.
Conductor, Lightning Roof	Roof conductors interconnecting all air terminals to form a two-way path to the EES from the base of each air terminal.
E	
Earth Electrode System (EES)	A network of electrically interconnected grounding systems such as ground rods, ground plates, ground mats, incidental electrodes including metallic piping and tanks, or ground grids installed below grade to establish a low resistance contact with earth.
Electromagnetic Interference (EMI)	Any emitted, radiated, conducted, or induced voltage that degrades, obstructs, or interrupts the required performance of electronic equipment.

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Electronic Multipoint Ground System (MPG)	An electrically continuous network consisting of interconnected ground plates, equipment racks, cabinets, conduit junction boxes, raceways, duct work, pipes, copper grid system, building framing steel, and other non-current-carrying metal elements. It includes conductors, jumpers, and straps that connect individual electronic equipment components to the signal reference structure (SRS).
Electronic Single Point Ground System (SPG)	A discreet signal reference network that provides a single point of reference in the facility for electronic equipment which require single point grounding. It consists of conductors, plates, and equipment terminals, all of which are isolated from any other grounding system except at the main ground plate.
Enclosed Cable Tray	A cable tray with steel/aluminum sides and bottom with a steel/aluminum cover or lid.
Equipment	A general term including materials such as fittings, devices, appliances, fixtures, apparatus, and machines, used in conjunction with an electrical installation.
Equipment Areas	Areas that house electronic equipment used to support NAS operations, such as electronic equipment rooms, telephone company (TELCO) rooms, Very High Frequency Omni Directional Range (VORs), and Radars.
Equipment Grounding Conductor (EGC)	The conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both. For FAA purposes, the EGC is to be green-insulated, solid or stranded, copper wire.
F	
Ferrous Conduit	Conduits composed of or containing iron, which are used to provide magnetic shielding, such as Rigid Galvanized Steel Conduit (RGS) or thick walled threaded conduit (NEC Rigid Metal Conduit-RMC). <u>Note:</u> For the purpose of this standard, Electrical Metallic Tubing (EMT), Intermediate Metal Conduit (IMC), and conduits made from silicon bronze and stainless steel are not adequate for magnetic shielding protection.
Fitting, High Compression	See "Pressure Connector Terminations."
G	
Ground	A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to a conducting body that serves in place of the earth.
Ground Dissipation Plate Design	Ground plate, refer to Figure 6.
Grounded	Connected to earth via a path of sufficiently low impedance and having sufficient current carrying capacity, such that fault current cannot build up voltage potentials that are hazardous to personnel.
Grounded Conductor	A system or circuit conductor that is intentionally grounded at the SDM or at the source of a separately derived system. This grounded conductor is the neutral conductor for the power system.
Grounding Conductor	A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

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Grounding Electrode	Copper rod, plate, or wire embedded in the ground for the specific purpose of dissipating electric energy to the earth. Also referred to as the Grounding Electrode System.
Grounding Electrode Conductor (GEC)	A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.
H	
High Frequency	All electrical signals at frequencies greater than 100 kHz, and pulse and digital signals with rise and fall times of less than 10 μ s.
High Transient Ground Plate	Entry or termination ground plate for connection of axial cable surge protection equipment and termination of cable shields, waveguides, conduits, and cable jackets. See Bulkhead Ground Plate.
Horizontal Transitions	Architectural term used to describe horizontal elements in a vertical structure, such as floor levels and stair landings.
Hydraulically Crimped Termination	Conductor termination using a hydraulic crimping tool that applies a 12-ton minimum compression force, using concentrically or circumferentially matching dies to form the connection.
I	
Inaccessible Location	A condition where gaining access to a system or part thereof requires significant effort, cost, or risk to personnel safety. Examples of such locations include below grade, behind walls and obstructions, or enclosed or concealed spaces that impede visual inspection.
L	
Landline	Any conductor, line, or cable installed externally above or below grade to interconnect electronic equipment in different facility structures or to interconnect externally mounted electronic equipment.
Low Frequency	Voltages and currents, whether signal, control, or power, up to and including 100 kHz. Pulse and digital signals with rise and fall times of 10 μ s or greater are considered to be low-frequency signals.
M	
Main Service Disconnect	A switch, fused switch, or circuit breaker that disconnects the main ac power service, generally utility power source, from a facility, located at the service disconnecting means (SDM).
O	
Office of Primary Responsibility (OPR)	The authority assigned to maintain and interpret this standard.
Operational Areas	Areas used to provide NAS support such as Instrument Flight Rules (IFR) rooms, Air Route Traffic Control Center (ARTCC) control rooms, ATCT tower cabs, operations control centers, and TRACON control rooms.
P	
Pressure Connector Terminations	Conductor termination using a mechanically bolted pressure connection.

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R	
Rack	A metal frame in which one or more electronic equipment units are mounted.
Rigid Metal Conduit (RMC), Rigid Galvanized Steel Conduit (RGS)	A threaded raceway of circular cross-section designed for the physical protection, routing, and shielding of conductors and cables.
S	
Service Disconnecting Means (SDM)	Refer to the NEC definition for Service Point location.
Shield	A housing, shield, or cover that substantially reduces the coupling of electric and magnetic fields into or out of circuits or prevents accidental contact of objects or persons with parts or components operating at hazardous voltage levels.
Signal	Any electromagnetic transmission of information or control function. A signal can be analog, digital data, or a control function such as a relay closure.
Signal Reference Structure (SRS) System	The conductive terminal, wire, bus, plane, or network that serves as the relative zero potential for all associated electronic signals. Signal Reference Structures are required at locations or areas containing NAS electronic equipment.
Structure	Any fixed or transportable building, shelter, tower, mast, or other load-bearing system that is intended to house electrical or electronic equipment or otherwise support or function as an integral element of the air traffic control system.
Surface Resistivity	Surface Resistivity can be described as follows: For electric current flowing across a surface, the ratio of DC voltage drop per unit length to the surface current per unit width. In effect, the surface resistivity is the resistance between two opposite sides of a square and is independent of the size of the square or its dimensional units. Surface resistivity is expressed in ohms/square. See ESD ADV1.0 Glossary of Terms.
Surge	A short-term disturbance characterized by a sharp, brief discontinuity of a waveform. May be of either polarity and may be additive to, or subtractive from, the normal waveform.
Surge Protective Device (SPD)	A device intended to limit surge voltages on equipment by diverting or limiting surge current and is capable of repeating these functions as specified. SPDs are also commonly referred to as Transient Voltage Surge Suppressors (TVSS) or secondary surge arresters.
Susceptibility Level	The transient level on signal, control, or data lines that causes damage, degradation, or upset to electronic circuitry connected to the line.
T	
Transient	See Surge.
Transient Suppressor	Components, devices, or circuits designed for the purpose of attenuating, absorbing, and suppressing conducted transient and surge energy to protect facility equipment.
Z	
Zone of Protection	The space adjacent to a lightning protection system that has a reduced probability of receiving a direct lightning strike.

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4 GENERAL REQUIREMENTS

4.1 Introduction

This chapter covers the common requirements and standard practice for the overall design, installation, construction, and evaluation of the following grounding systems in FAA facilities:

- a. Bonding Requirements
- b. Lightning Protection System Requirements
- c. Earth Electrode System (EES) Requirements
- d. National Electrical Code (NEC) Power Distribution System Grounding Compliance
- e. Surge Protective Device (SPD) Requirements
- f. Grounding and Bonding Requirements for NAS Electronic Equipment Areas
- g. Shielding Requirements
- h. Electrostatic Discharge (ESD) Requirements

4.2 Bonding Requirements

The method of bonding, for the purpose of achieving electrical continuity, shall be in accordance with 4.2.1 through 4.2.5.

4.2.1 General

This section covers the following topics:

- a. Dissimilar Metals Compatibility Requirements
- b. Methods of Bonding
- c. Bonding Connection Installation Requirements
- d. Hardware for Bonding Jumpers and Straps

4.2.1.1 [A1] Resistance of Bonds

Unless otherwise specified in this standard, bonds shall have a maximum direct current (dc) resistance of 1 m Ω when measured between the bonded components with a four-terminal milliohm meter.

4.2.2 Dissimilar Metals

Bonding connections and associated fastener hardware for grounding system conductors shall comply with Table 1.

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Table 1. Mechanical Bonds Between Dissimilar Metals

METAL	Copper, solid or plate	Brass and bronze	Stainless Steel	Tin-plate; tin-lead solder	Aluminum, wrought alloys of the 2000 Series	Iron, wrought, gray or malleable, plain carbon and low alloy steels	Aluminum, wrought alloys other than 2000 Series aluminum, cast alloys of the silicon type	Aluminum, cast alloys other than silicon type, plated and chromate	Galvanized steel	Zinc, wrought; zinc-base die-casting alloys; zinc plated
Copper, solid or plate	•••	•••	••	•	•	•	No	No	No	No
Brass and bronze	•••	•••	••	••	•	•	•	No	No	No
Stainless Steel	••	••	•••	•••	•••	••	•	•	No	No
Tin-plate; tin-lead solder	•	••	•••	•••	•••	••	••	•	No	No
Aluminum, wrought alloys of the 2000 Series	•	•	•••	•••	•••	•••	•••	••	•	•
Iron, wrought, gray or malleable, plain carbon and low alloy steels	•	•	••	••	•••	•••	•••	•••	•	•
Aluminum, wrought alloys other than 2000 Series aluminum, cast alloys of the silicon type	No	•	•	••	•••	•••	•••	•••	•	•
Aluminum, cast alloys other than silicon type, plated and chromate	No	No	•	•	••	•••	•••	•••	••	•
Galvanized steel	No	No	No	No	•	•	•	••	•••	•••
Zinc, wrought; zinc-based die-casting alloys; zinc plated	No	No	No	No	•	•	•	•	•••	•••
LEGEND: Four Basic Categories of Possible Metal Interfaces										
No	Not suitable. This interface is highly likely to result in significant corrosion.									
•	Suitable for indoor environments where temperature and humidity are controlled (non-condensing environment).									
••	Suitable for all indoor environment.									
•••	Suitable for all environments.									

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4.2.3 Methods of Bonding

Direct bonding techniques include:

- a. Exothermic Welds. Exothermic welds are permitted for any type of bond connection specified herein.
- b. Hydraulically Crimped Terminations. Crimped terminations are permitted as an alternative technique to facilitate installation of connections in permanently concealed or inaccessible locations.
- c. Welded Assemblies. Metal fabrication assembly process constructed by welding the joints between the individual components.
- d. Mechanical Connections. Electrical bond connections constructed with bolted assemblies.
- e. Brazing and Soldering. Metal-joining process formed by brazing or soldering a filler alloy metal is not permitted for bond connections.
- f. Silver Soldering - Only Applicable for NAS Electronic Equipment. To improve conductivity, silver soft soldering material may be applied for the bonding of enclosure shielding joints already secured with mechanical fasteners. Mechanical fasteners shall be attached prior to application of solder to prevent cold solder joints. Soft soldering techniques are not permitted as a method for providing mechanical restraint.

4.2.3.1 Exothermic Welds

Exothermic welded connections shall be provided for the following applications:

- a. Permanent Bonding. Permanent bonding of copper conductors to metal assemblies or building steel.
- b. Underground or Buried Locations.
- c. Exposed Exterior Locations. Any exposed location where an exothermic weld connection is possible.
- d. Permanently Concealed Locations. Locations where the connection will be permanently concealed after completion of fabrication or building construction process.
- e. Inaccessible Locations. Locations rendered inaccessible due to a building feature or other physical constraint that restricts routine access necessary to perform maintenance and visual inspection.

Exception. *Where exothermic welds are not possible due to dissimilar materials, incompatible shapes, voiding of a manufactured finish warranty, or in hazardous locations, such as near fuel tanks or other combustible material, provide UL listed hydraulically crimped or mechanical connections.*

4.2.3.1.1 Exothermic Welds – Installation within Existing Facilities

The following measures shall be taken in the installation of exothermic welds within existing facilities:

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- a. Where combustion from the use of a standard exothermic weld process would result in problems within the facility, a smokeless type exothermic weld process shall be provided.
- b. After completing the welding process, to prevent corrosion, remove or neutralize residual fluxes between components.

4.2.3.2 Hydraulically Crimped Terminations

A UL 467 and UL 96 listed irreversible compression type bonding connection is permitted for use within concealed and inaccessible locations.

- a. Bonding Conductors. Bonding conductors shall be wire size 6 AWG or larger.
- b. Hydraulic Compression Tool System. Hydraulic compression tool system shall be capable of producing a 12-ton minimum force applied with a tool using matching dies.

4.2.3.3 Welded Assemblies

Individual components of a welded assembly shall not require additional bonds between components if the dc resistance between individual components is less than 1 mΩ.

4.2.3.4 Mechanical Bolted Bond Connections

Mechanical bolted bond connections shall be prepared and completed in accordance with the installation conditions and requirements provided herein.

4.2.3.4.1 [A2] Coupling of Dissimilar Metals

Compression bonding with bolts and clamps shall comply with Table 1. When dissimilar base metals form couples that are not permitted per Table 1, the metals shall be coated, plated, or otherwise protected with a conductive finish.

4.2.3.4.2 Bolted Connections

Bonding bolts shall be used primarily as mechanical fasteners to hold electrical bonding components in place. Tighten bolts sufficiently to achieve adequate contact pressures for effective bonding, but do not overtighten them to the extent that deformation of bond members occurs. To prevent loosening of the connection, provide disc springs for connections using bolts 1/4-in. diameter and greater.

- a. Torque Requirements. Bolted connections 1/4-in. diameter and greater shall conform to the torque requirements in Table 2.
- b. Bolts, Nuts and Washers. Bolted connections in corrosive, damp, or wet locations, 1/4-in. diameter and greater, shall utilize stainless steel type 18-8 bolts, nuts, and load distribution washers. All other locations shall use corrosion-inhibited SAE Standard J429 Grade 5 nuts and bolts. Load distribution washers shall comply with ANSI B18.22.1 for stainless steel washers, Wide Series, Type B.
- c. Assembly. Bolted connections 1/4-in. diameter and greater shall be assembled in the order shown in Figure 1. Additional load distribution washers, if used, shall be positioned directly beneath the bolt head. Disc springs shall be between the nut and the

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load distribution washer. Washers shall not be placed between bonded members. Load distribution washers shall be Wide Series, Type B.

- d. Termination Lugs. Provide 2-hole termination lugs for connections to ground plates. Provide 2-hole termination lug connections to equipment metal members for conductors size 6 AWG and larger. If the equipment metal members do not allow modification for installation of 2-hole lug terminations, then 1-hole termination lug are permitted.

4.2.3.4.2.1 Sheet Metal Screws

Sheet metal screws shall not be used to provide an electrical bond.

4.2.3.4.2.2 Self-drilling and Self-tapping Screw Fasteners

Self-drilling and self-tapping metal screws are permitted to make a physical connection between metal back panels within equipment cabinet/enclosures when access to the opposite side of the bond is not available using other bonding methods.

4.2.3.4.3 Riveting

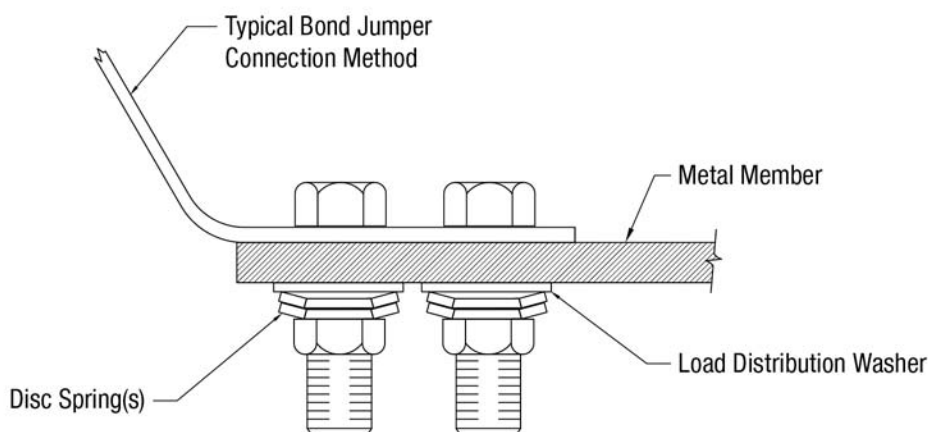
Rivets shall be employed solely as mechanical fasteners to hold multiple smooth, clean metal surfaces together or to provide a mechanical load-bearing capability to a soldered bond.

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Table 2. Connection Torque Requirements for Bolted Bonds

Bolt Specification for Stainless Steel 301 Type SS 18-8						
Bolt diam. (in.)	Threads per inch	Torque (ft-lbs) SS 18-8	Bolt Clamp Load (lbs.)	Flat Load (lbs.)	Washers Required (see note 2)	Solon Part Number (see note 1)
1/4	20	6	1,510	600	3	4-L-42-301
5/16	18	11	2,120	1,000	3	5-L-52-301
3/8	16	19	3,150	2,100	2	6-M-80-301
7/16	14	31	4,300	N/A	N/A	N/A
1/2	13	43	5,170	3,300	2	8-L-90-301
9/16	12	56	6,070	2,800	3	9-L-89-301
5/8	11	92	8,880	5,500	2	10-20-125-301
3/4	10	127	10,200	13,800	1	12-EH-168-177
7/8	9	194	13,310	14,400	1	14-H-168-177
1	8	286	17,200	14,200	2	16-H-187-177
Bolt Specification for SAE J429 Type Grade 5						
Bolt diam. (in.)	Threads per inch	Torque (ft-lbs) Grade 5	Bolt Clamp Load (lbs.)	Flat Load (lbs.)	Washers Required (see note 2)	Rolex-Fastenal Part Number (see note 1)
1/4	20	10	2,500	1,390	2	0124030
5/16	18	21	4,000	5,345	1	0124033
3/8	16	34	5,500	8,000	1	0124035
7/16	14	55	7,500	N/A	N/A	N/A
1/2	13	83	10,000	9,900	2	0124037
9/16	12	117	12,500	12,000	2	0124039
5/8	11	167	16,000	13,000	2	0124041
3/4	10	288	23,000	31,000	1	0124043
7/8	9	452	31,000	40,276	1	0124044
1	8	567	40,000	46,000	1	0124046
Notes: 1. Other manufacturers of disc spring washers of equal or better performance are permissible. Use bolt assembly manufacturer's recommended torque values. 2. The sum of the individual disc washer flat load ratings shall exceed the listed bolt clamp load. The number of washers required is calculated by the following formula: $B_{\text{Bolt Clamp Load}} < W_{\text{Number of Washers}} \times F_{\text{Washer Flat Load}}$ For example, a 1/4-in. stainless steel bolted connection requires minimum 1,510 lbs clamp load, therefore, 3 disc washers will be needed.						

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Notes:

1. Remove all paint on the entire bonding area of the metal member.
2. Stack disc spring washers to obtain required amount per Table 2.
3. Provide 2-hole termination lugs for connections to ground plates.

Figure 1. Order of Assembly for Bolted Connections**4.2.4 Bonding Connections – Installation Requirements**

Bonding connections shall be prepared and completed in accordance with the installation conditions and requirements provided herein.

4.2.4.1 Surface Preparation

Bonding surfaces shall be cleaned thoroughly and free of dirt, dust, grease, oxides, nonconductive films, and foreign material. Paint and other coatings at the location shall be removed to expose the base metal.

- a. Surface Area To Be Cleaned. Clean mating surfaces at least 1/4-in. beyond each side of the smaller bonded area.
- b. Clad Metals. Clean clad metal to a bright, shiny, smooth surface without penetrating the cladding. Wipe the cleaned area with solvent and allow the surface to air dry before completing the bond.
- c. Aluminum Alloys. To create a bright finish after cleaning, apply a conductive coating with paint or resin finish to aluminum mating surfaces.

4.2.4.2 Completion of Bonding Connection

Clean surfaces with a solvent suitable for electrical work immediately prior to assembly. Mating surfaces shall be joined within 2 hours after cleaning if an intentional protective coating has been removed from the metal surface. If delays beyond 2 hours are necessary in corrosive environments, then the cleaned surfaces shall be protected with an appropriate coating that shall be removed prior to completion of the bond connection.

- a. Refinishing of Bond. Areas around the bond connection shall be restored to match the original finish, unless not feasible.

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- b. Surface Plating or Treatments. Surface plating or treatments may be applied to the connection to improve abrasion resistance and corrosion protection, provided the treatment material enhances bond conductivity. Silver and other easily tarnished metals shall not be used to plate bonded surfaces, except where use of other metals may result in an unacceptable increase in surface contact resistance. In such cases, protect plating material by sealing exposed surfaces of the completed connection from the atmosphere.

4.2.4.3 Sealing and Finish Treatments for Bonding Connections

All bonds shall be protected against weather, corrosive atmospheres, vibration, and mechanical damage. Under dry conditions, apply a compatible corrosion preventive or sealant within 24 hours of assembly of the bond materials. Under conditions exceeding 60 percent humidity, seal the bond with a compatible corrosion preventive or sealant within 1 hour of joining.

Exterior bonds shall be protected against corrosion. Interior bonds exposed to moisture or high humidity shall be protected against corrosion.

- a. Sealing Treatment for Corrosion Protection. Corrosion protection shall be provided by sealing the bond connection with a moistureproof paint conforming to FAA-STD-012 or with a silicone or petroleum based sealant to prevent moisture from reaching the bonding area. Bonds protected by conductive finishes such as alodine and iridite shall not require painting to meet the requirements of this standard.
- b. Compression Bonds in Climatically Protected Areas. Sealing is not required for compression bonds between copper conductors or compatible aluminum alloys that are located in readily accessible areas that are not exposed to moisture, corrosive fumes, or excessive dust.
- c. Painted Finishes. If a paint finish treatment is required on the final assembly, then the bond shall be sealed in accordance with the manufacturer's recommendation. To ensure the bond is completely sealed against moisture, a waterproof type of paint or primer shall be used if the recommended finish treatment is not waterproof.

4.2.5 Bonding Connections – Hardware for Bonding Jumpers and Straps

Bonding jumpers and straps shall be installed in accordance with the requirements provided herein.

4.2.5.1 Installation of Bonding Jumpers

Bonding jumpers shall be insulated conductors, except as noted herein.

Bare conductors shall be used for the following applications:

- a. Raised access floor installations.
- b. Jumpers for structural steel or rebar connected to the EES, lightning protection systems, and plenums or environmental air spaces.
- c. Jumpers too short to be insulated or where required by NEC.

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4.2.5.2 Installation of Bonding Straps

Bonding straps for bonding of electronic equipment shall be as short as possible. Herein, bonding straps are expected to be bare.

Bonding straps shall conform to the following:

- a. Bonding straps shall be attached to the integral structural frame portion of the cabinet/enclosure rather than through adjacent parts to achieve optimal electrical connection.
- b. Bonding straps shall be installed so that the electrical bond is not affected by motion or vibration.
- c. Bonding straps shall be installed wherever possible in areas accessible for maintenance and inspection.
- d. Bonding straps shall be installed to allow movement of the components being bonded or other adjacent components intended to move as part of normal functional operation.
- e. Two or more bonding straps shall not be connected in series to provide a single bonding path.
- f. The method of installation and point of attachment of bonding straps shall not weaken the components to which they are attached.
- g. Bonding straps shall not be compression fastened through nonmetallic material.
- h. Bonding installed across shock mounts or other suspension/support devices shall not restrict the performance of the mounting device. Bonding connections shall be capable of withstanding anticipated motion and vibration of supports without suffering metal fatigue, loosening of ground connections, or other degradation.

4.2.5.3 Fastener Hardware

Fastener materials for attachment of bonding straps and jumpers to structures shall conform to materials listed in Table 1.

4.2.5.4 Temporary Bonding Connections

Alligator clips or spring-loaded clamping products are permitted only for the purpose of establishing a temporary bond connection while performing repair work on equipment or facility wiring.

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4.3 Lightning Protection System Requirements

4.3.1 General

The purpose of the lightning protection system is to provide preferred paths for lightning discharges to enter or leave the earth without causing damage to facility or equipment or injury to personnel. The essential components of a lightning protection system are air terminals and roof and down conductors connecting to the EES, the EES, and SPDs. These components act together as a system to dissipate lightning energy. The lightning protection system shall meet or exceed the requirements of FAA standards and orders as specified herein and the following:

- a. Standard for the Installation of Lightning Protection Systems (NFPA 780)
- b. Installation Requirements for Lightning Protection Systems (UL 96A)

The risk assessment guide in NFPA 780 indicates that many NAS facilities have a high risk index. Accordingly, lightning protection requirements that exceed the minimum requirements of NFPA 780 are specified herein. Inclusion of a UL Master label is not sufficient to indicate compliance with this standard.

- a. ATCT Special Requirements. See section 5.2 for Airport Traffic Control Tower (ATCT) special requirements.
- b. Other Special Conditions. See section 5.3 for other lightning protection system special conditions.

4.3.2 Lightning Protection System – Components

Products shall be UL listed and labeled with the UL certification mark in accordance with UL requirements. All equipment shall be new and of adequate design and construction to suit the application in accordance with UL 96A requirements. Provide copper or tinned copper cable materials. Aluminum cables shall only be used on aluminum and galvanized surfaces. Bimetallic connectors shall be used for interconnecting copper and aluminum conductors. Dissimilar materials shall conform to the bonding requirements of paragraph 4.2.2.

4.3.3 Lightning Protection System – Material Class Requirements

The FAA has opted to exceed minimum NFPA 780 cable sizing requirements. Provide Class II or larger rated materials, as specified in NFPA 780, for the following:

- a. Air Terminals
- b. Main and Down Conductors
- c. Bonding Conductors

4.3.4 Lightning Protection for NAS Facilities Buildings and Structures

Lightning protection shall be provided for buildings and structures, or parts thereof that are not within the zone of protection provided by another building, higher part of a building, an antenna, or a tower. The zone of protection scheme for all structures shall be as defined in NFPA 780.

4.3.4.1 Number of External Down Conductors for Buildings

The number of down conductors shall be based on both the building height and perimeter.

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- a. Buildings and Structures Less Than 60 ft High Above Grade. These buildings and structures measured to the highest point of the building or structure shall have at least two down conductors.
- b. Buildings and Structures More Than 60 ft High. See section 5.2.2.
- c. Buildings and Structures with Perimeters in Excess of 250 ft. These buildings and structures shall have one additional down conductor for each 100 ft of perimeter distance or part thereof. Down conductors shall be as widely separated as possible, e.g., at diagonally opposite corners on square or rectangular buildings.

4.3.4.2 Metal Parts of Buildings

Building steel, metal roofing, metal supporting structures, concrete reinforcing steel, siding, eave troughs, down spouts, ladders, duct, and similar metal parts shall not be used as substitutes for roof or down conductors. A lightning protection system shall be applied to the metal roof and metal siding of a metal clad building in the same manner as on a building without metal covering. Building metal parts shall be bonded in accordance with paragraph 4.3.8.

Exception. See paragraph 5.2.2.3b for ATCT lightning protection system design requirements.

4.3.4.3 Roof-Mounted Antenna Masts

Unless it is a radiating or receiving part of the antenna, the metallic mast of a roof-mounted antenna shall be bonded to the nearest main roof conductor or down conductor.

- a. If a main roof conductor or down conductor is not available where an antenna is installed on top of an ATCT, then bond the antenna mast to building steel in lieu of the EES. Reinforcing bars shall not be used in lieu of building steel.
- b. If an antenna is installed on top of a building or base building, and the path is longer than a tenth of the difference between building steel and the EES (i.e. building steel is 5 feet away and the EES is more than 50 feet away), then bond the antenna mast to building steel. Reinforcing bars shall not be used in lieu of building steel.

4.3.5 Lightning Protection System - Conductor Routing

Down conductors shall follow the most direct downward path to earth. Main and bonding conductors shall maintain a downward or horizontal course, and are permitted to rise at no greater than a 1 to 4 slope.

- a. Conductor Bends. Down conductors shall be installed without any sharp bends or kinks. No bend in a main and bonding conductor shall form an included angle of less than 90 degrees, nor shall it have a bend sweep radius of less than 8 in.
- b. Conductor Connections. T-style and cross-over cable-to-cable connections between main conductors shall be in accordance with Figure 2.
- c. Conductor Routing. Conductors shall be routed outside of structures and not penetrate structural cladding except as indicated in 5.2.2.3b. Conductors shall be routed 6 ft or more from power or signal conductors. If this clearance cannot be met, the power and signal conductors shall be routed in ferrous RGS conduit or enclosed ferrous cable tray.

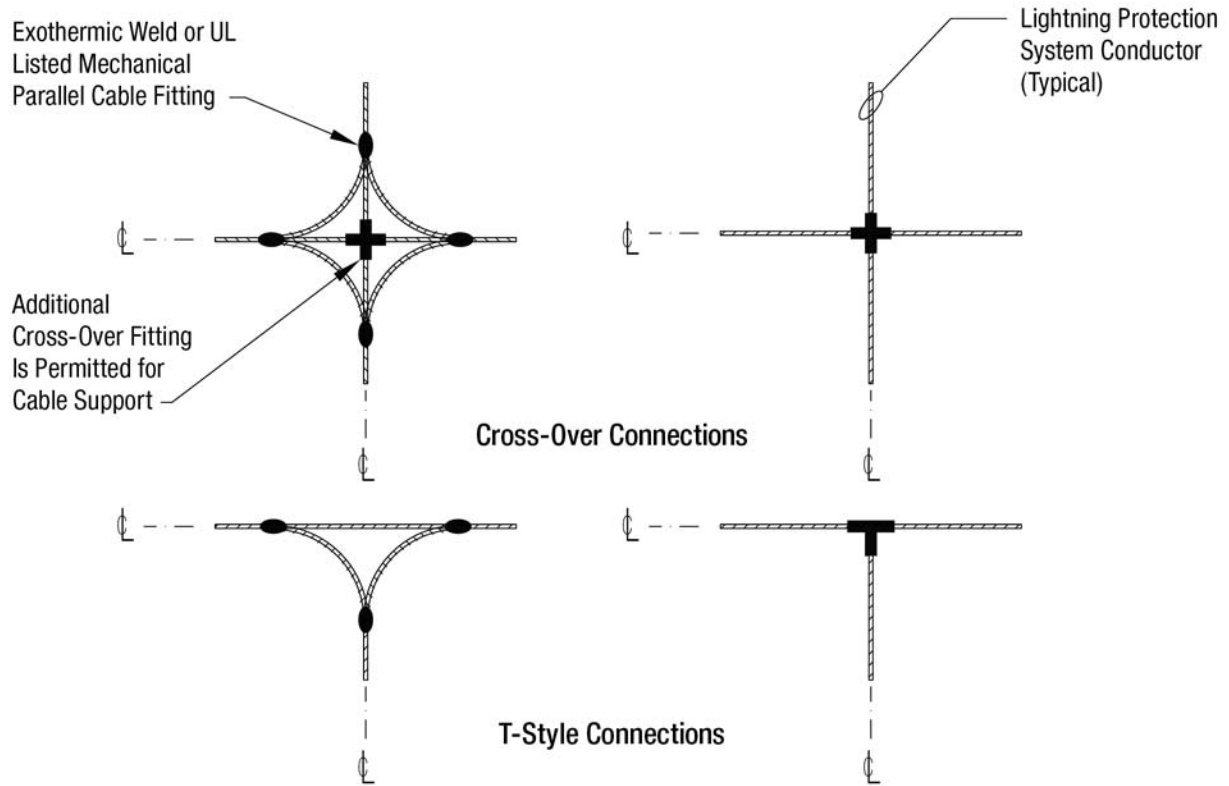
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- d. Main Conductors. Main conductors shall be permitted to pass through elements of the building structure, e.g., parapets, eaves, walkways, walls, where necessary to maintain horizontal or downward course. Provide a 2-in., Schedule 80 rigid PVC conduit sleeve, or UL listed through-connector fitting at penetrations. When the conductor penetrates a metallic structure of any thickness, the conductor shall be bonded to the metallic structure. Conductors are permitted to pass through metal gratings or plates without a conduit sleeve; however, the conductor shall be bonded to the metallic structure.

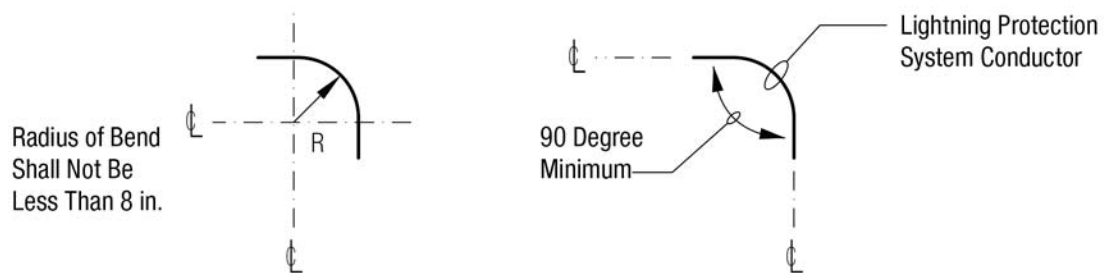
4.3.5.1 Main and Down Conductor Terminations to EES

Conductor terminations to the EES shall be exothermically welded to a 4/0 AWG copper conductor prior to entering the ground at not less than 18 in. above grade. The 4/0 AWG copper conductor shall be bonded directly to a ground rod or electrode conductor in the EES. Exothermic weld connections to the EES shall be in accordance with Figure 3.

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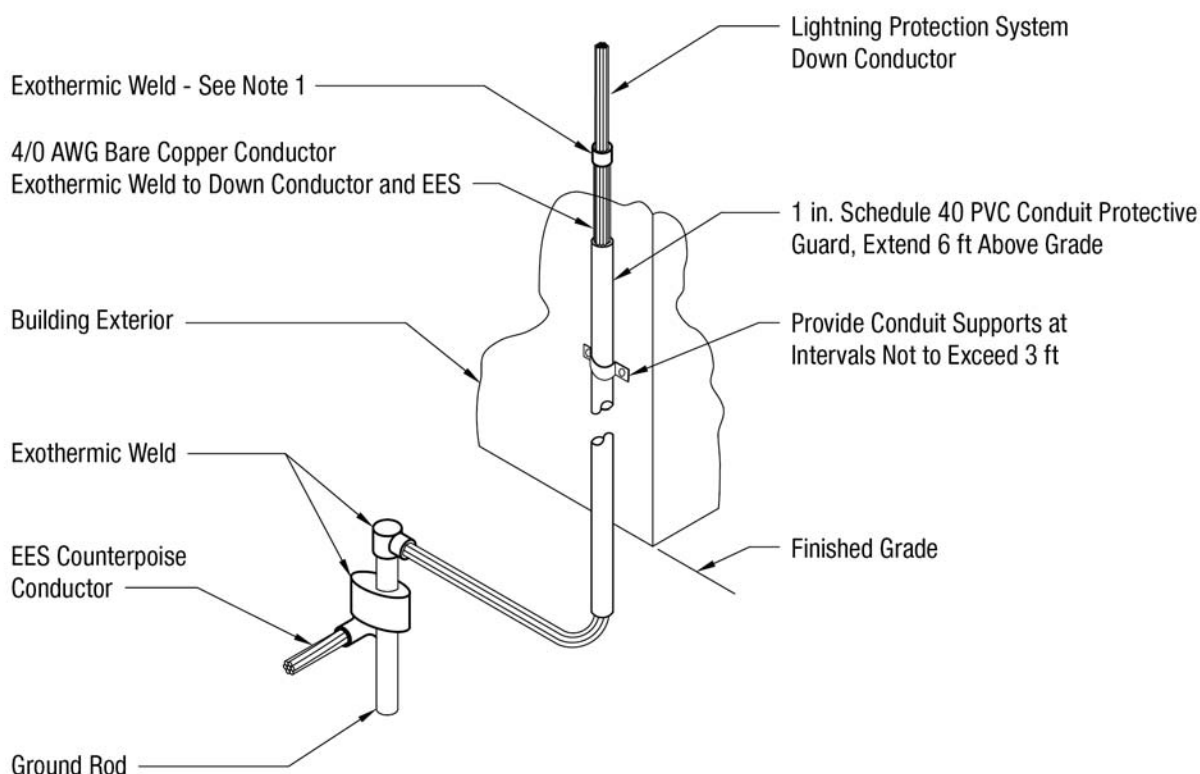
CABLE-TO-CABLE HORIZONTAL AND VERTICAL CONDUCTOR CONNECTIONS



CONDUCTOR BENDING REQUIREMENTS

Figure 2. Lightning Protection System Main Conductor Connections – Illustrative Example

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Note:

1. Locate exothermic weld above the conduit guard to ensure connection is available for visual inspection. When installation of the connection is not possible at top of conduit guard, locate the exothermic weld at least 18 in. above finished grade and provide guard system with pull box and removable cover that will permit visual inspection of the weld connection.

Figure 3. Main and Down Conductor Termination to EES – Illustrative Example

4.3.6 Lightning Protection System - Air Terminals

Air terminals shall be solid copper, bronze, or aluminum. Air terminals shall be stainless steel in areas of high potential for corrosion. Copper air terminals shall be allowed to have nickel plating. Air terminals shall be 12-in. high minimum, with a diameter of at least 1/2-in. for copper and 5/8-in. for aluminum, and have sharp, blunt or approved protective style tip. Air terminals shall be located and installed in accordance with NFPA 780 and UL 96A, and as required herein. Closer spacing is permitted for unique geometries. Air terminals shall extend at least 10-in. above the object or area it is to protect.

Air terminals located near working or walking surfaces may present an impalement hazard to personnel. The impalement protection design may be accomplished through use of air terminal selection, air terminal mounting type, mounting height, or a combination thereof. If mounting height is selected to mitigate the impalement hazard, the top of the air terminal shall not be less than 5-ft above the adjacent walking surface. If it is not feasible to install the air terminal on the

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object, locate air terminals next to the object to achieve this requirement, and bond the metallic object to the lightning protection system.

4.3.6.1 Mast Poles Used For Air Terminal Installation

Air terminals installed on mast poles shall be at least 2 ft tall and extend a minimum of 10 in. above the top of the mast pole. Provide a down conductor installed on the exterior of the mast pole. Air terminal and down conductor shall be fastened to the pole in accordance with NFPA 780. Connect air terminal to the nearest main roof conductor or down conductor. If a roof or down conductor is not available, bond directly to the EES.

4.3.7 Lightning Protection System - Hardware

Lightning protection system hardware and installation shall be prepared and completed in accordance with the installation conditions and requirements provided herein.

4.3.7.1 Fastener Hardware

Provide conductor fasteners at intervals in accordance with NFPA 780. Provide fastener material using the same base material as the system conductor, or a material equally resistant to corrosion as the system conductor.

- a. Plastic, Galvanized, or Plated Materials. Not permitted.
- b. Fasteners. Where fasteners are part of a bonding connection component, the bonding surface shall be prepared and protected in accordance with paragraph 4.2.4. Cable holders that do not have mechanical support such as products with fold-over or break-away tabs shall not be used.

4.3.7.2 Terminations and Fittings

The preferred method for conductor connections and terminations is by exothermic welding. Where mechanical bolted pressure termination fittings are used the bonding devices, conductor splices, conductor terminations, and connectors shall be compatible with the installed conductor. Provide stainless steel, copper, bronze, or aluminum termination materials in accordance with the following:

- a. Materials. Fitting material shall be suitable for use with the system conductor.
- b. Straight and 90 Degree Through-Connectors. UL listed straight and 90 degree through-connectors are permitted to facilitate horizontal and vertical routing of system conductors.

4.3.7.3 Conductor Protective Guards

Provide protective guards for system down conductors located in or next to driveways, walkways, or other areas where they are subject to damage or displacement.

- a. Nonmetallic Guards. Provide nonmetallic conductor guards, schedule 40 polyvinyl chloride (PVC) conduit or equivalent.
- b. Guard Installation. Install guard from 1 ft below grade level extending to 6 ft above grade. When the roof or roof soffit construction is within 2 ft of the guard, the protective guard may be lowered to facilitate termination of the down conductor.

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Exception. *Metal guards are permitted in lieu of nonmetallic material; however, metal guards shall be bonded to the down conductors at both ends of the guard. Provide bonding conductor size equal to the down conductor size.*

4.3.8 Lightning Protection System – Bonding Connections

Bonding connections shall be prepared and completed in accordance with the installation conditions and requirements provided herein. Provide exothermic welds for conductor connections to the EES.

4.3.8.1 Metallic Bodies Subject to Direct Lightning Strikes

Metallic bodies and assemblies that protrude beyond the zone of protection provided by the installed air terminals are subject to direct lightning strikes. This includes but is not limited to roof drains, gutters, vents, canopies, electrical raceway and fixtures, pipes, exhaust fans, metal cooling towers, HVAC units, ladders, railings, antennas, structures with metal louvers, etc.

Provide lightning protection for metallic bodies and assemblies for the following conditions:

- a. Electrically Continuous Assemblies.
 1. Where metal thickness is 3/16 in. or greater, bond the assembly to the nearest lightning protection system main conductor. Provide fitting with bonding surface of at least 3 in.²
 2. Where metal thickness is less than 3/16 in., install air terminals, main conductors, and fittings to provide at least two paths to ground from each air terminal device.
- b. Not Electrically Continuous Assemblies. If the assembly consists of segmented parts and is not electrically continuous, then provide an additional main conductor interconnected to the nearest lightning protection system. Bond the individual metal parts. Provide at least two paths to ground.

4.3.8.2 Metallic Bodies Subject to Induced Charges

Metallic bodies that are subject to induced charges from lightning, including those in a zone of protection, shall be bonded to the lightning protection system in accordance with NFPA 780. This includes, but is not limited to, roof drains, vents, coping, flashing, gutters, downspouts, doors, door and window frames, balcony railing, conduits, and pipes, etc.

4.3.8.3 Metallic Bodies – Special Conditions

Metallic bodies located at grade or outside the lightning protection system's zone of protection may be bonded by direct connections to the EES.

4.3.8.3.1 Exhaust Stack Grounding

Fossil fuel exhaust stacks shall be bonded to the nearest lightning protection system main conductor or directly to the EES, using a bonding conductor of greater than or equal size as the main conductor. Provide exothermic weld or mechanical connection at exhaust stack, and exothermic weld at EES.

When the exhaust stack is located farther than 6 ft from a main conductor and, the exhaust stack shall be bonded directly to the EES.

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4.3.8.3.2 Fuel and Oil Storage Tanks

Provide exothermic welds to bond tank vent piping and assemblies to the EES. Mechanical bonds may be used where required for dissimilar metals or component compatibility at the tank assembly. Bond tank vent piping and assemblies in accordance with following:

- a. Above-Ground Nonpressurized Fuel and Oil Tank Vent Piping. Bond above-ground tank vent piping directly to the EES using a bonding conductor of greater than or equal size as the lightning protection system main conductor.
- b. Above-Ground Tank Assemblies. Provide at least two easily accessible and widely separated grounding points for the tank assembly. Bond each grounding point directly to the EES using a 2/0 AWG conductor. Bond other metallic components, e.g., stairs, ladders, or skids, with a 2/0 AWG copper conductor.
- c. Above Ground Pressurized Fuel Tanks. For pressurized fuel tanks, e.g., propane and compressed natural gas, provide at least one bond connection from tank mounting supports connected directly to the EES using a 2/0 AWG copper conductor.
- d. Indoor Fuel and Oil Tank Vent Piping. Bond indoor mounted engine-generator day tank or other metallic fuel storage system vent piping mounted on the building exterior in accordance with NFPA 780.
- e. Secondary Containment Systems. Secondary containment for fuel piping shall be bonded directly to the EES.

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4.4 Earth Electrode System (EES)

4.4.1 General

An EES shall be installed at each facility to provide a common point of reference for all grounded systems at the facility. The EES establishes a low resistance to earth for lightning discharges, electrical and electronic equipment grounding, and surge/transient protection. The EES shall be capable of dissipating within the earth the energy of direct lightning strikes with no ensuing degradation to the system itself. The EES shall dissipate dc, ac, and radio frequency currents from equipment and facility grounding conductors.

4.4.2 [A3] Site Survey and Geotechnical Investigation

A subsurface geotechnical investigation shall be required to establish the design approach and parameters for new building construction to determine soil composition and resistivity characteristics. Information to be collected shall include location of rock formations, gravel deposits, soil types and classifications, and moisture content. The survey data shall be noted on a scaled drawing or sketch of the site, and documented in the Facility Reference Data File (FRDF). Soil resistivity testing shall be in accordance with FAA-HDBK-010.

4.4.3 EES – Design

The EES normally consists of driven ground rods, buried interconnecting conductors, and connections to underground metallic pipes, excluding gas lines and fuel tanks. The site survey and geotechnical investigation shall be used as the basis for the design of new buildings. The design objective for the EES resistance to earth shall be as low as possible, but shall not be greater than 10 Ω . Where “poor soil” conditions are encountered such as surface rock, shallow soils, permafrost, soils with low moisture, or high mineral content, then grounding enhancement methods listed in paragraph 4.4.5 shall be considered.

4.4.4 EES - Configuration

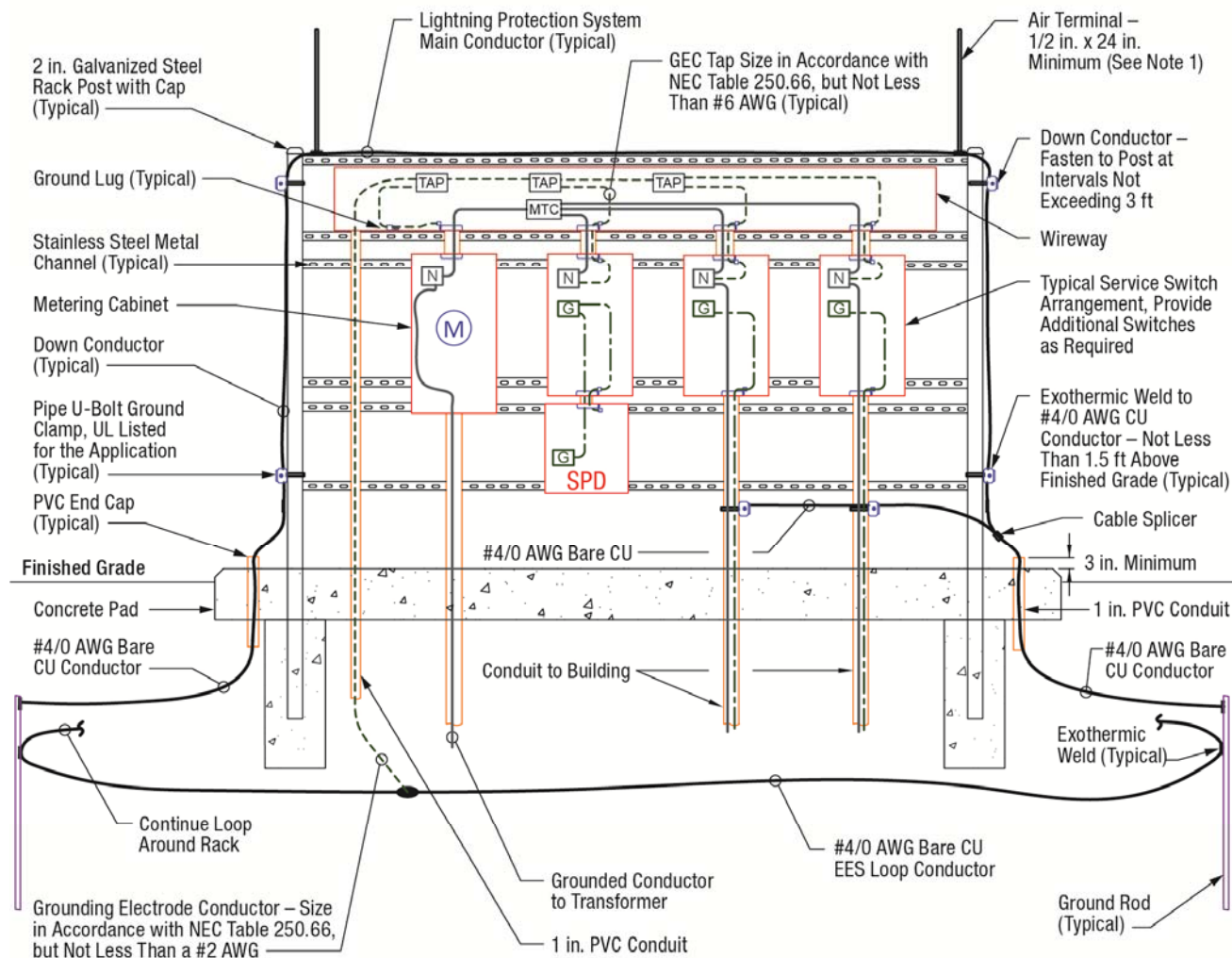
The EES shall consist of a continuous buried counterpoise conductor loop that extends around the entire perimeter of the facility or building structures. Provide ground rods interconnected along the counterpoise loop, spaced at least one ground rod length apart. Refer to FAA-HDBK-010 for design considerations.

For sites comprising multiple building structures, such as a building and antenna tower, configure the EES based on the following facility separations:

- a. Less than 15 ft. A single EES loop designed to encircle the adjacent facilities is permitted.
- b. Greater than 15 ft but Less than 30 ft. Design a separate EES for each facility, where adjacent EES loops may share a common side.
- c. Greater than 30 ft but Less than 100 ft. Design a separate EES loop for each facility. Interconnect all EES loops by a minimum of two buried conductors, separated as widely as possible.
- d. Greater than 100 ft. Design a separate EES for each facility. Interconnection of the separate EES is not required.

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For small facilities, such as airfield navigation aids (NAVAIDS) or outdoor equipment service racks illustrated in Figure 4, an alternative EES design consisting of a minimum of two ground rods with a 4/0 AWG interconnecting ground wire is permitted.



Notes:

1. Only one air terminal, mounted at the center of the rack, is required for racks less than 6 ft in width.
2. Drawing is diagrammatic, phase conductors are not shown for illustrative purposes.

Figure 4. Typical Service Rack EES Installation – For Illustrative Purposes Only

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4.4.4.1 Ground rods

Installation of ground rods shall meet the following requirements:

- a. Material and Size. Ground rods shall be copper or copper clad steel, a minimum of 10 ft long and 3/4 in. diameter. Rod cladding shall not be less than 1/100 in. thick.
- b. Spacing. Ground rods shall be as widely spaced as possible, and in no case spaced less than one rod length. Nominal spacing between ground rods is between two and three times the rod length.
- c. Depth of Rods. Install top of ground rods at least 1 ft below grade level, or 1 ft below frost depth if required to suit climatic conditions.
- d. Location. Rods shall be located 2 to 6 feet beyond the foundation or exterior footing of the structure, except at locations where abutting sidewalks, equipment, or other obstructions warrant locating rods farther away from the foundation. On buildings with overhangs or sidewalks in close proximity, then the ground rods are permitted to be placed at locations further out.
- e. Orientation. Ground rods shall be driven at 90 degree (vertical) orientation to finish grade. If ground rods cannot be driven vertically to their full length, then the installation of grounding dissipation plates needs to be considered.

4.4.4.2 Interconnections

The EES installation shall include the following:

- a. Counterpoise Loop. Ground rods shall be interconnected by a direct buried, bare 4/0 AWG copper conductor installed at least 2 ft below grade. Locate the counterpoise conductor and ground rods below the minimum frost depth. The interconnecting conductor shall close on itself forming a complete loop with the ends exothermically welded. Locate the counterpoise conductor and ground rods below the minimum frost depth with the exception of permafrost.
- b. Exothermic Welds. Provide exothermic weld connections, except where prohibited by the NEC and at locations where welding creates hazards, such as near fuel tanks. In these cases, connections shall be installed with hydraulically crimped terminations using 12-ton minimum force applied with a tool using matching dies.
- c. Building Structural Steel. Building perimeter steel columns shall be bonded to the EES at spacing intervals of approximately every other column, but not more than 60-ft intervals.
- d. Reinforced Concrete Structures. Bond reinforcement bars to the EES once every 60 linear feet along the building foundation perimeter with a minimum 4/0 AWG bare stranded copper conductor exothermically welded or by a hydraulically crimped termination.
- e. Underground Metallic Structures. Bond underground metallic pipes and tanks, except where cathodic protection systems are used or where prohibited by the NEC, such as gas piping.

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- f. Telephone Ground. Where present, the ground shall be connected to the EES by a bare copper conductor not smaller than 2 AWG.

4.4.4.3 Ground Dissipation Plates

In shallow soil locations with limited surface space, ground dissipation plates are permitted in lieu of ground rods in the EES. In difficult soils/areas, a combination of trenches filled with metallurgical coke and ground dissipation plates is highly recommended.

Installation of ground dissipation plates shall meet the following requirements:

- a. Dissipation Plate Surface Area. Ground dissipation plates have four times the surface area of one ground rod, 3/4 in. diameter and 10 ft long. Therefore, substitute one ground dissipation plate for four ground rods.
- b. Material and Size. Plates shall be fabricated and installed in accordance with Figure 6.
- c. Spacing. Nominal spacing is 100 ft between ground plates.
- d. Depth of Plates. Install plates to the same depth or deeper than the interconnecting EES counterpoise conductor, but maintain a minimum of 1 ft of native soil above the upper edge of the plate.
- e. Location. The plates shall be installed at the corners of the EES at the farthest accessible point from the facility to be protected.
- f. Orientation. Plates should be installed in a vertical plane to take advantage of seasonal moisture and temperature changes in the soil.

4.4.4.4 [A4] Access Well

Access wells are permitted to enable inspection and maintenance activities. When installed, the well should be located at a ground rod in unpaved areas with access to open soil, to allow for inspection. The access well shall be made from concrete or other approved material, with a removable cover. The access well shall provide a 12-in. minimum radius clearance from the center of the ground rod to the inside wall of the access well.

4.4.5 Grounding Enhancement Materials for Earth Electrode System (EES) Installation

Enhancement materials and methods are listed in order of preference.

4.4.5.1 Metallurgical Coke

Metallurgical coke is a steelmaking byproduct material of coal-to-coke production. Metallurgical coke is environmentally safe, stable, and conductive even when completely dry or frozen, moisture independent, compactable and economical to install.

Normal installation is in a 1-ft square trench filled with metallurgical coke in an EES configuration with a continuous 4/0 AWG stranded copper conductor in the center of the material per Figure 5. The top of the metallurgical coke trench shall be covered by a minimum of 1 ft of native soil. Metallurgical coke shall contain no more than 1 percent sulfur by weight. Charcoal and/or petroleum-based coke breeze shall not be substituted for metallurgical coke derived from coal in coke ovens. Charcoal and petroleum coke typically contain high levels of sulfur, which in the presence of moisture will accelerate corrosion of the EES. Placement of the

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trench is based on the geometry of the facility and the physical site location. Radial trenches with a center conductor can be used to enhance RF ground planes in communication facilities.

4.4.5.2 Engineered Soil Materials

Engineered soil materials are cements, soils, or clays treated with a variety of materials to enhance soil conductive properties. These materials may be used in bored holes for ground rod installations and in trenches for counterpoise conductors. These engineered soils can be a mixture of moisture-absorbing materials such as Bentonite or homogenous clays in combination with native soils and/or chemicals. Some engineered soil enhancements use cement-based materials, but should be avoided in areas subject to significant soil movement. Engineered soil should have a moisture content of greater than 14 percent to be effective.

4.4.5.3 Chemical Soil Enhancements

Chemical enhancements (doping) using materials such as mineral salts, Epsom salts, and sulfates, should only be used as a last resort to enhance soil conductive properties. These materials may be used in bored holes for ground rod installations and in trenches for counterpoise conductors. Chemical enhancement is dependent on soil moisture content and requires periodic (usually annual) re-treatment and continuous monitoring to be effective. The chemicals can leach into the surrounding soil and can be deposited into the water table.

4.4.5.4 Chemical Ground Rods.

Similar to chemical enhancements, chemical ground rods also require re-treatment and monitoring to ensure continuous effectiveness. Many of these systems require a drip irrigation system in dry soil conditions. Installation and periodic inspections shall be in accordance with manufacturer's instructions.

4.4.6 Installation of Earth Electrode Systems in Corrosive Soils

Careful consideration must be given to the installation of any grounding system in soils with corrosive elements. Two geological areas of known concern are the volcanic soils in Hawaii and Alaska. It is recommended that supplemental cathodic protection be applied to the grounding system at these locations. A buried steel plate acting as a sacrificial anode shall be connected to the EES by a 4/0 AWG stranded bare copper conductor. The 4/0 AWG conductor shall be exothermically welded to the EES and to the sacrificial plate. The conductor shall be welded to the center of the plate. The sacrificial plate shall be a minimum 2 ft by 2 ft by 1/2 in. thick, installed in a vertical orientation.

For enhanced performance in shallow soils, provide a ground dissipation plate design per paragraph 4.4.4.3 or equivalent. Provide sacrificial anodes in addition to these standard ground plates.

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4.5 National Electric Code - Power Distribution System Grounding Compliance**4.5.1 General**

The facility electrical grounding shall exceed requirements of NEC Article 250 as specified herein.

4.5.2 Grounding Electrode Conductors (GEC)

Grounding electrode conductors (GEC) shall conform to the following:

- a. GEC and Jumper Size. The GEC and system bonding jumper shall be sized in accordance with NEC Article 250.
- b. GEC Termination and System Bonding Conductor. The GEC connection shall be terminated in the service disconnecting means (SDM). System bonding conductor shall be installed at the same location as the SDM.
- c. GEC Splicing and Routing through Metal Enclosures. If the GEC is spliced using a hydraulically crimped connector, the connector shall comply with paragraph 4.2.3.2. When a GEC is routed through a metal enclosure, such as conduit, the enclosure shall be bonded with the same size conductor at each end to the GEC.
- d. Separately Derived Systems. For a separately derived system, the system bonding jumper and the GEC shall be located at the first downstream system disconnecting means or overcurrent device. Connect the GEC directly to the EES, where possible, or terminate the GEC to the nearest effectively grounded structural steel member.

4.5.3 Equipment Grounding Conductors (EGC)

The EGC shall be a green insulated wire routed in the same raceway as the circuit phase and neutral conductors. Where power is supplied to electronic equipment through a cable and connector, the connector shall contain a pin to continue the EGC to the equipment chassis. Conduit or cable shields shall not be used as the sole EGC. Installation shall be in accordance with the NEC, FAA-C-1217, and the following:

- a. Grounding Terminals in Receptacles on Multi-Outlet Assemblies. These terminals shall be hardwired to an EGC. Strips that depend on serrated or toothed fingers for grounding shall not be used.
- b. Expansion joints. Conduit expansion joints shall be UL listed expansion joint fittings.

Where power conductors and the EGC are to be extended to a second building or structure, the neutral to ground bond of the power system shall originate at the first building electrical service entrance point. The grounded conductor shall not be connected to the EGC or EES at the second building or structure.

4.5.4 Grounding Bushings for Conduit Raceways

A grounding bushing is a conduit fitting that contains a lug for connecting a bonding jumper from the conduit bushing to the equipment ground bus or metal enclosure. This bonding jumper supplements the existing mechanical connection using locknuts and therefore improves the grounding integrity of the installation. The FAA has opted to exceed the minimum NEC raceway

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grounding bushing installation requirements for power and communication distribution systems that serve NAS facilities.

Provide grounding bushings for conduit raceway systems for the following conditions:

- a. IMC and RMC Conduits. A grounding bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation (see Figure 7).
- b. EMT Conduits. The connectors shall have an insulated throat, smooth bell shaped end, or a grounding bushing.
- c. Communication Conduit Pathways. Provide grounding bushings where conduits enter or leave the building. Additional grounding bushings are not required for electrically continuous conduit pathways located inside the building, unless otherwise required for electronic equipment operations. Bond each conduit with a 6 AWG or larger size conductor to the nearest SRS (with the exception of the single point ground system). If there are multiple conduits in the same junction box, the conduits can be bonded to a new ground bus established within the junction box with a 6 AWG or larger size conductor connected to the SRS (with the exception of the single point ground system).

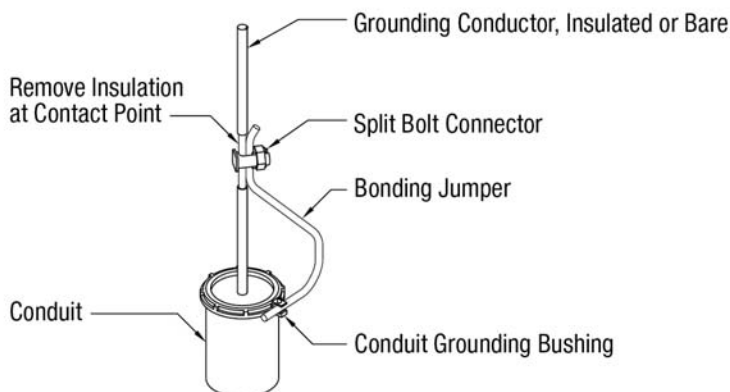
Exception. *Pullboxes and junction boxes are exempt from the grounding bushing requirement unless required by NEC or equipment installation requirement.*

4.5.4.1 Non-Current-Carrying Metal Equipment Enclosures

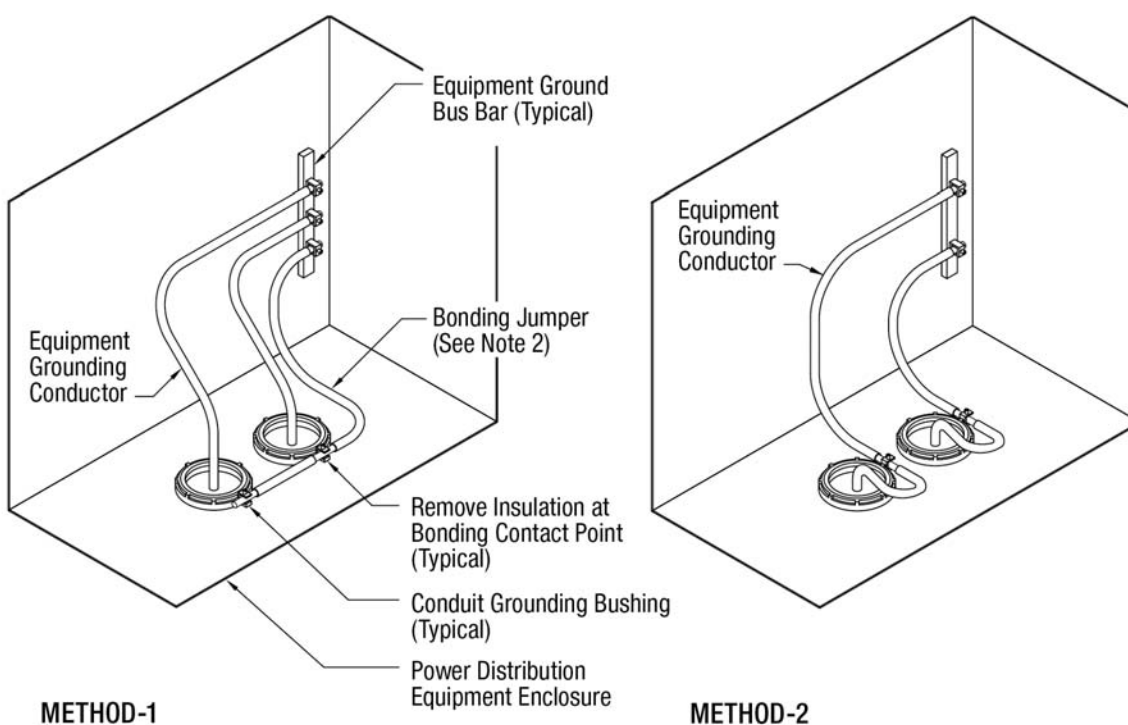
Non-current-carrying metal equipment enclosures include electrical equipment such as switchgear, panelboards, safety disconnect switches, raceways, and cable trays. The insulating finishes shall be removed between grounding and bonding areas of mating surfaces or bonding jumper connection points. The raceway systems shall be made electrically continuous in accordance with the following:

- a. Noncontinuous Ferrous Conduit Pathways or Sleeves. Pathways used for routing conductors only shall be equipped with grounding bushings at each end of the conduit pathway. The grounding conductor shall be bonded to the bushings with a bonding jumper the same size as the grounding conductor, see Figure 7 illustrative example.
- b. Continuous Conduit Systems. Systems that terminate at electrical equipment with grounding bushings as required in 4.5.4 shall be bonded to equipment ground bus with a bonding jumper the same size as the EGC. This shall be accomplished in accordance with Figure 7.
- c. Ferrous Materials. These materials shall be used for enclosures, raceways, and cable trays when required to provide shielding from magnetic fields.
- d. Battery Supporting Racks. These racks shall be bonded either directly to the EES or to a grounded structure with a minimum 2 AWG conductor.

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ILLUSTRATIVE EXAMPLE: CONDUIT RACEWAY



ILLUSTRATIVE EXAMPLES: POWER DISTRIBUTION EQUIPMENT

Notes:

1. The illustrative examples depict typical bonding concept, other engineered solutions may be possible.
2. The bonding jumper shall be sized as large as the largest EGC going through the conduits being used for grounding bushings.

Figure 7. Bonding of Grounding Conductor to Conduit or Equipment

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4.5.5 Interior Metal Piping Systems

Interior metal piping systems shall be bonded in accordance with the NEC.

Interior metal piping systems, such as mechanical and related metal piping systems located within the perimeter of SRS areas for NAS electronic equipment, shall be bonded in accordance with paragraph 4.7.3.2.

4.5.6 Building Structural Steel

Bonding of building structural steel elements shall be in accordance with the following:

- a. NEC Compliance. At the electrical power service entrance and separately derived power source equipment, building structural steel shall be bonded in accordance with the NEC.
- b. Periphery of NAS Equipment Room. Main building structural steel members of columns and beams at the periphery of NAS electronic equipment rooms shall be electrically continuous. This shall be accomplished by either direct or indirect bonding of the columns and beams. Where direct bonding is not practical, indirect bonds with copper conductor shall be used with a minimum of two 2 AWG conductors per 100 ft² of steel decking, metallic wall covering, etc. These connections shall be applied via an exothermic weld or a hydraulically crimped two-hole termination. Surface coatings shall be removed in accordance with paragraph 4.2.4.1.
- c. Building Perimeter Steel. Building perimeter steel columns shall be bonded to the EES in accordance with paragraph 4.4.4.2c.

Exception. *Concrete-encased steel reinforcement used in precast construction elements is exempt from the bonding requirements.*

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4.6 Surge Protection Device (SPD) Requirements

4.6.1 General

SPDs shall be provided at locations where electrical power systems are susceptible to conducted power line surges. SPD equipment functional performance requirements are detailed in section 5.7. Selection of appropriate SPD depends on location and application. The SPDs and transient suppression provided at electronic equipment power line entrances shall be coordinated as required herein and paragraph 5.6.4.

4.6.2 SPD for Power Distribution System

SPDs shall be provided at the following locations:

- a. Service Disconnecting Means. Provide SPD on the load side of the SDM.
- b. Facility Entrance Point. Provide SPD on the load side of a facility entrance point. For example, if the facility entrance point is within a NAS electronic equipment room, the SPD is required at the first distribution panelboard that supplies the branch panelboards within the room.
- c. Transfer Switch, Switchboard, or Panelboard. Provide SPD either on the load side of an engine generator transfer switch, or on the first switchboard or distribution panelboard located downstream of the transfer switch.
- d. Panelboards Feeding Building Exterior Loads. Provide SPDs at panelboards that supply branch circuit wiring exiting the building to serve exterior equipment.
- e. Secondary Transformer. Provide SPD at separately derived power source that feeds NAS electronic equipment.

A lightning arrester shall be installed on the primary side of FAA-owned distribution transformers. Lightning arresters and SPDs shall be approved by the OPR.

4.6.2.1 SPD for Facility Entrance Equipment

SPDs shall be provided at the SDM, at all facility entrance penetrations, and at feeder and branch panelboards as specified in paragraph 4.6.2.2. Additional SPDs shall be provided at the power line entrances to operational electronic equipment.

4.6.2.2 SPD for Power Distribution Feeders and Panelboards

SPDs shall be installed on switchgear, panelboards, and disconnect switches providing service to NAS operational equipment or supplying exterior circuits.

Examples of exterior circuits include obstruction lights, convenience outlets, guard houses, security systems, electric gates, and feeds to other facilities.

Where feeder and branch panelboards are located close together and their panelboards do not serve exterior circuits, use the SPD location decision tree diagram, Figure 8, to determine if an SPD is required for branch panelboards. SPDs for panelboards that provide service to exterior circuits shall meet requirements of paragraphs 5.7.2.1.1, 5.7.2.1.2, and 5.7.2.1.3 for facility entrance SPDs.

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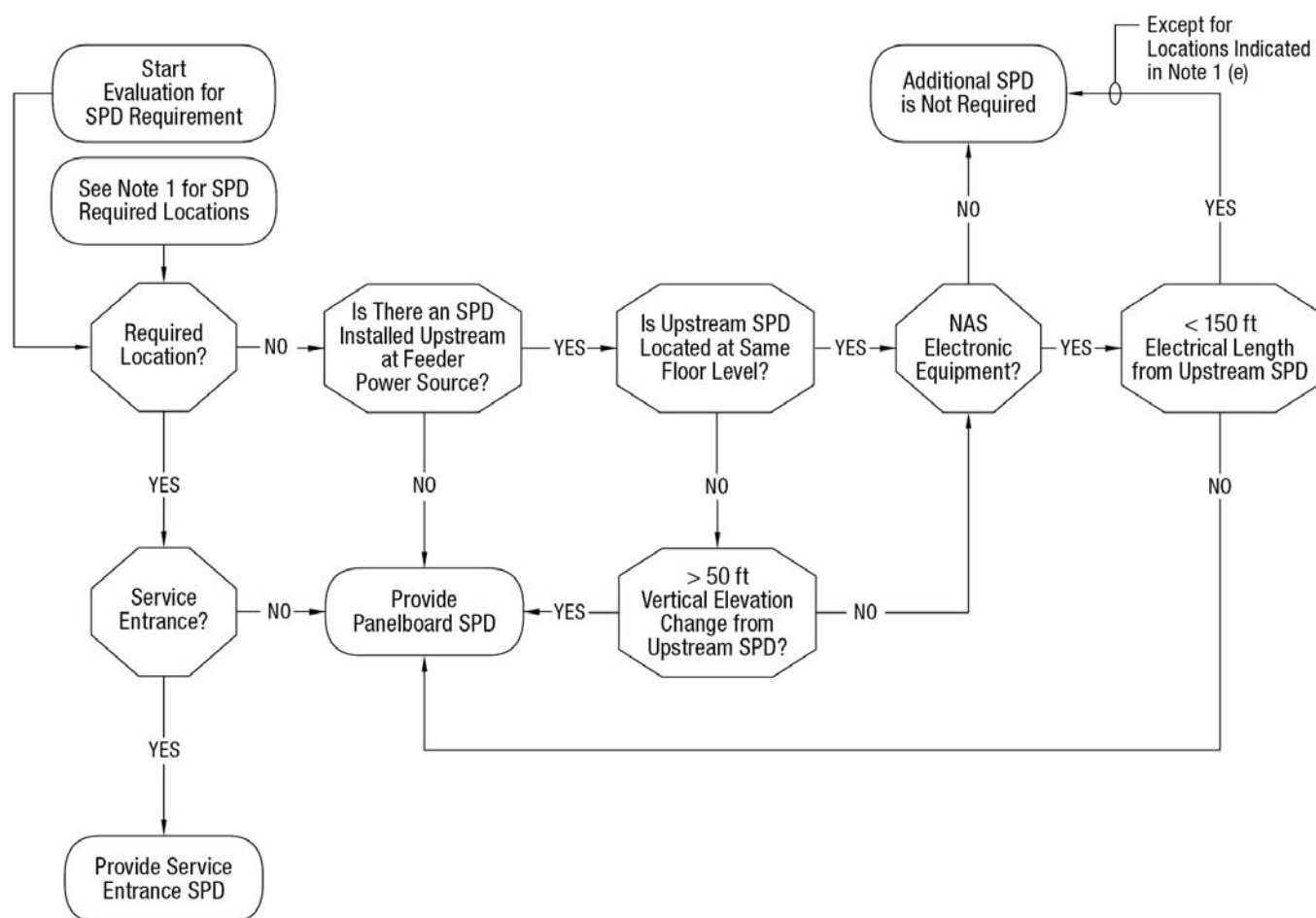
SPDs shall be installed as close as possible to the panelboard they serve and in accordance with the manufacturer's instructions. A feeder or branch panelboard SPD shall be provided with an overcurrent protection device. Overcurrent protective device (OCPD) examples include a fuse or circuit breaker fitted internal to the SPD or fitted to the panelboard and dedicated to the SPD. The overcurrent device shall not increase the clamp voltage of the SPD by more than 5 percent and shall pass the surge current values listed in Table 11 up to the 40 kA level without opening. Overcurrent devices for exterior circuits shall pass all surge current values in Table 11. Overcurrent devices, both internal and external to the SPD, and SPD short circuit current ratings, shall be sized and coordinated in accordance with the NEC and be field resettable or replaceable.

4.6.2.3 SPD Installation Requirements

SPDs shall be installed as close as possible to the panelboard or equipment that is being protected. Conductors shall be made as short as possible. Connections shall be made with UL listed connectors identified for the wire size and type used.

- a. Connections. Install the maximum conductor size allowed by the SPD manufacturer, but do not exceed the incoming circuit phase and grounding conductor size permitted by the panelboard, SDM, or protected equipment. Conductors shall be color-coded in accordance with FAA-C-1217, and as short and direct as possible without loops, sharp bends, or kinks. The ground bus in the service entrance enclosure shall be bonded directly to the SPD terminal marked G or ground. The SPD enclosure shall be bonded to the SPD ground terminal.
- b. Conduit Sealing. The conduit connecting the SPD enclosure to the SDM enclosure or panelboard shall be sealed with duct seal or other UL listed nonflammable, inorganic potting material to prevent soot from entering the protected enclosure in the event of SPD failure.

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Notes:

1. Provide SPDs in accordance with paragraph 4.6.2 and for the following locations.
 - a. Power service disconnecting means (SDM).
 - b. Load side of automatic transfer switch (ATS).
 - c. Transformer, secondary of separately derived power source.
 - d. Panelboards with branch circuits that feed building exterior loads.
 - e. Power feeder that supplies the panelboards for NAS electronic equipment room. SPD is required at the first panelboard located within the room.

Figure 8. SPD Location Diagram - Close Proximity Allowance Decision Tree

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4.6.3 SPD for Signal, Control, and Data Line Surge Protection

Provide SPDs at the following locations:

- a. Facility entrances,
- b. Entrances to NAS electronic equipment (see paragraph 5.6.3),
- c. Entrances to electronic equipment installed by the telecommunication service provider.

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4.7 Grounding and Bonding for NAS Electronic Equipment Areas

4.7.1 General

This section describes grounding and bonding requirements for protection of NAS electronic equipment housed in designated NAS electronic equipment areas within FAA Facilities. Aspects of the grounding and bonding system include the following:

- a. NAS Facilities Main Grounding Connection. This connection requires a main and supplemental ground plate, designed in accordance with paragraph 4.7.2. See paragraph 5.2.3 for ATCT facilities special requirements.
- b. Signal Reference Structures. The SRS system requires grounding elements designed in accordance with paragraph 4.7.3.

4.7.2 Main and Supplemental Ground Plates

A main ground plate shall be established as a common point of connection for SRSs for the entire facility.

A supplemental ground plate shall be established at the opposite side of the facility to the main ground plate. This supplemental ground plate shall be used for a second connection of the multipoint ground system, signal reference grid, or signal reference plane to the EES. The use of multiple supplemental ground plates is permitted at large facilities.

Both the main ground plate and the supplemental ground plates shall conform to the following:

- a. Located within 50 ft of the EES.
- b. Each plate shall be connected to the EES with a 500 kcmil conductor.
- c. Supplemental ground plates and the main ground plate shall be interconnected with an insulated 4/0 AWG cable, color coded with green and orange tracer.

See Table 4 for the main and supplemental ground plate installation requirements. See Figure 9 for typical facility grounding system.

Exception. For buildings of 200 ft² or less, only the main ground plate is required. Connect the main ground plate to the EES with two 4/0 AWG stranded copper conductors. One of the conductors shall be 20 percent longer than the other. All signal grounding, single point or multipoint, shall terminate on this plate. No additional ground plates are required.

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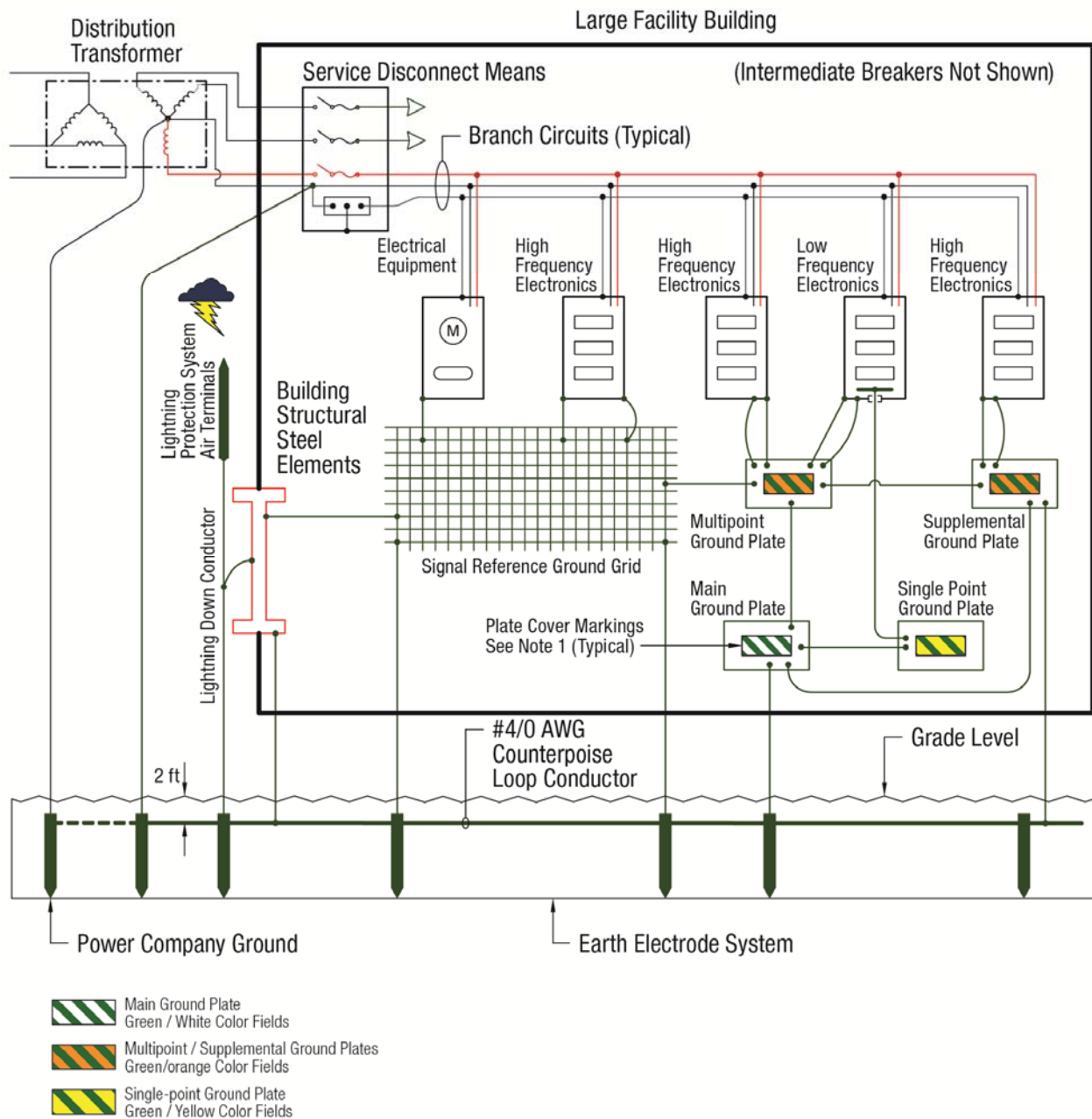


Figure 9. Typical Facility Grounding System

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4.7.3 Signal Reference Structures (SRS) – Requirements

Enclosed building facilities used to house NAS electronic equipment shall be equipped with an SRS. Types of SRS include the following systems:

- a. Multipoint Ground System (MPG) constructed using conductors and ground plates.
- b. Signal Reference Ground Grid (SRGG) constructed using copper strips.
- c. Signal Reference Ground Plane (SRGP) constructed using copper sheets.
- d. Single Point Ground System (SPG) is a special grounding system defined in section 5.5. This topology shall only be installed as directed in section 5.5 and connected to the MPG, SRGG, or SRGP as directed in section 5.5, and it shall not be used as an applicable SRS as outlined in the rest of 4.7 and its sub-sections.
- e. Engineered Hybrid System is a combination of MPG, SRGG, or SRGP grounding systems.

Provide an SRS for the following areas:

- a. NAS Operations Areas. Entire room area.
- b. Other Electronic Equipment Areas. Areas containing electronic equipment supporting NAS operations. Provide for the entire room area.
- c. Other Power Conditioning Equipment Areas. Areas containing power conditioning equipment, such as site wide uninterruptible power supply (UPS), shall be bonded to the SRS system described above.

The above-referenced electronic and electrical equipment shall be bonded to the SRS in the area. SRSs located on the same floor or on different floors shall be bonded together using at least two separate paths. Multiple components of the facility SRS, but not the SPG system, shall be bonded together with a minimum of two 4/0 AWG conductors.

Design SRS systems for site-specific requirements of the facilities and equipment. SRS applications require analysis of equipment bandwidth, and equipment and SRS impedances. SRS analysis shall consider, among other parameters, operating frequencies and impedances, transmission line communication models for bonding wires, noise levels in low-frequency analog-based equipment, and the influence of high-frequency digital signal and logic equipment. All conductors and cabling of NAS electronic equipment systems operating nominally at a wavelength less than $\lambda/20$ of the highest system frequency shall lay on or very close to the SRS. Bonding connections between the electronic equipment and SRS shall be close-coupled so that the bonding jumpers are as short as possible, and routed to the nearest SRS connection point.

The SRS shall be located in the vicinity of the electronic equipment. Signal-carrying conductors, axial lines, waveguides, and cabling interconnections between equipment shall be routed in immediate proximity to the SRS. For overhead feeds, use overhead SRS systems. For underfloor feeds in raised access floors, use underfloor SRS systems. Where equipment is fed from both overhead and underfloor feeds, use a hybrid SRS system made up of MPG, SRGG or SRGP bonded together. MPGs, SRGGs, and SRGPs may be installed on ceilings, walls, or floors.

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If NAS electronic equipment is installed in non-NAS electronic equipment rooms such as administrative areas, the NAS electronic equipment shall be bonded to a nearby SRS system. If there is no nearby SRS system, then establish a new MPG based on the footprint area of the NAS electronic equipment. If the square footage of the area is small enough, then install a small MPG system in accordance with paragraph 4.7.2.

The MPG and SRS systems shall be connected to the main and supplemental ground plates with conductors sized in accordance with paragraph 4.7.3.1.3. Each connection shall be to the nearest MPG plate or SRS.

4.7.3.1 Multipoint Ground System (MPG)

The protection of electronic equipment against potential differences and static charge buildup shall be provided by interconnecting non-current-carrying metal objects to an MPG that is effectively connected to the EES. The MPG consists of a network of plates and bonding jumpers, racks, frames, cabinets, conduits, wireways, cable trays enclosing electronic conductors, structural steel members, and conductors used for interconnections. The MPG shall provide multiple low-impedance paths to the EES, between various parts of the facility, and between electronic equipment within the facility so that any point of the system has a low-impedance path to the EES. This will minimize the effects of spurious currents present in the ground system due to equipment operation or malfunction, or from lightning discharges. The MPG shall not be used in lieu of the safety ground required by the NEC or as a signal return path.

4.7.3.1.1 Labeling

The MPG shall be clearly labeled to preserve its identity as described in the following paragraphs.

4.7.3.1.1.1 Conductor Identification

MPG conductors shall be labeled in accordance with paragraph 4.7.3.1.6.

4.7.3.1.1.2 Ground Plate Labeling

Ground plates shall be installed in accordance with Table 4.

4.7.3.1.2 MPG - Ground Plates and Buses

Multipoint ground plates shall be located to facilitate the interconnection of equipment cabinets, racks, and cases within a particular area. If more than one ground plate is necessary, they shall be located throughout the facility. Ground buses may be used when distributed grounding is required along a long continuous row of electronic equipment cabinets.

See Table 4 for the multipoint ground plate installation requirements. Ground buses shall be copper material. Ground bus width and thickness shall be selected from Table 3, and shall be as long as required.

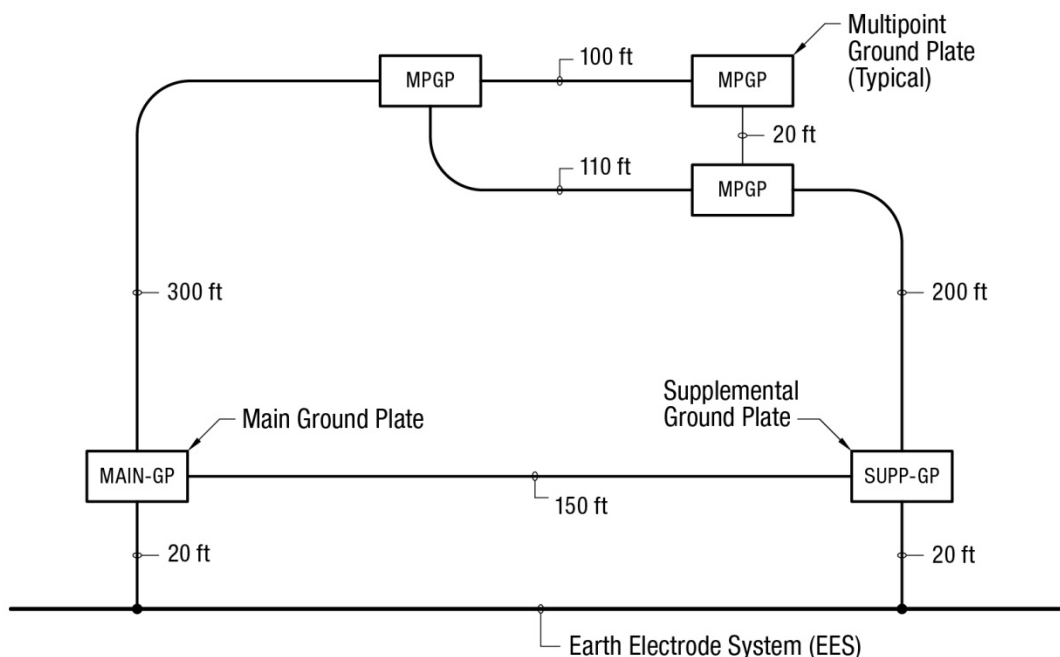
Provide a secondary conductor return path for each MPG plate or ground bus. A single-ended, radial connected plate or bus configuration is not permitted. Building structural steel shall not be used as a secondary return path for the MPG.

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4.7.3.1.3 MPG Conductors – Plate to Plate and Plate to Bus

Conductors between plates and buses in the multipoint system shall be insulated and sized in accordance with Table 3 based on the maximum path length to the farthest point in the MPG from the EES. To determine the distance to the farthest point in the multipoint system, add the length of conductors in the multipoint system to reach the farthest plate in the system via the longest path as shown in Figure 10. Divide the sum obtained by two to obtain the maximum path length. Use this path length to determine the conductor size from Figure 10, but in no case use a conductor smaller than 4/0 AWG. These conductors shall be insulated, labeled, and color-coded in accordance with paragraph 4.7.3.1.6. In cable trays, ground conductors shall be insulated and separated as far as possible from the other conductors.

Exception. In plenum spaces, where plenum-rated insulated conductors are not available, bare ground conductors are permitted.

**Notes:**

1. Determine the longest cable path between the main and supplemental ground plate connections to the EES by adding the sum of individual cable segments along the pathway.
Maximum path length = $20 + 300 + 100 + 20 + 200 + 20 = 660$ ft
2. Divide total obtained in step 1 by two.
 $660 / 2 = 330$ ft
3. Determine conductor size from Table 3. Using 330 ft path length, select 750 kcmil size conductor.

Figure 10. Multipoint Ground Conductor Size Determination

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Table 3. Size of Electronic Multipoint Ground Interconnecting Conductors

Conductor Size (AWG or kcmil)	Max. Path Length (ft)	Bus Bar Size, See Note 2 (in.)	Max. Path Length (ft)
750, See Note 1	375	4 x 1/4	636
600, See Note 1	300	4 x 1/8	318
500	250	3 x 1/4	476
350	175	3 x 1/8	238
300	150	2 x 1/4	318
250	125	2 x 1/8	159
4/0	105	2 x 1/16	79
3/0	84	1 x 1/4	159
2/0	66	1 x 1/8	79
1/0	53	1 x 1/16	39
1	41		
2	33		
4	21		
6	14		
8, See Note 3	9		
10, See Note 3	6		
12, See Note 3	4		

Notes:

1. Where these conductors are not available, parallel conductors are permitted, 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. Conductor sizing is based on providing a cross-sectional area of 2,000 cmil per linear ft. Bus bar sizes are chosen from available cross-sections and shall exceed the cross-sectional requirement of 2,000 cmil per linear ft.
2. Denotes an MPG designed with a continuous bus bar layout in lieu of ground plates and interconnecting conductors.
3. Conductor wire sizes 12 AWG through 8 AWG are permitted only for bond jumper connections between subassemblies and interior cabinet ground plate within the electronic equipment enclosure.

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Table 4. Ground Plate Specification Requirements

Plate Type	Acronym	Application Requirements (see article)	Material	Configuration Notes	Identification Notes
Main	Main-GP	4.7.2	Copper	1, 2, 3, 4	5, 6
Supplemental	Supp-GP	4.7.2	Copper	1, 2, 3, 4	5, 6
Multipoint	MPGP	4.7.3.1	Copper	1, 2	5, 6
Single Point	SPGP	5.5.4	Copper	1, 2	5, 6
Notes:					
1.	<u>Plate Dimensions.</u> Ground plate dimensions shall be at least 4 in. wide and 1/4 in. thick. Provide adequate length to accommodate number of bond connections plus at least two spare positions.				
2.	<u>Conductor Terminations at Ground Plates.</u> Provide either UL listed hydraulically crimped 2-bolt-hole style terminal lugs or exothermic welds for conductor terminations.				
3.	<u>Conductor Terminations at the EES.</u> The connections from ground plates to the EES shall be made with exothermic welds at the EES. The connections shall be as follows: <ol style="list-style-type: none"> <u>Conductor between Main-GP and EES.</u> Provide at least one 500 kcmil conductor. The Main-GP location shall be chosen to minimize conductor length, but shall not be more than 50 ft from the EES. <u>Conductor between Supp-GP and EES.</u> Provide at least one 500 kcmil conductor. The Supp-GP location shall be chosen to minimize conductor length, but shall not be more than 50 ft from the EES. The conductor length from Supp-GP to the EES shall be 30 percent longer or shorter than the conductor between the Main-GP and the EES. 				
4.	<u>Interconnection of Main-GP and Supp-GP.</u> Provide a 4/0 AWG bonding conductor connected between the Main-GP and Supp-GP.				
5.	<u>Ground Plate Covers.</u> Provide clear plastic covers with a permanently attached label or metal nameplate. The nameplate text shall be color black with 3/8-in. high letters and Arial font. The cover shall be identified with color-coded overlay markings configured by system type. The nameplate caption and cover identification shall be as follows: <ol style="list-style-type: none"> <u>Main-GP.</u> Provide label caption, “MAIN GROUND PLATE” and cover markings with clear background and green slashed marking tags around the caption. <u>Supp-GP.</u> Provide label caption, “SUPPLEMENTAL GROUND PLATE” and cover markings with clear background and green slashed marking tags around the caption. <u>MPGP.</u> Provide label caption, “MULTIPOINT GROUND PLATE” and cover markings with green background and bright orange slashed marking tags around the caption. <u>SPGP.</u> Provide label caption, “SINGLE POINT GROUND PLATE” and cover markings with green background and bright yellow slashed marking tags around the caption. 				
6.	<u>Conductor Identification Requirements.</u> See Table 5.				

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4.7.3.1.4 MPG Conductors - Plate and Bus to Equipment

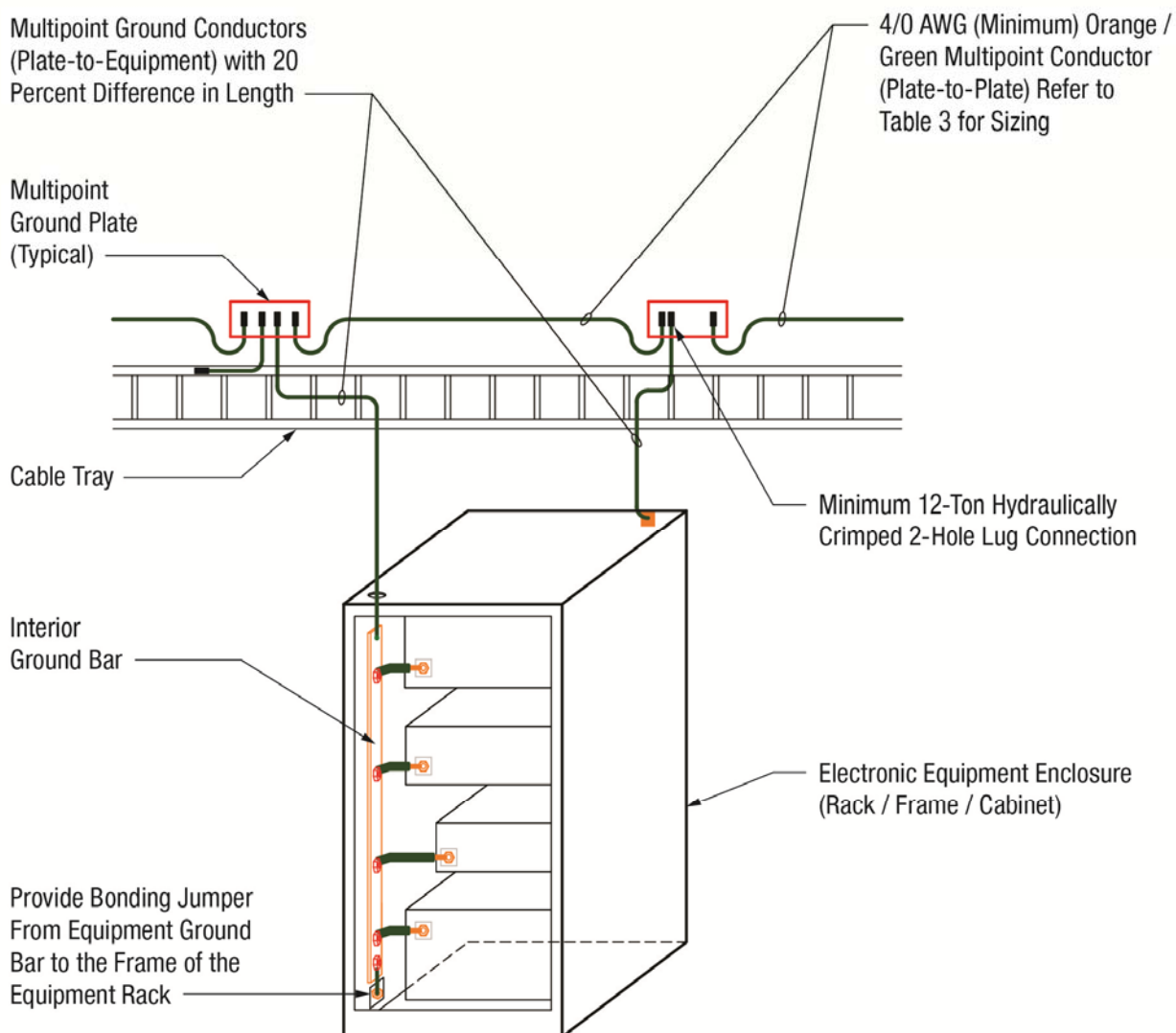
Conductors from plates and buses in the multipoint system to equipment chassis shall be sized in accordance with Table 3 based on the maximum path length from the plate or bus to the equipment. These conductors shall be insulated, labeled, and color-coded in accordance with paragraph 4.7.3.1.6. In cable trays, ground conductors shall be separated as far as possible from the other conductors. In wireways, ground conductors shall be visible by opening any cover.

Provide grounding connections between the electronic enclosure and the MPG system in accordance with following:

- a. Bonding Connections. Bonding connections shall prevent resonant impedances at equipment operating frequencies. Provide two short low-impedance bonding jumper between the MPG and two corners of the equipment. These bonding jumpers shall be connected as far apart as possible on the equipment (ideally on opposite corners) to reduce mutual inductance, and they shall have few bends or sags. The two bonding connections shall be of unequal length (one of the connections shall be 20 percent longer or shorter than the other) so that if one strap undergoes resonance, by limiting current flow, the other strap will not. Any bend radius in the bonding conductors shall be a minimum of 8 in.
- b. Bonding Connectors. Provide bonding conductors size in accordance with Table 3 at MPG system connections.
- c. Bonding Connection Length. Bonding connections to the SRS should be as short as possible.

See Figure 11 for typical electronic equipment grounding illustrations.

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ILLUSTRATIVE EXAMPLE:

Notes:

1. If MPG conductors are mounted on the side or face of the cable tray, provide cable support at intervals of at least 3 ft. MPG conductor support is not required if the cables are laying on the cable tray system.
2. Paint shall be removed from the bonding surfaces before making grounding connections to the equipment enclosure. The bonding surfaces do not require paint sealing treatment if the connection is made inside an environmentally controlled room.

Figure 11. Electronic Equipment Grounding

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4.7.3.1.5 Grounding Conductor Protection

Provide protection for MPG conductors subject to physical damage by use of conduit, floor trenches, routing behind permanent structural members, or other approved means. If grounding conductor is routed through metal conduit, the conduit shall be bonded to the conductor at each end.

4.7.3.1.6 Grounding Conductor Labeling

Provide conductor and pathway identification labeling where cables pass between areas physically separated by walls. Labeling is not required for cables that originate and terminate in the same room, such as a room without wall partitions.

Table 5. Grounding Conductor Insulation Color Codes

Conductor Insulation - Color Identification	Use
Green with red and yellow tracers	Isolated grounds
Green with yellow tracer	Single point ground
Green with orange tracer	Multipoint ground
Green with red tracer	High-Transient ground
Notes: 1. Some commercial off-the-shelf (COTS) equipment uses green with yellow tracer as the color identification for the EGC. These conductors are permitted. 2. Conductor labeling material type and format specification shall be in accordance with FAA-C-1217.	

4.7.3.2 Signal Reference Ground Grid (SRGG)

When required, the SRGG shall be provided for raised access floor systems and/or ceiling systems in NAS electronic equipment rooms or areas serving NAS electronic equipment.

The SRGG shall be configured in accordance with the following:

- a. Configuration. SRGG shall consist of a grid of 2-in. wide copper strips, 26 gauge or thicker, placed on a 2x2-ft square grid and welded at each grid intersection.
- b. Installation Location. SRGG shall be installed below a raised access floor system, below a ceiling or above a suspended ceiling system, or both. The SRGG perimeter shall extend to within 6-in. from the room perimeter or the perimeter of electronic equipment area served.
- c. Perimeter Conductor. A minimum 4/0 AWG bare copper conductor loop shall be routed around the SRGG and located within 6 in. from the SRGG perimeter. The SRGG perimeter shall be bonded to the perimeter loop conductor at every grid intersection with a 4 AWG bare copper conductor.
- d. Bonding to EES. The perimeter loop conductor shall be bonded to the EES with a minimum of four 4/0 AWG conductors spaced as widely apart as possible.

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- e. Bonding to Building Steel. Building structural steel located within 6 ft of the SRGG perimeter loop conductor shall be bonded to the loop conductor with minimum 4/0 AWG conductor. Building structural steel located within the perimeter of the SRGG shall be bonded to the SRGG with a minimum 4 AWG conductor.
- f. Bonding to Floor and Ceiling Systems. The SRGG shall be bonded to the raised access floor system or the ceiling metalwork at intervals not less than 6 ft using minimum 4 AWG bare copper conductors.
- g. Bonding of Multiple SRGGs. Floor and ceiling portions of a SRGG in the served area shall be bonded together with a minimum of four sets of 4/0 AWG conductors spaced as wide apart as possible.
- h. Bonding of Raceways and Metal Objects. Conduits, wireways, pipes, cable trays, or other metallic elements that penetrate the SRGG area shall be bonded to the SRGG where they enter the area and every 25 ft for their entire length within the area. Conduits, wireways, pipes, cable trays, and other metallic elements within 6 ft of the grid shall be bonded to the SRGG. These bonds shall be minimum 4 AWG bare copper conductors.

4.7.3.2.1 SRGG to Equipment

Provide bonding straps 1 in. wide and at least 26 gauge solid copper at SRPG or SRGG connections.

4.7.3.3 Signal Reference Ground Plane (SRGP) - Special Conditions

SRGP is a continuous signal reference ground plane constructed of 24 gauge minimum thickness copper sheets. SRGP shall be provided when required by the electronic equipment vendor. SRGP designs shall be approved by the OPR.

4.7.4 Bonding of Electrical Systems in NAS Electronic Equipment Areas

Raceways/conduits, wireways, and electrical distribution equipment shall be bonded to the SRS. Metal framing channel systems used to support conduit/raceway or other equipment are expected to be installed to achieve electrical continuity, and are not required to have additional bonding jumpers between individual assembly components.

4.7.4.1 Conduit Raceways

Every component of metallic conduit runs such as individual sections, couplings, line fittings, pull boxes, junction boxes, and outlet boxes shall be made electrically continuous and bonded, either directly or indirectly, to the SRS or facility steel at intervals not exceeding 25 ft.

If otherwise not indirectly or directly bonded, bond conduits using a minimum 6 AWG bonding conductor. Conduit raceways that are less than 1.5 in. trade size or less than 10 ft in length are exempt from the bonding requirement.

4.7.4.2 Cable Trays and Wireways

If not indirectly or directly bonded, bond individual sections of metallic cable tray and wireway systems together with a minimum 6 AWG insulated copper conductor. Bonds shall be in accordance with section 4.2.

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Bonding jumpers between individual sections are not required when all of the following conditions are met:

- a. The cable tray or wireway systems are electrically continuous,
- b. The systems are UL classified, suitable for use as an EGC,
- c. The systems are installed in accordance with manufacturer recommendations.

Where installed in electronic areas, cable trays and wireways shall be bonded to the SRS within 2 ft of each end of the run and at intervals not exceeding 50 ft. The minimum size bonding conductor for connection of a cable tray and wireway to the SRS shall be 2 AWG copper conductor.

4.8 Shielding Requirements

4.8.1 General

The facility design and construction shall include both protective shields to attenuate radiated signals, and separation of equipment and conductors to minimize interference coupling. The equipment design shall incorporate component compartments and overall shields as necessary to meet the electromagnetic susceptibility and emission requirements of MIL-STD-461 as required by NAS-SS-1000 and FAA-G-2100. In addition, the design shall provide personnel safety protection shielding.

4.8.2 Facility Shielding

Shielding of facility buildings, shelters, and equipment spaces shall be provided when other facility or environmental sources of radiation are of sufficient magnitude to degrade the operation and performance of electronic equipment or systems.

4.8.3 Shielding for Conductors and Cabling

Conductor and cable shielding shall comply with the following:

4.8.3.1 Cables and Signal Lines

Cables consisting of multiple twisted pairs shall have individual shields for each twisted pair. The shields shall be isolated from each other. Cables with an overall shield shall have the shield insulated and isolated from individual shields.

Exception. *Structured cabling for computer and telephone networks, such as Ethernet over balanced-line twisted pair with differential signaling design for noise rejection, are permitted to be used without individual shields for each twisted pair.*

4.8.3.2 Cables - Termination of Individual Shields

Shields of pairs of conductors, line shields, and the shield of cables containing unshielded conductors shall be terminated in accordance with the following:

- a. Shield Terminations. Shields shall be terminated to ensure correct equipment operation.

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- b. Shield Termination Lengths. Shield terminations shall consist of minimum length pigtails between the shield and the connection to the bonding halo or ferrule ring and between the halo or ferrule ring and the shield pin on the connector. The unshielded length of a signal line shall not exceed 1 in. with not more than 1/2 in. of exposed length as the desired goal.
- c. Shield Isolations. Shields, individually and collectively, shall be isolated from overall shields of cable bundles and from electronic equipment cases, racks, cabinets, junction boxes, conduit, cable trays, and elements of the MPG. Except for one interconnection, individual shields shall be isolated from each other. This isolation shall be maintained in junction boxes, patch panels, and distribution boxes throughout the cable run. When a signal line is interrupted such as in a junction box, the shield shall be carried through. The length of unshielded conductors shall not exceed 1 in. To meet this requirement, the length of shield pigtail longer than 1 in. shall be allowed but shall be the minimum required.
- d. Circuits and Chassis. Circuits and chassis shall be designed to minimize the distance from the connector or terminal strip to the point of attachment of the shield grounding conductor to the electronic signal reference. The size of the wire used to extend the shield to the circuit reference shall be as large as possible but not less than 16 AWG or the maximum wire size that will fit the connector pin. A common shield ground wire shall not be used for input and output signals, high and low level signals, signal lines, electronic signal lines, control lines, and power conductors.
- e. Extensions. Extension of shields through the connector or past the terminal strip to individual circuits or chassis is permitted if required to minimize unwanted coupling inside the electronic equipment. Where extensions of this type are necessary, overall cable or bundle shields shall be grounded in accordance with paragraph 4.8.3.3.

4.8.3.3 Cables - Termination of Overall Shields

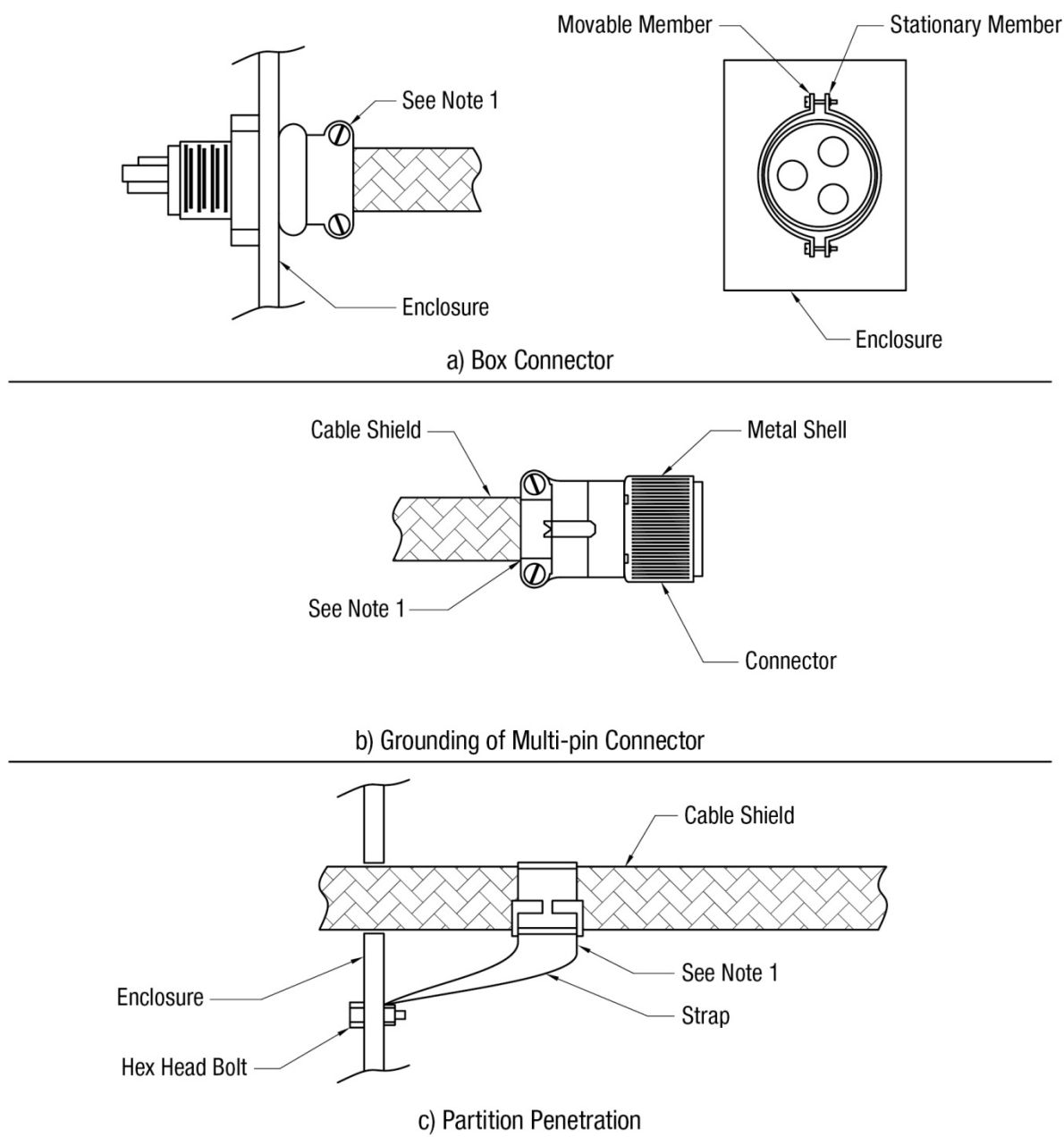
Cables that have an overall shield over individually shielded pairs shall have the overall shield grounded at each end unless otherwise required by the equipment. Grounding through an SPD is permissible if grounding both ends of the conductors degrades system performance. If present, the drain wire shall be grounded in the same manner as the shield.

- a. Cable Shields. Cable shields terminated to connectors shall be bonded to the connector shell as shown in Figure 12 (a) or (b). The shield shall be carefully cleaned to remove dirt, moisture, and corrosion products. The connector securing clamp shall be tightened to ensure that a low-resistance bond to the connector shell is achieved along the entire circumference of the cable shield. The bond shall be protected against corrosion in accordance with paragraph 4.2.4.3. The panel-mounted part of the connector shall be bonded to the mounting surface in accordance with paragraph 5.6.6.2.
- b. Interruption of Continuity. Where the cable shield continuity is interrupted, such as in a junction box, the shield shall be extended through and grounded at the box. The length of unshielded cable conductors shall not exceed 1 in. Where dictated by constructability constraints, shield pigtails may be longer than 1 in., but shall be as short as possible.

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- c. Cables Bonded to Penetrated Surfaces. Cables that penetrate walls or panels of cases or enclosures without the use of connectors shall have their shields bonded to the penetrated surface in the manner shown in Figure 12 (c). Overall shields shall be terminated at the outer surface of cases to the maximum extent possible.
- d. Overall Shield Grounding. Grounding of overall shields to terminal strips shall be as shown in Figure 13.

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Note:

1. Ensure that cable shield is clean and that securing clamp is tightened to provide a suitable ground.

Figure 12. Grounding of Overall Cable Shields to Connectors and Penetrating Walls

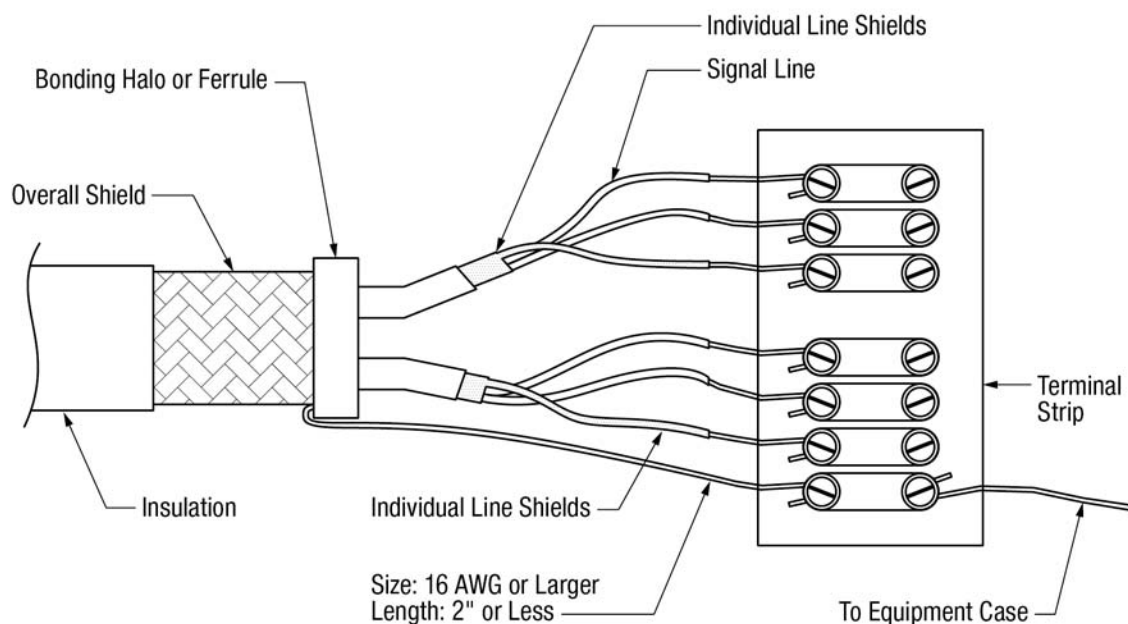


Figure 13. Grounding of Overall Cable Shield to Terminal Strip

4.8.4 Electromagnetic Environment Control

Shielding shall be integrated with other interference control measures such as filtering, wire routing, cable and circuit layout, signal processing, spectrum control, and frequency assignment to achieve the highest operational reliability of the equipment. Implementation procedures necessary to achieve the required filtering and shielding shall be detailed in the control plan described in 5.9.2 to include material requirements, shield configurations, placement and installation limitations, gasket utilization, filter integration, aperture control, bonding and grounding requirements, and wire routing and circuit layout constraints.

4.8.4.1 Space Separation

The design and layout of facilities shall physically separate electronic equipment and conductors that produce interference from other equipment and conductors that are susceptible to interference. The minimum separation distance between power and signal cables shall be in accordance with Table 6.

4.8.4.2 Wire and Cable Routing

The routing and layout of wires, conductors, and cables shall be performed in a manner that does not jeopardize the integrity of the equipment shield. Signals with power level differences of greater than 20 dB shall be routed as far apart as possible. Alternating current power conductors and control lines shall be routed away from sensitive digital or other susceptible circuits. Shielded cables shall be used where required to prevent emissions and/or to provide shielding. Cable shields shall be grounded in accordance with the requirements of paragraphs 4.8.3.2 and 4.8.3.3.

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Table 6. Minimum Separation Distance between Signal and Power Conductors

Condition	Circuit Power Level		
	< 2 kVA	2-5 kVA	> 5 kVA
Unshielded power lines or electrical equipment in proximity to signal conductors in open cable tray or nonmetal raceway.	5 in.	12 in.	24 in.
Unshielded power lines or electrical equipment in proximity to signal conductors in a grounded metal raceway.	2.5 in.	6 in.	12 in.
Power lines enclosed in a metal raceway (or equivalent shielding) in proximity to signal conductors in a metal raceway.	-	3 in.	6 in.

4.8.4.3 Bonding and Grounding of Compartment Shields

All shields shall be grounded. Bonding shall be in accordance with section 4.2.

4.9 Electrostatic Discharge (ESD) Requirements**4.9.1 General**

Modern electronic and electronically controlled electrical equipment are susceptible to damage from ESD. The requirements of this section are intended to reduce the frequency and minimize the effects of ESD events. Electronic circuitry that contains miniaturized or solid-state components shall be considered ESD susceptible.

4.9.2 Requirements

NAS electrical and electronic equipment, subassemblies, and components subject to damage from exposure to electrostatic fields or ESD shall be protected in accordance with section 5.8. ESD controlled areas shall be provided for operations, storage, repair, and maintenance spaces used for electrical and electronic equipment or subassemblies that are subject to damage from static electricity or ESD.

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5 DETAILED REQUIREMENTS

5.1 Introduction

This chapter describes detailed performance requirements, which are specific to FAA facility applications, organized by facility special conditions and equipment as follows:

- a. Airport Traffic Control Tower (ATCT) Facilities
- b. Lightning Protection System – Special Conditions
- c. Facility Transient Protection – Special Conditions
- d. Single Point Ground System (SPG) – Special Conditions
- e. NAS Electronic Equipment – Interface and Procurement Requirements
- f. Surge Protection Device (SPD) – Procurement Requirements
- g. Electrostatic Discharge (ESD) Equipment – Interface and Specification Requirements
- h. Electromagnetic Compatibility Requirements

5.2 Airport Traffic Control Tower (ATCT) Facilities

Figure 14 depicts the elemental relationship of areas located at the top of a typical ATCT. Operation of NAS electronic equipment areas located in the cab, junction, and subjunction levels present a unique set of challenges for implementation of lightning and transient protection. NAS electronic equipment areas are spaces where the equipment is physically located or associated passageways that distribute utilities within the tower. Power and telecommunication distribution systems (NAS supporting utilities) either originate from the base of the tower or an attached base building.

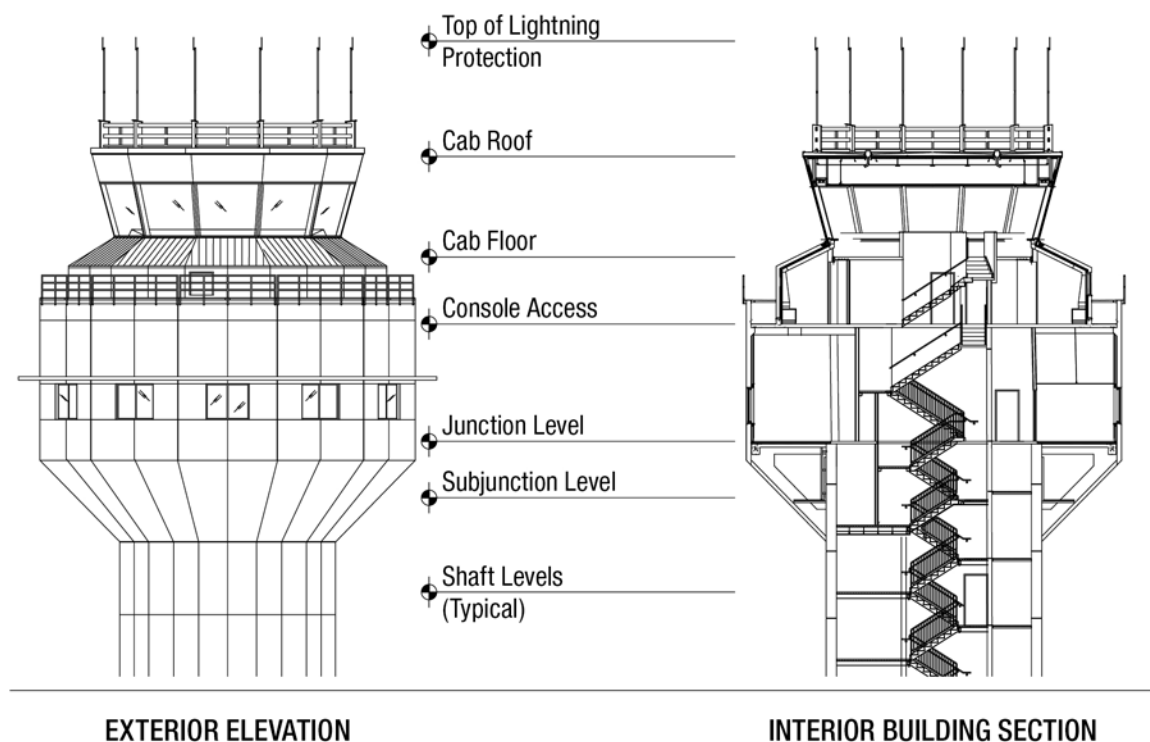


Figure 14. Airport Traffic Control Tower – Typical Floor Levels

5.2.1 General

During lightning strikes, there is a potential difference between the reference voltage at the top of the tower and the base of the tower. It is therefore necessary to reference all systems at the top of the tower to each other and treat this area as a separate facility. The NAS electronic equipment and associated supporting utility distribution system are subject to large electromagnetic fields during a lightning strike. For this reason, special techniques are required to provide an environment that minimizes the damaging effects of lightning. ATCT systems requiring special consideration include:

- a. Lightning and Transient Protection
- b. Main Ground Connections
- c. Power Distribution System
- d. NAS Electronic Equipment Areas

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5.2.2 Lightning Protection System

Provide lightning protection in accordance with section 4.3, and this section.

5.2.2.1 Common Bonding of Grounded Systems

The lightning protection, electrical, electromechanical, electronic systems, and building structural steel shall be bonded together for safety.

5.2.2.2 Potential Equalization Loop

Provide a continuous potential equalization loop conductor at the following locations:

- a. Roof or Roof Parapet. Install a loop conductor within 24 in. of the periphery of the structure. Interconnect air terminals and down conductors to the equalization loop. Any secondary roof area or parts of the structure that extends beyond the upper most roof zone of protection scheme shall be provided with additional air terminals in accordance with NFPA 780.
- b. Exterior Platforms, Catwalks, and Personnel Access Areas. Provide a potential equalization loop for platforms that extend beyond the ATCT building perimeter. Interconnect down conductors to the equalization loop.
- c. Tower Shaft Intermediate Floor Levels. Install a loop conductor at tower intermediate levels, evenly spaced no more than 60 ft apart, measured from the roof equalization loop. Interconnect down conductors to the equalization loop.

5.2.2.2.1 Horizontal (Side Strike Protection) Air Terminals for Equalization Loop

Provide horizontal air terminals on equalization loops, in addition to the zone of protection scheme, for exterior platforms and catwalks located at the cab, cab roof, or occupied areas along the ATCT shaft. Install the horizontal air terminals positioned at building corners and along the periphery of the loop where required by the lightning protection zone of protection scheme.

Exception. *Horizontal (side strike) air terminals are not required for equalization loops located at intermediate floor levels of the tower shaft within the zone of protection scheme where there are no platforms for personnel access, or electronic or electromechanical equipment.*

5.2.2.2.2 Connection of Down Conductor to Equalization Loop

The connection method between the down and equalization loop conductors shall be in accordance with paragraph 4.3.5.

5.2.2.3 Number of External Down Conductors for ATCT

MIL-HDBK-419A, Volume II, paragraph 1.3.2.2.2(d), provides that “buildings and structures shall add one down conductor for every 60 ft of height or fraction thereof, but horizontal spacing between down conductors need not be less than 50 ft.”

The number of down conductors shall be based on both the ATCT height and its largest horizontal perimeter dimensions. For the purposes of this document, the above referenced 50-ft dimension is the horizontal distance between down conductors along the largest projected

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perimeter area. The following guidelines shall be used in determining the number and configuration of external down conductors:

- a. External Down Conductors for ATCTs. All ATCTs shall have a minimum of four down conductors. ATCTs greater than or equal to 180 ft above ground level to cab roof shall add one down conductor for every 60 ft of height or fraction thereof above 180 ft. For ATCTs greater than or equal to 180 ft, the number of down conductors may be substituted, but not less than four, by using larger sized individual conductors to achieve equivalent overall conductor cross-sectional area.

Exception. Existing ATCTs are exempt from the minimum number of external down conductor requirement, if less than 60 ft above ground level to the cab roof and the horizontal perimeter dimension spacing between down conductors is less than 50 ft. However, when removal of the down conductors is performed as part of a major project, such as when replacing siding of an ATCT, reinstallation shall incorporate the minimum number of down conductors as stated in this paragraph.

- b. Building Structural Steel. Building structural steel is permitted as a substitute for only one down conductor for lightning protection. Concrete encased structural reinforcing bars or precast construction systems are not qualified for use as building structural steel. It is permissible to substitute substantial metal structural elements of buildings for regular lightning conductors where, inherently or by suitable electrical bonding, they are electrically continuous from the air terminal to the earth electrode connection. The structural elements shall have a conducting cross-sectional area, including at the structural connections, at least twice that of the lightning conductor that would otherwise be used. Lightning conductors may be installed on the interior or exterior to the building enclosure. Steel frame buildings enclosed in architectural precast concrete or masonry products shall have external air terminals and roof conductors installed and bonded directly to the structural members to keep the lightning discharge from having to penetrate the masonry shell to reach the frame members. Refer to MIL-HDBK-419A, Volume II, paragraph 1.3.2.2.2(i).

5.2.2.4 Transient Surge Protection

Provide SPDs in accordance with section 4.6 for NAS facility entrance points located at the base building/tower shaft and at the top of the shaft.

5.2.3 Main Ground Connections

A low-impedance connection shall be provided to the EES to ensure good high-frequency grounding during normal operation. Ground connections shall be established in the ATCT as a common point of connection within the facility. Provide ground plates in accordance with paragraph 4.7.2 and as specified herein.

5.2.3.1 ATCT MPG Configuration – Preferred Method

Refer to Figure 15 for MPG configuration topology and connection requirements. A main ground plate shall be established on the lowest level with electrical, electromechanical, or electronic equipment serving the ATCT cab. Grounding systems located at or above this level of the ATCT shall be connected to this main ground plate. Provide a combination of conductors, in accordance

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with Table 7, and two parallel paths as indicated in Figure 15. Install each conductor path within separate chases located in the tower shaft. Conductors shall be routed continuously between ground plates without sharp bends, loops, or kinks.

Recombine risers to an MPG plate at each maintenance level of the ATCT shaft. These conductors shall be mechanically bonded to the main ground plate and the base plate. Connect base plate(s) exothermically to the EES with the same number and size of conductors used for the riser conductors in accordance with Table 7.

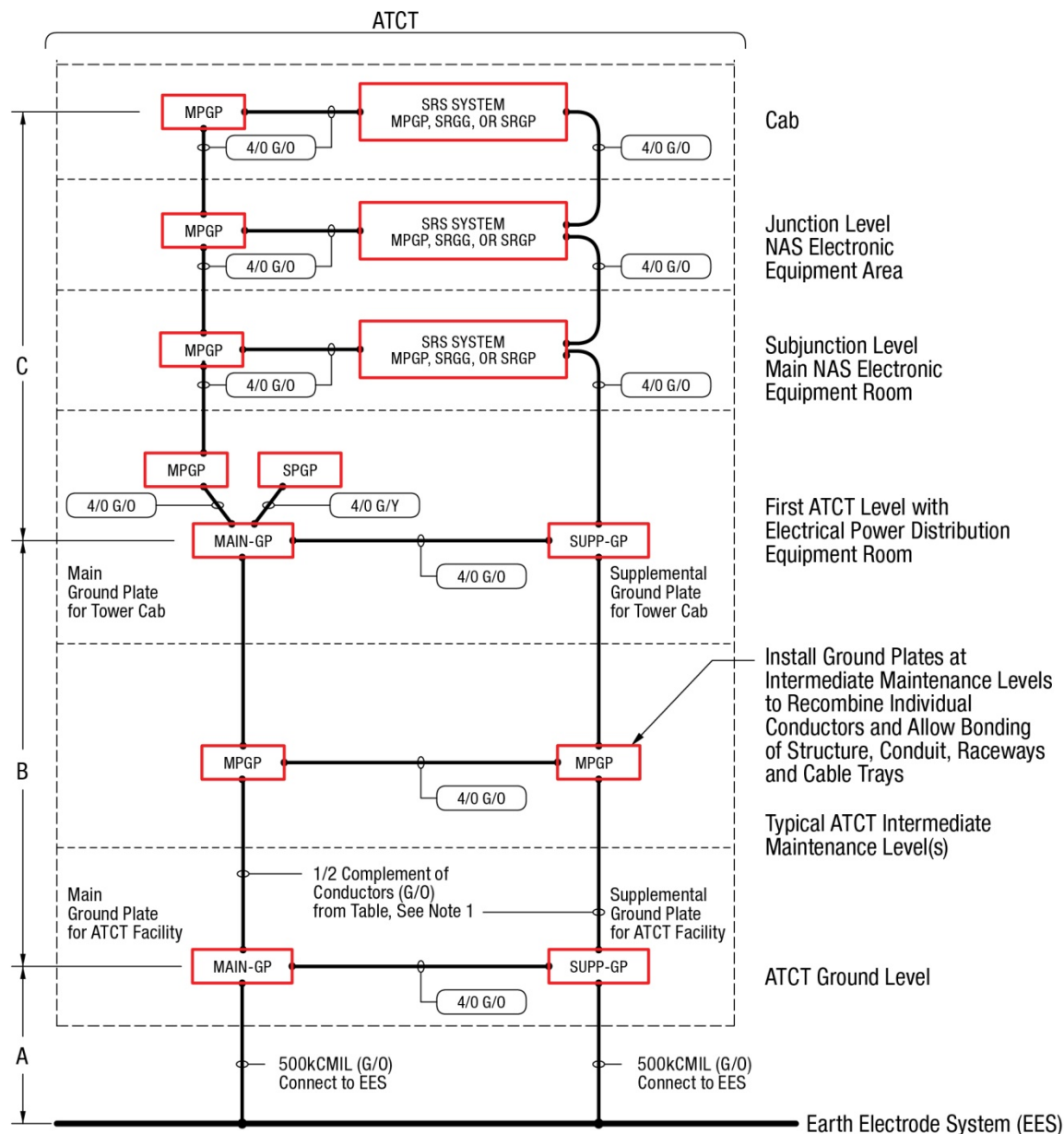
5.2.3.2 ATCT MPG Configuration - Alternative Method

Refer to Figure 16 for MPG configuration topology and connection requirements. A main ground plate shall be established on the lowest level with electrical, electromechanical, or electronic equipment serving the ATCT cab. Grounding systems located at or above this level of the ATCT shall be connected to this main ground plate. Provide a combination of conductors, in accordance with Table 7, and connect this main ground plate to a plate at the base of the ATCT. These conductors shall be routed continuously from the main ground plate to the base plate without sharp bends, loops, or kinks.

Table 7. ATCT MPG Configuration – Parallel Conductor Complements

Electrical Distance from EES to Farthest MPG Plate Measured in Feet, See Note 1	Two (2) Conductor (kcmil)	Three (3) Conductor (kcmil)	Four (4) Conductor (kcmil)	Five (5) Conductor (kcmil)	Six (6) Conductor (kcmil)	Number of 4/0 (AWG)
Up to 250	500	350	250	4/0	-	5
251 to 300	600	400	300	250	4/0	6
301 to 350	700	500	350	300	250	7
351 to 400	800	600	400	350	300	8
401 to 450	900	600	500	400	300	9
Note: 1. Refer to Figure 15 and Figure 16 for conceptual MPG configurations.						

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SYMBOLS:

MPGP	Ground Plate, Subscript Denotes:
MAIN-GP	: Main Ground Plate
SUPP-GP	: Supplemental Ground Plate
MPGP	: Multipoint Ground Plate
SPGP	: Single Point Ground Plate

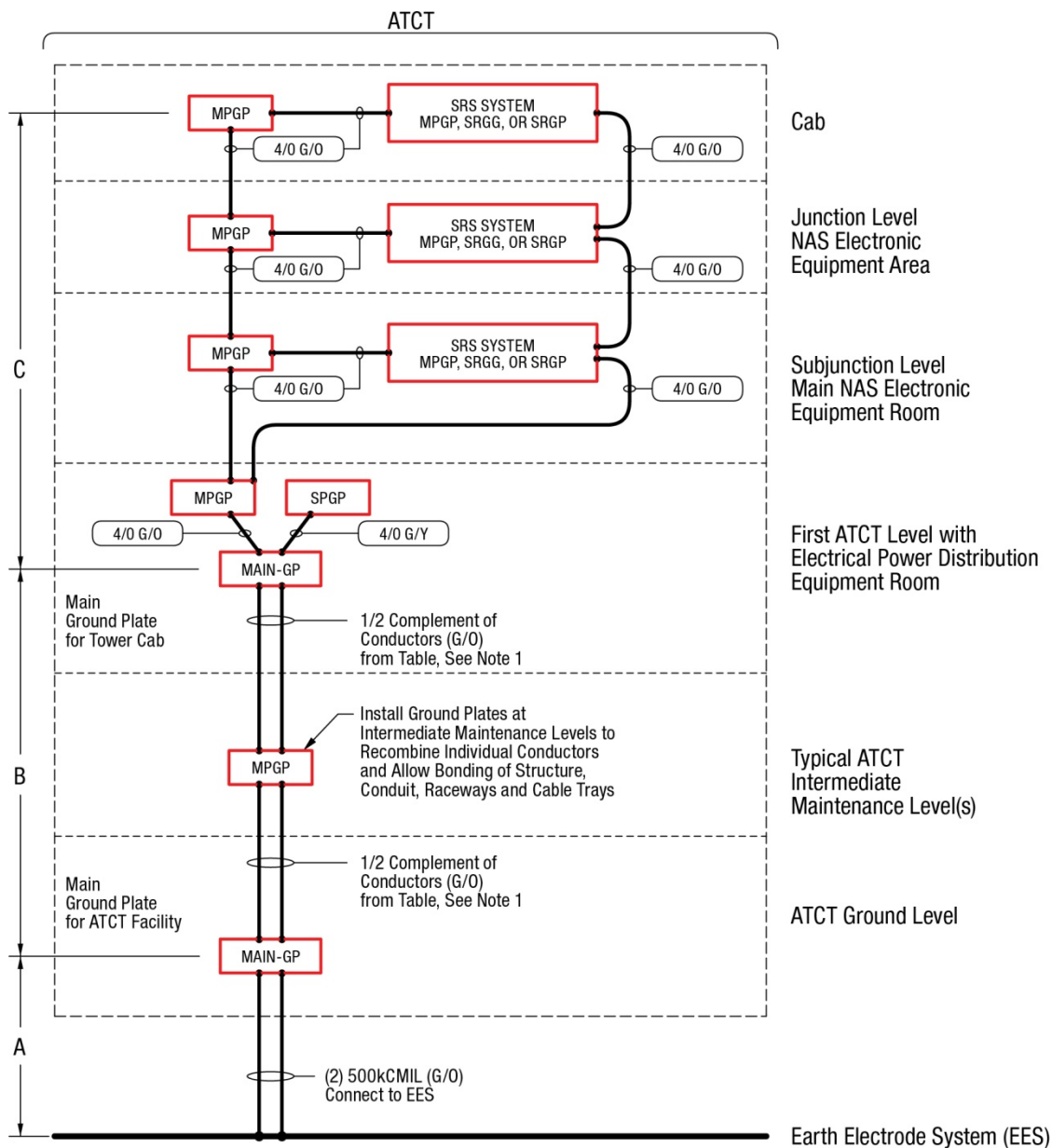
4/0 G/O	Conductor Type Designation, Insulation Color Code and Wire Size
G/O	Multipoint Ground System Conductor, Green with Orange Tracer
G/Y	Single Point Ground System Conductor, Green with Yellow Tracer
4/0	AWG Wire Size

Note:

1. Total height calculation (A+B+C) shall be used to determine cable size parameter indicated in Table 7.

Figure 15. Typical Electronic Equipment Grounding Riser Diagram for ATCT (Preferred Method)

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SYMBOLS:

MPGP Ground Plate, Subscript Denotes:
 MAIN-GP : Main Ground Plate
 MPGP : Multipoint Ground Plate
 SPGP : Single Point Ground Plate

4/0 G/O Conductor Type Designation, Insulation Color Code and Wire Size
 G/O Multipoint Ground System Conductor, Green with Orange Tracer
 G/Y Single Point Ground System Conductor, Green with Yellow Tracer
 4/0 AWG Wire Size

Note:

1. Total height calculation (A+B+C) shall be used to determine cable size parameter indicated in Table 7.

Figure 16. Typical Electronic Equipment Grounding Riser Diagram for ATCT (Alternative Method)

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5.2.4 Power Distribution System

Provide power distribution for ATCT in accordance with section 4.5 and as specified herein.

- a. NAS Electronic Equipment Power Loads. Provide separately derived power sources for NAS electronic equipment loads when the ATCT height is greater than 100 ft measured to the cab floor level.
- b. Separately Derived Power Systems. The separately derived systems shall be grounded in accordance with the requirements of NEC article 250 and paragraph 4.5.2d at the first downstream disconnecting means or overcurrent device. This point of connection is mandated to facilitate the effective installation of an SPD.
- c. Surge Protection. Provide SPDs, in accordance with paragraph 4.6.2. The SPD shall be installed on the load side of the first downstream 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 main ground plate established in accordance with the requirements of paragraph 5.2.3. This connection is in addition to the grounding electrode conductor requirements of NEC article 250.
- d. Bonding of Metallic Piping Systems. The interior metallic piping supply systems located at the top and bottom of the ATCT mechanical piping chase, such as water, plumbing, and mechanical piping systems, shall be bonded to the main ground plates established in accordance with the requirements paragraph 5.2.3. If interior metallic piping systems are not located near the main ground plate, bond interior piping to the nearest MGP. This connection is in addition to the bonding requirements of NEC article 250.

5.2.5 NAS Electronic Equipment Areas

Provide grounding and bonding for NAS electronic equipment in accordance with section 4.7 and paragraph 5.2.3 and as specified herein.

5.2.5.1 ATCT Building Structural Steel Bonding Requirements

Structural steel columns and beams of the ATCT shall be bonded together and to the EES in accordance with paragraph 4.5.6 and as specified herein.

The design of the ATCT shaft shall make provisions to ensure that all concrete reinforcing steel used throughout the shaft is electrically bonded together, continuously, horizontally and vertically, and to the EES.

Horizontal metal transitions, such as floors, stairs, and walkways shall be bonded to the ATCT structural steel members or concrete reinforcing steel bars at every level. Elevator support structures shall be bonded to horizontal metal transitions and to the EES. All bonding jumpers shall be a minimum 2 AWG copper conductor.

5.2.5.2 Signal, Communications, Axial Cables, and Control Line Protection

Transient protection shall be applied at each end of vertical cables routed between the equipment room located near the top of the ATCT and the associated base building. Cables between the tower cab and equipment room areas shall be protected in accordance with paragraph 4.6.3. Both

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facility and equipment levels of protection shall be provided for these lines. Enclosing metallic cabling in ferrous conduit or the use of all dielectric fiber optic cable can significantly reduce the threat of lightning related damage to ATCT and base building circuits.

5.2.5.3 Signal Reference Structure

An SRS shall be constructed in accordance with applicable requirements of paragraph 4.7.3, including the cab and other areas at the top of the ATCT that contain electrical, electromechanical, or electronic equipment serving the cab.

- a. SRGG Installation. The main and supplemental ground plates and building steel may be used to establish equipotential bonding for the SRGG perimeter loop conductor in lieu of the EES for facilities located at the top of the ATCT. Provide one connection between the perimeter loop conductor to the main and supplement ground plates. Provide at least two additional connections between the perimeter loop conductor and building steel.

5.2.5.4 Floor Coverings for Electronic Equipment and Operational Areas

Floor coverings for cab and areas serving the cab shall either be tile or carpeting and shall be composed of static dissipative material. The floor coverings and installation shall be per the manufacturers' specifications and paragraph 5.8.9 and shall be connected to a component of the SRS, but not to the SPG system.

5.2.5.5 Single Point Grounding

SPGs, if required, shall be constructed in accordance with section 5.5. SPGs and independent ground systems required by equipment manufacturers shall be bonded to the ATCT main ground plate, located at the top of the tower, in accordance with the requirements of paragraph 5.2.3. The SPG shall be constructed in a radial configuration and not form a loop.

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5.3 Lightning Protection System – Special Conditions**5.3.1 General**

This section describes facilities or systems that require additional design considerations for installation of lightning protection systems. The following applications are addressed:

- a. Antenna Towers
- b. Antenna Protection
- c. Tower Guying
- d. Waveguide, Axial Cable, and Conduit Grounding
- e. Staircase/Ladder Protection
- f. Facilities without Buildings or Antennas
- g. Lightning Protection for Fences and Gates
- h. Lightning Protection for Photovoltaic Solar Arrays

5.3.2 Antenna Towers**5.3.2.1 Number of Down Conductors for Towers**

Towers consisting of multiple, parallel segments or legs that are erected on a single pad or footing not over 9 ft² in area are considered pole type towers. Other towers shall have at least two down conductors. Large towers, such as radar towers, shall have one down conductor per leg. Down conductors on towers shall be bonded to each tower section. Down conductors shall be routed down the outside of the legs wherever possible and secured at intervals not exceeding 3 ft.

5.3.2.2 Pole Type Towers

Pole type towers shall be protected by at least one air terminal and have at least one down conductor. This is to provide a zone of protection for antennas located on the tower.

5.3.2.3 Towers without Radomes

Protection shall be provided for large radar antennas by extending structural members above the antenna and mounting the air terminal on top as shown in Figure 17 unless directed otherwise by the radar system OPR. Structural members shall be braced as necessary and shall not be used as part of the air terminal or down conductor. The air terminal shall be supported from structural framing and shall have a UL listed fitting on its base. The down conductor from the air terminal shall be connected to a perimeter conductor that forms a loop around the perimeter of the tower platform. Down conductors shall extend from the perimeter conductor to the EES. Each air terminal shall be provided with at least two paths to the ground. Conductors shall be in accordance with NFPA 780. Tower legs shall be bonded to the EES with a 4/0 AWG copper conductor exothermically welded at each end. This bonding conductor shall be either a separate conductor, or permitted to be a part of the down conductor, as described in paragraph 4.3.5.1.

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5.3.2.4 Radomes

Radomes shall be located within a zone of protection established according to the 100-ft radius “rolling sphere model” described in NFPA 780. This protection is provided by air terminals mounted on the radome, or by air terminals or catenary wires mounted independently of the radome. Air terminals mounted on the radome must have two paths to the EES. A perimeter conductor shall be provided at the radar antenna deck level.

Lightning protection systems for standalone radomes shall be designed and installed in consultation with the OPR of the radar system and the OPR of this document. Paragraph 5.3.2.5 shall be used as guidance in developing lightning protection systems for these radomes.

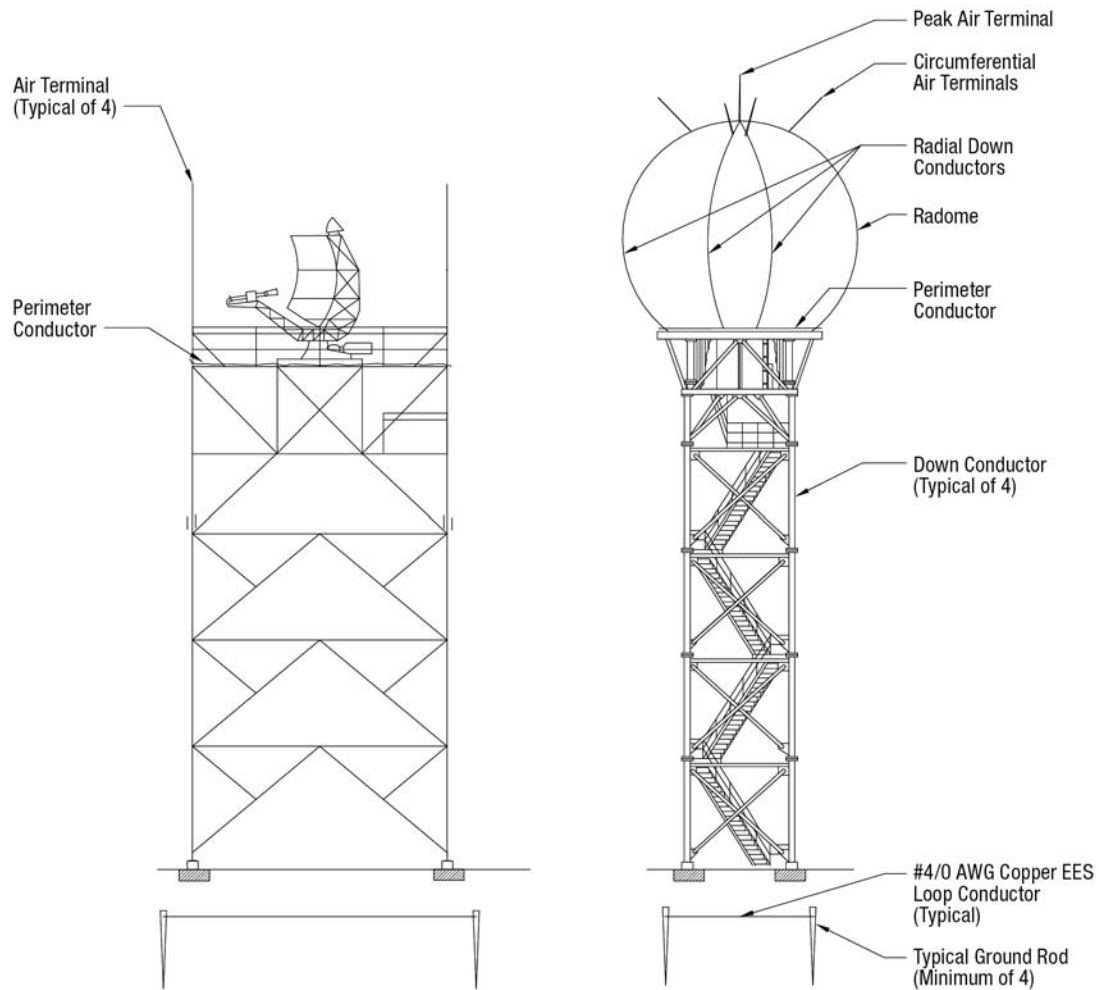
5.3.2.5 Towers with Radomes

Lightning protection systems for towers with radomes shall be designed and installed in consultation with the OPR of the radar system and the OPR of this document.

Towers with radomes shall be protected with a minimum of one 2-ft-long air terminal at the peak and four or more air terminals equally spaced along the circumference of the radome and oriented perpendicular to the radome. The spacing and quantity of circumferential air terminals shall be adjusted if the antenna pattern is affected, but their sizing, position, and height shall establish a protection zone as specified in paragraph 5.3.2.4. Circumferential air terminals shall be interconnected with main-sized conductors.

Radial down conductors, as indicated in Figure 17, shall be connected to the air terminal on the peak. The radial down conductors shall also be connected to the perimeter conductor that forms a loop around the base of the radome. Radial down conductors on the radome shall be routed from the air terminal at the peak of the radome, in a path following the contour of the radome, to a connection with the circumferential air terminals and then to a connection with the perimeter conductor as shown in Figure 17. Deviations from the shortest possible path are permitted where nearfield radar analyses determine that interference from the conductors will degrade the performance of the radar. Bends in the radial down conductors on the radome shall maintain the largest possible radii and in no case shall be less than 12 in. One down conductor per leg shall connect the perimeter conductor at the base of the radome to the EES. Down conductors shall be bonded to each leg section. Tower legs shall be bonded to the EES with a 4/0 AWG copper conductor exothermically welded at each end. This bonding conductor can be the same conductor required in paragraph 4.3.5.1.

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Notes:

1. Bond down conductors to each tower leg section. Exothermically weld down conductor to a 4/0 AWG copper conductor above grade. Route 4/0 AWG conductor through a 1-in. PVC conduit around the foundation concrete pier to 12 in. below grade and connect the conductor to the EES.
2. Where a radome has an electrically continuous frame, the framing may be used in lieu of the lower air terminals.
3. All lightning protection connections shall be free of paint and galvanizing. Scrape all steel free of surface contaminants prior to making exothermic welds or mechanical connections.

Figure 17. Lightning Protection for Radomes and Radar Antenna Platforms

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5.3.3 Antenna Protection

Air terminals shall be located to protect structural towers and buildings, and antennas mounted to towers and on buildings.

Most antennas throughout the FAA can be installed or engineered to be installed within the lightning zone of protection. However, there are select times where engineered solutions cannot be easily installed. Antennas may be deemed sacrificial if either of the following conditions exist:

- a. A 20 foot air terminal (or air terminal installed on a support with the combined height of 20 feet) does not provide proper zone of protection; or
- b. Lightning protection for an antenna will cause radiation pattern distortion.

Sacrificial antennas shall comply with the following:

- a. Bonding and surge protection in accordance with 4.6.3, 5.3.5, and 5.4.3.2; and
- b. The antenna or base is bonded to the lightning protection system.

All sacrificial antennas must be identified by the designer/program office to the SSC (e.g. ASSC). An SRM is one established method that is permitted to meet this requirement.

5.3.4 Tower Guying

Provide grounding and bonding for tower guying in accordance with TIA-222.

5.3.5 Waveguide, Axial Cable, and Conduit Grounding

Waveguide, axial cable, and conduit located on the tower and feeding into the facility shall be bonded to a bulkhead ground plate mounted on the tower and configured in accordance with 5.4.3.2.

- a. Overhead Cable Runs. Bulkhead plate bonding connections shall be located above the cable path at transition/turning point (90 degree bend point) near the tower's base where the cable transitions horizontally from the tower and enters the facility. Above-ground ferrous conduit located at the facility entrance shall be bonded in accordance with 5.4.3.1.1.
- b. Underground Cable Runs. Bulkhead plate bonding connections shall be located above the cable transition point where the cables enter the facility conduit riser. If cables enter ferrous conduit, the conduit shall be bonded to the EES in accordance with 5.4.3.1.

5.3.6 Staircase and Ladder Protection

The metallic staircase or ladder access to the tower shall be exothermically bonded near its base to the EES with a 4/0 AWG copper conductor installed in a location that avoids accidental tripping or striking hazards that could result in personnel injury. Where the staircase or ladder material is not thick enough for an exothermic weld, provide a two-hole hydraulically crimped connection. To ensure electrical continuity, sections of stairs or platforms that are not welded together shall be connected by bonding jumpers.

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5.3.7 Lightning Protection for Facilities without Buildings or Antennas

Small facilities such as Runway Visual Ranges (RVR) commonly are built without buildings or antennas. Since loss of these facilities can have a significant impact on NAS operations, these facilities shall be included within a zone of protection with either air terminals or overhead catenary wires.

5.3.8 Lightning Protection for Fences and Gates

General airport fencing is not subject to the requirements of this standard. Non-FAA owned fencing that is adjacent to FAA facilities shall be protected as mandated by agreement with the owner of the fencing.

Fences shall be constructed using electrically conducting materials (for example, chain link fabric, metal crossbar, stranded wire, etc) using metal posts that extend a minimum of 2 ft below grade into a concrete base. Metallic fence fabric with nonconductive coatings is not permitted, except where corrosive climatic conditions require corrosion protection.

5.3.8.1 Fence Grounding

Provide fence grounding in accordance with the following:

- a. Fence Post Grounding. Provide a ground rod adjacent to the fence post. Locate ground rods at horizontal linear spacing intervals not greater than 100 ft along the perimeter fence line. Provide a 4/0 AWG bare stranded copper conductor, exothermically welded to each ground rod and fence post.
- b. Ground Rod Installation. Ground rod material and installation parameters shall be in accordance with paragraph 4.4.4.1. If soil conditions will not permit installation of ground rods, provide ground dissipation plate(s) in accordance with paragraph 4.4.4.3.
- c. Fence Gate. Provide a 1-in. by 1/8-in. flexible tinned copper bond strap or an insulated 4/0 AWG flexible welding type copper conductor connected between the gate and adjacent fence post. Exothermic welding is recommended for these connections. Install the bonding strap between the gate and post so it will not limit full motion of a swing or slide gate.
- d. Fence Gate Post. Provide a ground rod adjacent to each gate post. Install a 4/0 AWG bare stranded copper conductor, exothermically welded to the ground rod and gate post. Locate the post connection at not greater than 1-ft above grade. Interconnect ground rods located between the gate opening with an exothermically welded 4/0 AWG bare copper conductor buried below frost depth, but not less than 18-in. below ground.
- e. Fence Gate Fabric. Provide a horizontal 6 AWG bare stranded tinned copper conductor threaded continuously through the gate fabric and mechanically bonded to the gate vertical support rails.
- f. Fence Security - Barbed Razor Wire. Bond security wires to the fence post using 6 AWG bare stranded tinned copper conductor and UL listed bonding connectors. Bond across terminations in the security wire using a short piece of the security wire material and UL listed bonding connectors at the same locations in 5.3.8.1 (a), (c), and (d).

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- g. Fence Wire Fabric - Chain Link. Attach metallic fence fabric to fence posts with wire ties of the same material.
- h. Proximity to a Facility EES. Portions of a fence that are located within 22 ft of a facility EES shall be bonded to that EES with a 4/0 AWG bare copper conductor exothermically welded to a fence post ground rod. Connections shall be made at a maximum spacing of 100 ft, with a minimum of two connections.

See Figure 18 for illustration of fence grounding installation methods.

5.3.8.1.1 Architectural Style Fences

Where architectural fences are installed, bond the nearest post with a two-hole hydraulically crimped lug to the ground rod. The security barbed razor wire bonding requirement does not apply to architectural fences.

5.3.8.2 Fences Crossed by Overhead Power Lines

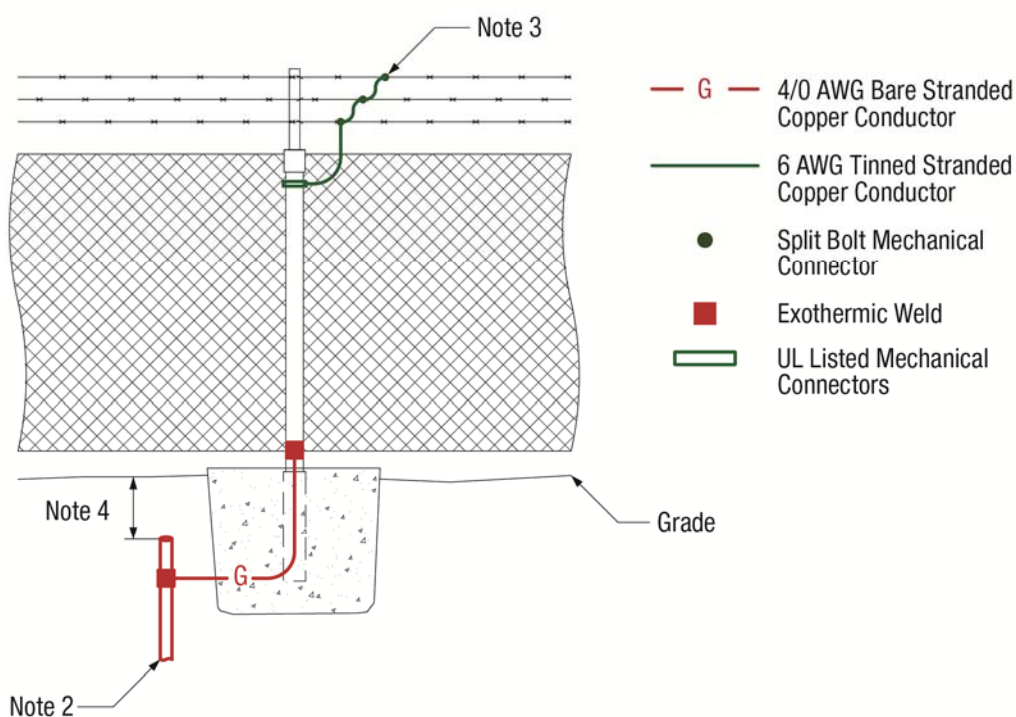
At locations where overhead power lines cross a fence, bond a fence post no more than 20 ft on each side of the crossing to a ground rod with a bare 4/0 AWG copper conductor. Bond the fence fabric at the top, middle, and bottom of the fence, and bond each strand of security wire placed above the fencing fabric to the grounded post with a bare 6 AWG tinned copper conductor. Where cross-bars or stranded wire is used to support the fence posts, bond the cross-bars or wire supports to the posts.

These connections shall be located 20 ft on side of the overhead power line crossing.

5.3.9 Lightning Protection for Photovoltaic Solar Arrays

Lightning protection for photovoltaic solar arrays shall be provided in accordance with NFPA-780.

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Illustrative Example: Chain Link Fence

Notes:

1. Diagram depicts elemental parts of a typical fencing grounding and bonding installation. Other architectural style fence configurations are possible.
2. Install 10 ft long by 3/4 in. diameter copper clad ground rods at all corners, gate posts, and at intervals not to exceed 100 feet. Exothermically weld each ground rod to the post.
3. Mechanically bond each strand of security wire to the fence post at all corners, gate posts, and at intervals not to exceed 100 feet.
4. 12 in. minimum below grade, but not less than frost depth.

Figure 18. Fence Grounding

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5.4 Facility Transient Protection – Special Conditions

5.4.1 General

This section describes additional design considerations for facility transient protection against induced currents from nearby, direct, or indirect lightning strikes. All metallic conduits, conductors, and cables in NAS operational facilities can be subject to currents induced by nearby lightning strikes. These induced effects can adversely affect the operation of sensitive electronic equipment.

5.4.2 Existing Metallic Conduit, Conductors, and Cables

Unless not approved by the facility manager, all unused conduits, conductors, and cables shall be removed.

For any remaining unused items, the voltage differential between ends shall be minimized by the following bonding methods:

- a. Unused Metallic Conduits. Metallic conduits shall be bonded to adjacent grounded metalwork at both ends. If not directly bonded, the connection shall use a minimum 6 AWG jumper not longer than 18 in.
- b. Unused Conductors and Cables. These conductors and cables shall be bonded to adjacent grounded metalwork at both ends. Multiple unused conductors shall be grouped together and bonded to the adjacent metalwork, directly or with a bonding jumper.

Exception. *Bonding is not required for unused conductors of a structured cable system and vertical risers installed for spare purposes for the following conditions:*

1. *Vertical cable risers are located no more than 50 ft from grounded metalwork.*
 2. *Cable circuit length totals are not more than 300 ft and do not pass between facilities.*
 3. *Cable circulating currents are present; installation of a SPD at one end of the cable may be used for this condition.*
- c. Cables With Shields. Unused shielded cables shall be bonded to adjacent grounded metalwork at both ends.

5.4.3 Electromagnetic Shielding for Lines, Conductors, and Cables

5.4.3.1 Facility Entrance Conduit

Direct routed conductors and cables, both buried or above ground, shall enter the facility through a minimum of 10-ft ferrous RGS conduit at the exterior face of the building. For above-ground conditions, provide a minimum 10-ft ferrous RGS conduit on the exterior face of the facility at the entrance point. Entrance conduits shall be bonded to the EES with a bare copper stranded conductor, 2 AWG minimum. This entrance conduit, if buried, shall extend a minimum of 5 ft beyond the EES. Entrance conduits can be bonded below or above grade.

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Exception. *Power feeders maintained by and installed to the requirements of the electric utility provider are exempt from the facility entrance RGS requirement.*

5.4.3.1.1 Above-Ground Conduit Entrance to Facility

At the conduit entrance point, a bonding connection shall be made either to the EES or to a bulkhead connector plate that is bonded to the EES in accordance with paragraph 5.4.3.2. If neither of these bonds is feasible, the bond shall be made to the main or supplemental multipoint ground plate. Provide a minimum 2 AWG stranded copper conductor using exothermic welds or UL-listed pressure connectors for this connection.

5.4.3.1.2 Conduit Joints and Fittings

Conduit joints and fittings shall be electrically continuous with bonding resistance of 5 mΩ or less between joined parts. Conduit enclosing signal, control, status, power, or other conductors to electronic equipment shall be terminated using conductive fittings to their respective junction boxes, equipment cabinets, enclosures, or other grounded metal structures.

5.4.3.2 Metal Bulkhead Connector Plates

A metal bulkhead connector plate shall be provided where overhead axial-type cables and waveguides enter the facility. The bulkhead connector plate shall be mounted on the outside surface of the facility or inside the facility within 2 ft of an exterior wall.

- a. **Bulkhead Plate Dimensions.** Ground plates shall be 1/4-in. thick copper or aluminum, and shall have the required number and type of feed-through connectors for axial cable terminations. Plates shall have adequate surface area for bonding all components, such as waveguides, cable shields, and conduits, plus at least two spare positions.
- b. **Bulkhead Plate Connections.** Provide either hydraulically crimped two-bolt-hole style terminal lugs or exothermic welds for conductor connections to the ground plate. Bonding jumpers shall be as short as possible.
- c. **Cable Shields.** Cable shields shall be bonded and grounded, except where the shield must be isolated for proper equipment operation. If external and internal cables are of different sizes, the changeover in cable size is permitted by feed-through connectors at the plate.

Bulkhead plates shall be bonded to the EES with a minimum 4/0 AWG copper cable, color-coded green with a red tracer. When the bulkhead connector plate is located within 6 ft of the building steel, the bulkhead plate shall be connected to the building steel with a 4/0 AWG insulated copper conductor, color-coded green with a red tracer. The building structural steel shall be bonded to the EES using exothermic welds.

Axial type cables, waveguides, and conduits that are not directly bonded to the EES shall be bonded to bulkhead plates with a minimum 6 AWG bonding jumper. The waveguide bonding cable can be connected to the bulkhead waveguide flange with a ring terminal specifically sized for the application. Conduits shall be bonded with a UL-listed U-bolt bonding connector. Axial cable shields shall be bonded with bonding kits sized for the specific cable type. Where SPDs are installed for axial cables, they shall be installed on the antenna or surge side of the metal

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bulkhead plate. The SPD ground bus bar shall not be connected to the lightning protection system.

Where a bulkhead plate is installed on top of an ATCT, then the ground conductor can be bonded to building steel as opposed to the EES. Reinforcing bars shall not be used in lieu of building steel.

Where a bulkhead plate is installed on top of a building or base building and the path is longer than a tenth of the difference between building steel and the EES (i.e. building steel is 5 feet away and the EES is more than 50 feet away), then the ground conductor can be bonded to building steel. Reinforcing bars shall not be used in lieu of building steel.

5.4.3.3 Facility External - Buried Power Cables and Conductors

Buried external power cables and conductors shall have magnetic shielding to prevent damage from coupling of transient currents due to lightning or other electrical sources. This shielding shall be provided by a ferrous metal sheath, ferrous armor, or ferrous RGS conduit.

Cables are permitted to be installed in metallic or nonmetallic conduit where permitted by the NEC. When a conduit is not used for installation of buried cables, the cables shall be identified for direct earth burial (DEB).

Ferrous shielding is recommended for portions of buried power cables and conductors located beyond 300 ft cable length from the facility entrance point. Facility entrance surge protection shall be in accordance with paragraph 4.6.2.1.

5.4.3.3.1 Armored DEB Cables

Steel armor is the preferred assembly for Armored DEB cables. DEB cable armor shall be bonded to the EES with a 2 AWG conductor prior to entry into a facility or where transitioning to conduit.

DEB cable armor shall also be bonded to the main or supplemental ground plate. If bonding to the main or supplemental multipoint ground plates is not feasible, the armor shall be bonded to the electrical ground bus located at the SDM.

If armor is continued to the electronic equipment, bond the cable armor to the equipment MPG plate.

When the electronic equipment is required to be isolated, bond the cable armor to the equipment SPG plate in accordance with section 5.5.

For initial cable installations, bond resistance shall be less than 5mΩ between joined parts. Complete cable replacement is not required if only a short length of the installation does not meet this requirement.

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5.4.3.3.2 Guard Wires

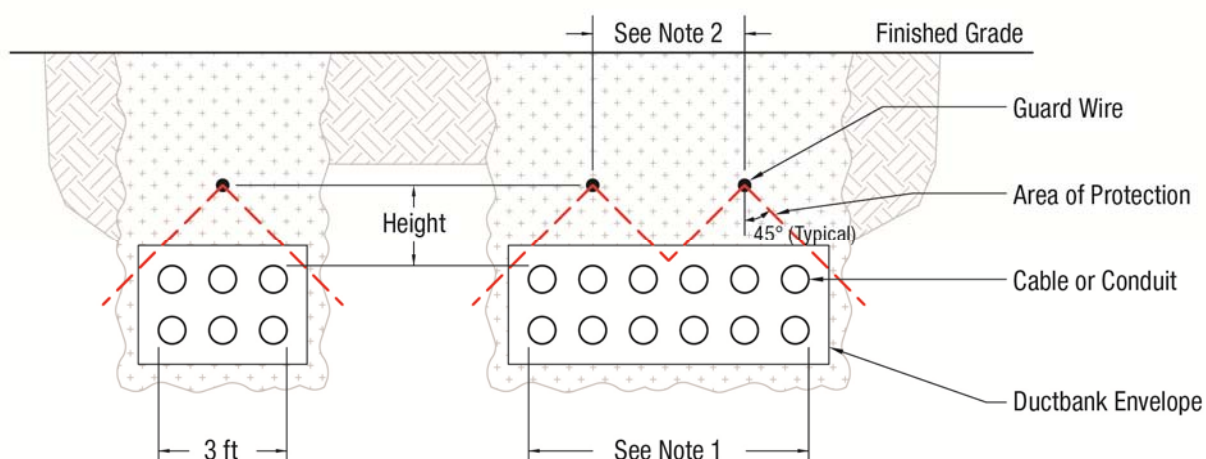
A 1/0 AWG bare copper stranded guard wire shall be provided for buried cables and conductors not routed in ferrous conduit, except as noted below.

Exception. *Guard wires are not required for penetration under runways, taxiways, or topographical features or for 15 kV concentric neutral power cables constructed in accordance with FAA-C-1391d, paragraphs 5.5.7 and 5.5.8. This exception does not apply to concrete-encased PVC duct bank with communication, data, or control cables or to spare ducts that do not contain a corrugated innerduct reserved exclusively for fiber optic cables.*

The guard wire shall be configured as follows:

- a. **Location.** The guard wire should be located at least 8 in. below the finished grade, at minimum height of 10 in. above the cable or cable ductbank, and shall run parallel to the cable or cable ductbank path that is being protected.
- b. **Number of Wires.** Provide one guard wire when the width of the cable ductbank is less than 3-ft wide. Provide additional parallel guard wire runs for cables or cable ductbanks wider than 3 ft, in accordance with the Area of Protection criteria. The guard wires should be spaced approximately 12-in. apart to provide an area of protection for the cable ductbank.
- c. **Area of Protection.** This is the protected area encompassed within a 45 degree zone on either side of the guard wire as illustrated in Figure 19.
- d. **Bonding to EES.** Guard wires shall be bonded to the EES at each end, and to ground rods located at approximately 90-ft intervals along the guard wire path using exothermic welds. The spacing between ground rods must vary by 10 to 20 percent to prevent resonance. Install the ground rods approximately 6 ft on either side of the ductbank trench.
- e. **Airfield Runway Lighting.** Where the cable or cable ductbank runs parallel to the edge of a runway, the ground rods shall be located at least 10 ft clear of the navigation lights in the direction of open available space away from the runway or lighting pathways.

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Notes:

1. Provide additional parallel guard wire runs for cables or cable ductbanks wider than 3 ft.
2. The spacing intervals between the center lines of the guard wires should not exceed twice the height distance between the guard wire and ductbank.

Figure 19. Buried Guard Wire Detail for Underground Cables or Cable Ductbanks

5.4.3.3.3 Buried Landlines

The preferred type of buried landline that represents best engineering practice is fiber optic type. Fiber optic cable does not require electromagnetic shielding and is exempt from these requirements.

Metallic buried landlines that carry NAS critical, essential, or mission support services to a facility shall have a ferrous shield or be enclosed in ferrous RGS conduit. Ferrous shielding is recommended for portions of these buried landlines located beyond 300-ft cable length from the facility entrance. Facility entrance surge protection shall be provided for these landlines in accordance with paragraph 4.6.3.

5.4.4 Balanced Pair Cables

When possible, shielded circuits should be provided for signal and control circuits routed external to electronic equipment. Balanced pair cables shall be two-conductor circuits.

5.4.5 Fiber Optic Cable

When possible, fiber optic cables should be used in lieu of metallic cables. Fiber optic cables are inherently not susceptible to electromagnetic interference (EMI) or the induction fields produced by lightning, and are not required to be installed in ferrous conduit or have conductive armor for shielding. The use of fiber optic cables without a conductive shield or armor is permitted. Suppression components are not required for fiber optic cables.

- a. Facility Entrance. The conductive armor of external fiber optic cables at the facility entrance point shall be bonded to the EES. Use 2 AWG bare copper conductor when bonding directly to the EES. When bonding connection to the EES uses an SPD, the

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SPD bonding conductor shall be a 4 AWG stranded copper conductor insulated green with an orange tracer.

- b. Facility Cabling. When the cable is internal to the facility and includes metallic electrically conductive sheaths or strength members, the sheaths shall be grounded to any SRS. When the electronic equipment is required to be isolated, bond the cable armor to the equipment SPG plate in accordance with section 5.5. To prevent circulating ground currents in the cable armor, an SPD located at one end of the cable may be used for grounding.
- c. Transmitter and Receiver Modules. Fiber optic transmitter and receiver modules shall be contained in ferrous enclosures and bonded to the nearest SRS. Penetrations of the equipment enclosures shall be gasketed or constructed to limit RF coupling. SPDs for the metallic signal and power circuits shall be installed as equipment level protection at the fiber optic receiver or transmitter equipment entrance, and bonded to the equipment enclosure chassis. The transmitter and receiver modules shall have 90 dB of attenuation against EMI.

5.4.6 Interior Wiring, Conductors, and Cables

Permanent single conductors, cables and wiring shall be in ferrous raceway systems, such as RGS conduit, intermediate metal conduit (IMC), electrical metallic tubing (EMT) conduit, cable tray, or wireway, except when prohibited by NEC. Flexible metal conduit (FMC) is permitted when installed in accordance with FAA-C-1217.

Cable tray systems comprising single rail or wire construction are permitted where the installation of conventional ladder cable tray is impractical, provided the cable tray system meets the following requirements:

- a. Suitable for use and classified by UL as an EGC.
- b. Installed in accordance with manufacturer instructions to maintain the UL classification.

5.4.6.1 Metal-Clad Cable - Type MC

Type MC cable is permitted when installed in accordance with FAA-C-1217 and where all of the following conditions are met:

- a. The MC cable shall include a steel armor of interlocking metal tape or sheath construction to form a ferrous magnetic exterior shield. MC cable with an aluminum exterior shield is prohibited.
- b. Both ends of the MC cable shall be terminated using UL-listed compression fittings recommended by the OPR of this document.
- c. The MC cable shall include a separate internal equipment grounding conductor or wire.

When MC cables are installed in MC cable tray, the following conditions shall be met:

- a. The MC cable shall be UL-listed and marked suitable for use in metallic cable tray (hereinafter referred to as MC cable tray).

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- b. The MC cable tray shall be used exclusively for MC cable and type UL-listed raceways for power distribution.
- c. The MC cable tray shall be separated from all other cable trays that transport non-axial communications, signal, and/or control cables or conductors by at least 12 in. The MC cable tray shall not carry more than 90 individual power branch circuits.
- d. The MC cable bend radius shall be in accordance with the NEC and cable manufacturer installation instructions, but not less than 8 in.

5.5 Single Point Ground System (SPG) – Special Conditions

5.5.1 General

An SPG shall be provided when required by the electronic equipment or requested by the electronic equipment vendor. FAA facilities that do not use single-point-ground equipment are not required to install an SPG. The SPG shall be isolated from the power grounding system, the lightning protection system, MPG, or SRGG and SRGP systems, except at the main ground plate. The SPG shall be terminated at the main ground plate or to the EES, whichever is closer. The SPG shall be configured to minimize conductor lengths. Conductive loops shall be avoided by maintaining a trunk and branch arrangement as shown in Figure 20.

5.5.2 Isolation between SPG and Other SRS Systems

The minimum resistance between the SPG and the MPG, SRGG, or SRGP systems shall be 10 MΩ. The resistance shall be measured after the complete network is installed and before connection to the EES or SRS system at the main ground plate.

5.5.3 Resistance of Bonds

The maximum resistance of a bond connection from a conductor to a ground plate shall not be greater than 1 mΩ.

5.5.4 SPG - Ground Plates

Main, branch, and feeder ground plates shall be copper and at least 4 in. wide and 1/4 in. thick. The plates shall be mounted to nonconductive material of sufficient cross-section to rigidly support the plates after all conductors are connected. Bolts or other devices used to secure the plates in place shall be insulated or shall be of a nonconducting material. The plates shall be mounted in a manner that provides ready accessibility for inspection and maintenance.

See Table 4 for the single ground plate installation requirements.

5.5.5 SPG - Ground Conductors

Ground conductors shall be insulated copper conductors color-coded green with a yellow tracer.

5.5.5.1 Main SPG Conductor

Where an SPG is established directly from the EES, the SPG main conductor shall be an insulated 500 kcmil copper conductor not exceeding 50 ft in length. The main ground conductor shall be connected to the EES by an exothermic weld in accordance with paragraph 4.2.3.1.

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5.5.5.2 Trunk and Branch Ground Conductors

Provide an insulated trunk ground conductor to interconnect all branch ground plates to the main ground plate as illustrated in Figure 20. Provide insulated copper branch ground conductors to interconnect feeder plates to branch ground plates. Conductor insulation shall be green with yellow tracer. Trunk and branch conductors shall be connected to ground plates by exothermic welds or UL-listed double-bolted connections in accordance with paragraph 4.2.3.4, and shall be mounted as shown on the facility drawings.

Trunk and branch conductors shall be routed using the shortest possible path.

- a. Conductors Shorter than 400 ft. Trunk conductors shall be 4/0 AWG insulated copper conductors where the conductor length to the farthest feeder plate in the system is no more than 400 ft from the EES via the conductor runs.
- b. Conductors Longer than 400 ft. For longer runs, select a conductor size to provide a cross-sectional area of 500 cmil per linear foot of conductor, but in no case that the conductor is smaller than 250 kmil.

5.5.5.3 Electronic Equipment SPG Conductors

The conductor from the feeder ground plate (branch ground plate when there are no feeder ground plates in the conductor run) shall be connected to the isolated ground terminal or bus on the electronic equipment. This conductor shall be sized in accordance with Table 3.

5.5.5.4 Interconnections

Connections to the SPG shall be made on ground plates or buses. Split bolts and other connections to existing conductors are not allowed.

5.5.6 Labeling

The SPG shall be clearly labeled to preserve its identity as described in the following paragraphs.

5.5.6.1 Conductor Identification

SPG conductors shall be labeled in accordance with paragraph 4.7.3.1.6.

5.5.6.2 Ground Plate Labeling

Ground plates shall be installed according to Table 4.

5.5.7 Protection

Provide protection for conductors in the SPG subject to physical damage by use of conduit, floor trenches, routing behind permanent structural members, or other approved means. Single-point ground conductors shall be isolated from contact with any metal elements.

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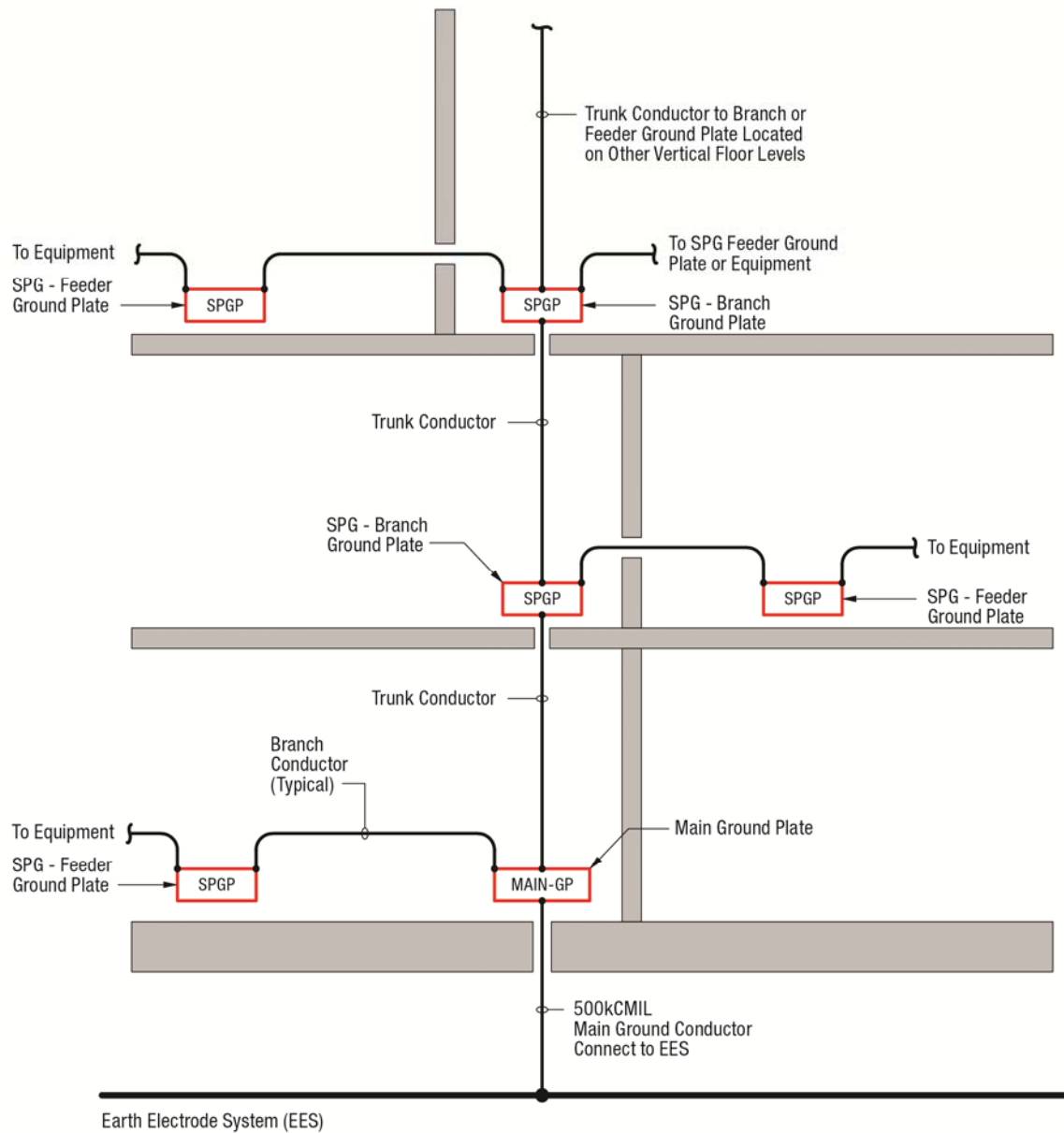


Figure 20. Single-Point Ground System Installation – Illustrative Example

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5.6 NAS Electronic Equipment – Interface and Procurement Requirements**5.6.1 General**

This section provides detailed performance and interface requirements for installation and procurement of NAS electronic equipment. Electronic equipment installed in NAS facilities shall comply with the requirements herein that address the following:

- a. Electronic Signal Lines and Cables – Shielding
- b. Signal, Control, and Data Line Entrance – Transient Protection
- c. Equipment Power Entrance – Transient Protection
- d. Electronic Equipment – Grounding and Bonding
- e. Equipment – Signal Grounding and Bonding
- f. Equipment Shielding Requirements
- g. Circuit and Equipment ESD Design Requirements

5.6.2 Electronic Signal Lines and Cables - Shielding

Electronic signal lines shall be shielded twisted pairs with an insulated covering. Cables consisting of multiple twisted pairs shall have the individual shields isolated from each other. Cables shall have an overall shield with an overall insulated covering.

5.6.2.1 Electronic Signal Return Path

The electronic signal return path shall be routed with the circuit conductor. For axial circuits, the shield serves this purpose. The electronic equipment case and SRS shall not be used as a signal return conductor.

5.6.2.2 Termination of Individual Shields

Termination of individual shields shall be in accordance with paragraph 4.8.3.2.

5.6.2.3 Termination of Overall Shields

Termination of overall shields shall be in accordance with paragraph 4.8.3.3.

5.6.3 Signal, Control, and Data Line Entrance – Transient Protection

Procurement organizations are responsible for ensuring that electronic equipment, such as radars, NAVAIDS, and transmitters shall be provided with transient protection to reduce surges and transients to below the equipment transient susceptibility level. Signal, control, data line, and antenna cabling entrance transient protection shall be provided at the facility entrance point and at electronic equipment. Equipment SPDs shall be an integral part of the equipment, installed either internally or on the exterior of the equipment. Coordination of these protectors shall be addressed and completed in the system design stage and should not be delegated to field personnel during construction.

Equipment susceptibility level is defined as the transient level on the signal, control, or data lines that cause damage, degradation, or upset to electronic circuitry connected to the line. Transient protection for these lines is in addition to the facility transient protection levels specified in

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paragraphs 5.7.2 through 5.7.4. Procurement organizations are responsible for ensuring that testing is performed to establish voltage, current, and energy levels that will damage components, shorten operating life, or cause operational upset to the equipment. These tests shall include electrical and electronic equipment components exposed to the effects of surges or transients.

The procurement organization shall ensure that facility and electronic equipment entrance transient protection is coordinated to limit transients at the equipment to below the equipment susceptibility level. Requirements of this paragraph shall be included in the comprehensive control and test plans included in paragraph 5.9.2. The following characteristics shall be evaluated:

- a. Component Damage Threshold. The component damage threshold is the transient level that renders the component nonfunctional or operationally deficient. Voltage is usually the relevant parameter for solid-state components.
- b. Component Degradation Level. The component degradation level is the transient voltage or energy level that shortens the useful life of the component.
- c. Operational Upset Level. The operational upset level is the transient voltage or energy level that causes an unacceptable change in operating characteristics for longer than 10 milliseconds for analog equipment or a change of logic state for digital equipment.

5.6.3.1 Lines and Cables Requiring Protection

Surge protective devices shall be placed on both ends of signal, data, antenna, and control lines and cables longer than 10 ft where connecting pieces of electronic equipment are not located and bonded to the same SRS, or where the SRS ground system is located in different rooms or on different building floor levels, as illustrated in Figure 21. Electronic equipment shall be protected as specified in paragraph 5.6.3.

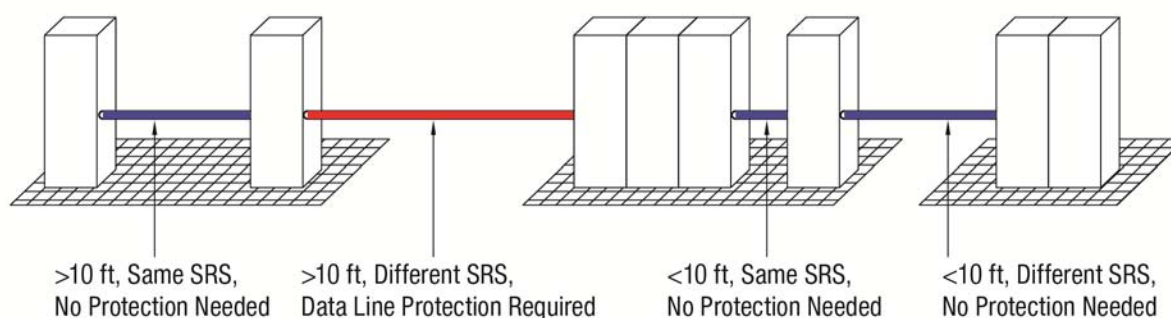


Figure 21. Lines and Cables Requiring Protection

5.6.4 Equipment Power Entrance – Transient Protection

SPDs, components, or circuits for the protection of electronic equipment power lines shall be provided by the equipment manufacturer as an integral part of electronic equipment mounted internally or on the exterior of the equipment at the cable entrance point. These devices shall be located at the ac power conductor entrance to electronic equipment housed in a shielded,

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compartmentalized enclosure. SPDs at equipment shall provide a clamping level less than the equipment operational upset susceptibility level as defined in paragraph 5.6.3c and shall conform to Table 8, Table 9, and Table 10.

- a. Maximum Continuous Operating Voltage (MCOV). The MCOV is the maximum rms voltage an SPD can withstand while operating continuously at maximum temperature without degradation or change to any of its parameters greater than +/-10 percent. The MCOV shall be at least 10 percent above the nominal system voltage, and leakage current, as defined below, shall not be exceeded.
- b. Leakage Current. The dc leakage current shall be less than 1 mA for voltages at or below the dc voltage value of $1.414 \times \text{MCOV}$.
- c. Clamping Discharge Voltage (CDV). The CDV is the maximum voltage that appears across an SPD output terminal while conducting surge currents. To ensure performance in the linear region without impacting the device lifetime performance, the CDV values measured at 3 kA for an 8/20 μs current impulse waveform shall not change more than 10 percent over the operating life of the SPD as defined in Table 10.
- d. Overshoot Voltage. Overshoot voltage is the surge voltage level that appears across the SPD terminals before the device turns on and clamps the surge to the specified voltage level. Overshoot voltage shall not exceed two times the SPD clamping voltage for more than 10 ns.
- e. Self-restoring Capability. The SPD shall automatically return to its off state after surge dissipation when line voltage returns to normal.
- f. Operating Lifetime. The SPD shall safely dissipate the number and amplitude of surges listed in Table 10.
- g. Fusing. The SPD overcurrent protection shall not increase the clamp voltage of the SPD and shall pass the surge current levels listed in Table 10 up to the 20 kA level without opening. Fusing shall be coordinated with the power source overcurrent protection scheme.

5.6.4.1 Slope Resistance

The purpose of this parameter is to establish a system that ensures SPD device coordination for equipment protection. The slope resistance R_{slope} , as calculated by the formula below, shall comply with Table 8:

$$R_{\text{slope}} = (V_{10} - V_1)/9000$$

Where V_{10} is the clamping voltage measured at 10 kA for an 8/20 μs waveform and V_1 is the clamping voltage measured at 1 kA for an 8/20 μs waveform.

The values of V_{10} and V_1 shall be based on actual measured values of SPD performance testing and not calculated values.

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Table 8. Electronic Equipment Power Entrance SPD - Slope Resistance (R_{slope})

Location	Slope Resistance Value
Electronic equipment power entrance	60 m Ω minimum

5.6.4.2 SPD Voltage Protection Rating - V_3

SPD voltage protection rating shall be based on actual measured values of SPD performance testing and not calculated values. Voltages to be achieved during testing at 3 kA for an 8/20 μ s current impulse waveform are shown in Table 9. All voltages shall be measured at the device terminals. The 8/20 μ s waveform shall not lead or lag the voltage waveform by more than 30 degrees.

Table 9. Electronic Equipment Power Entrance SPD - Voltage Protection Rating (V_3)

Location	System Voltage (V)	SPD Voltage Protection Rating (V_3 per mode)	Limit
Electronic equipment power entrance	120/208 or 120/240	550 L-N, L-G 850 L-L	Minimum
	277/480	850 L-N, L-G 1350 L-L	Minimum
	380 Delta	1350 L-L, L-G	Minimum
	480 Delta	1350 L-L, L-G	Minimum

Table 10. Electronic Equipment Power Entrance SPD – Surge Current Lifetime Rating

Surge Current Level Amplitude with an 8/20 μ s Waveform (see note 1) (kA)	Number of Surges Lifetime
1	100
10	25
20	1
Note: 1. Each level of surge current and the number of lifetime surges required represents a single lifetime of the SPD.	

5.6.4.3 Electronic Equipment dc Power Supplies – Transient Protection

Procurement organizations are responsible for ensuring that equipment power supplies that use 60 Hz power to derive dc operating voltages for solid-state electronic equipment supporting the NAS shall have transient suppression components installed for each power supply output line. The suppression components shall be bonded to the protection equipment chassis. The chassis side of the suppressor enclosure shall be bonded to the rectifier output ground connection. The

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suppressor should be located as close as possible to the rectifier grounding connection. Suppression components for power supply's rectifier output lines shall comply with following operating characteristics:

- a. Operating Lifetime. Transient suppressors shall safely dissipate 1,000 surges at 200 A amplitude for a 1.2/50 μ s current impulse waveform. Methods of testing shall be in accordance with the guidance in IEEE C62.45.
- b. Limiting Voltage. Voltage shall be limited to a point 20 percent below the maximum peak inverse voltage (PIV) of the dc rectifier.

5.6.5 NAS Electronic Equipment Enclosures and Assemblies - Grounding and Bonding

Bonding connections for electronic equipment enclosures and assemblies shall be prepared and completed in accordance with the installation conditions and requirements provided herein.

5.6.5.1 Electronic Equipment Cabinets, Racks, and Cases

Cabinets, racks, and cases shall be provided with a grounding terminal or bus assembly whereby a bonding jumper or wire can be mechanically connected through an electrically conductive surface to the chassis frame. The metal enclosure of each individual unit or piece of electronic equipment shall be bonded to its cabinet, rack, or directly to the SRS or MPG system.

5.6.5.2 Equipment Enclosures - Isolated Grounding Receptacles

Isolated receptacles installed in accordance with the NEC are permitted for reduction of electrical noise. Isolated EGCs used for these receptacles shall be color-coded green with red and yellow tracers at each termination, and where passing through an enclosure without termination.

5.6.5.3 Portable Equipment (with Grounding Conductor)

Portable electrical or electronic equipment cases, enclosures, and housings shall be considered to be effectively grounded for fault protection through the EGC of the power cord, if positive continuity is provided between the case, enclosure or housing, and the receptacle ground terminal. The power cord EGC shall not be used for signal grounding.

5.6.5.4 Alternating Current Power Filters

Filter cases shall be bonded directly to the equipment case or enclosure in accordance with paragraph 5.6.5.5. Filter leakage current shall not exceed 5 mA per filter. Transient suppression devices, components, or circuits shall be installed in accordance with paragraph 4.6.3.

5.6.5.5 Electronic Equipment Enclosure Bonding

Where subassemblies and equipment are in physical contact with the equipment enclosure, they shall be bonded directly with the enclosure and mounting surfaces.

5.6.5.5.1 Enclosure Subassemblies for Equipment Mounting

Use the maximum possible contact area when bonding subassemblies to the equipment chassis. Raceway penetrations, filters, and connectors shall be bonded at the periphery to the subassembly enclosure to maintain shield effectiveness. Enclosure covers and mounting trim

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shall be securely fastened to the enclosure. COTS equipment is considered a sealed unit and does not require additional internal bonding for the purposes of this requirement.

5.6.5.5.2 Electronic Equipment

The equipment chassis components shall be bonded together and directly to the rack, frame, or cabinet to which they are mounted. Clean flange surfaces and the bonding contact surface in accordance with paragraph 4.2.4.1. Fasteners shall maintain sufficient pressure to ensure surface contact to meet the bond resistance requirements in paragraph 4.2.1.1. Captive nuts, sheet metal screws, and tapping screws shall not be used for fasteners. If equipment operation is necessary when partially or completely withdrawn from its mounted position, the bond shall be maintained by an effective area of direct metal-to-metal contact or by the use of a flexible bonding strap. Mechanical designs shall employ direct bonding, without bonding jumpers, whenever possible.

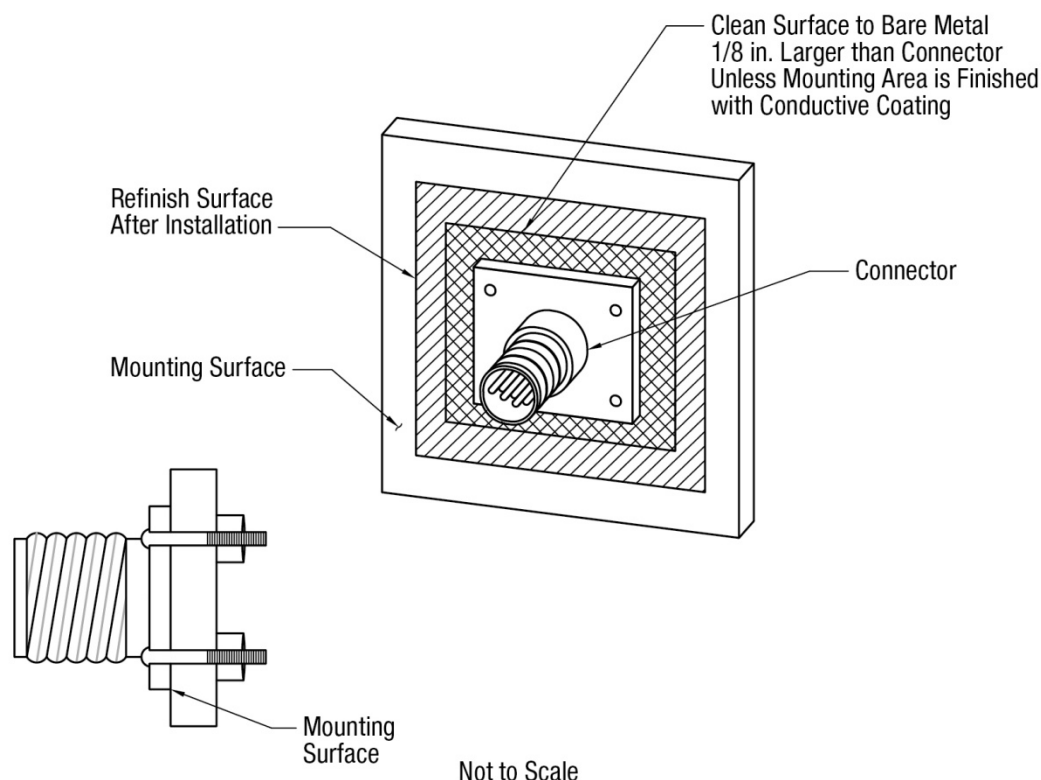
Exception. Self-drilling (tapping) metal screws are permitted to make a physical connection between metal back panels within equipment cabinet/enclosures for conditions where equipment access is not available to the opposite side of the bond connection.

5.6.5.5.3 Connector Mounting

Connectors shall be mounted so that electrical contact is maintained between the connector body and the metal mounting panel. The connector flange shall be fastened to equipment enclosure to ensure direct contact between components for effective bonding. The connector flange surface and the enclosure contact area shall be cleaned in accordance with paragraph 4.2.4.1.

Nonconductive material shall be removed from the contact area as illustrated on Figure 22. After mounting each connector, the completed bond shall be sealed and finished for corrosion protection in accordance with paragraph 4.2.4.3.

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Notes:

1. The connection detail depicts an illustrative example and is exaggerated for clarity.

Figure 22. Bonding of Connectors to Mounting Surface

5.6.5.5.4 Shield Terminations

Cable shields shall be terminated in accordance with paragraphs 4.8.3.2 and 4.8.3.3. Axial cable shields shall be fastened to the cable connector shell with a compression fitting. A soldered connection is permitted to improve conductivity of the shielding joints in accordance with paragraph 4.2.3f. The cable shall withstand the anticipated use without degradation in shielding efficiency performance. Axial cable connectors shall be corrosion resistant in accordance with FAA-G-2100. Low frequency shields shall be soldered in place or, if solderless terminals are used, the compressed fitting shall afford maximum contact between the shield and the terminal sleeve. The cable shield casing shall be exposed less than 1 in. from the internal conductors of the cable as illustrated in Figure 13.

5.6.5.5.5 RF Gaskets

Conductive gaskets shall be corrosion resistant, electrically conductive to meet the resistance requirements of paragraph 4.2.1.1, and resilient to ensure the shielding effectiveness of the bond. Surfaces in contact with the gasket shall be smooth and free of insulating films, corrosion, moisture, and paint. The gasket shall be firmly affixed to the bonding surface by conductive cement and screw fasteners, a milled slot or other means that do not interfere with the effectiveness of the gasket. These methods shall prevent lateral movement or dislodging of the

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gasket when the bond is disassembled. Gaskets shall be a minimum of 1/8-in. wide. The gasket and the contact surfaces shall be protected from corrosion.

5.6.6 NAS Electronic Equipment – Equipment Grounding and Bonding

5.6.6.1 Equipment Input and Output Electronic Signals

If a common signal reference is used, low-frequency analog input and output signals shall be balanced with respect to the signal reference. Maintain complete isolation between the SPG and the MPG, SRGG or SRGP system, except at the main ground plate or EES.

5.6.6.2 Multipoint Grounding of Electronic Equipment

Where permitted by circuit design requirements, internal ground references shall be bonded directly to the chassis and the equipment case. Where mounted in a rack, cabinet, or enclosure, the electronic equipment case shall be bonded to the racks, cabinet, or enclosure in accordance with paragraph 5.6.5.1. The dc resistance between any two points within a chassis or electronic equipment cabinet serving as ground shall be less than 25 mΩ total and not more than 2.5 mΩ per joint. Shields shall be provided where required for personnel protection and EMI reduction.

5.6.6.2.1 Prevention of Resonance in Bonding Straps

Due to resonance from a single bonding strap, two widely spaced straps of unequal length shall be used to connect equipment to the multipoint grounding bus in the equipment cabinet. Bonding connections shall be as short as possible and sized in accordance with Table 3.

5.6.6.3 Single-Point Grounding of Electronic Equipment

If electronic equipment performance necessitates an isolated SPG system for proper operation, then equipment and installation shall comply with the following:

- a. SPG System. The SPG or plane shall be isolated from the electronic equipment case. If a metal chassis is used as the SPG, the chassis shall be floated relative to the case. The SPG system shall be designed such that electronic equipment SPG may be interfaced with other electronic equipment without compromising the system. Provide filtering if this SPG is required to be isolated from high frequencies.
- b. SPG Conductor and Plate System. The system shall not form a conductive ground loop and it should be set up as a signal drain.

5.6.6.3.1 Single-Point Isolation of Input and Output Signal Requirements

The “high” and “low” sides of input and output signals shall be isolated from the electronic equipment case and balanced with respect to the signal reference. Operating and adjusting controls, readouts, indicating devices, protective devices, monitoring jacks, and signal connectors shall be designed to isolate both the high and low side of the signal from the case.

5.6.6.3.2 Single-Point Isolation of Case Requirements

The isolation between the SPG terminals and the case shall be 10 MΩ or greater with external power, signal, and control lines disconnected from the electronic equipment.

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5.6.6.3.3 Equipment Power Input Isolation Requirements

The isolation between the SPG terminal and each power conductor (including ac neutral) shall be 10 MΩ or greater with the equipment power switch in the “on” position and the equipment disconnected from its power source.

5.6.6.3.4 Equipment Single-Point Ground Terminals

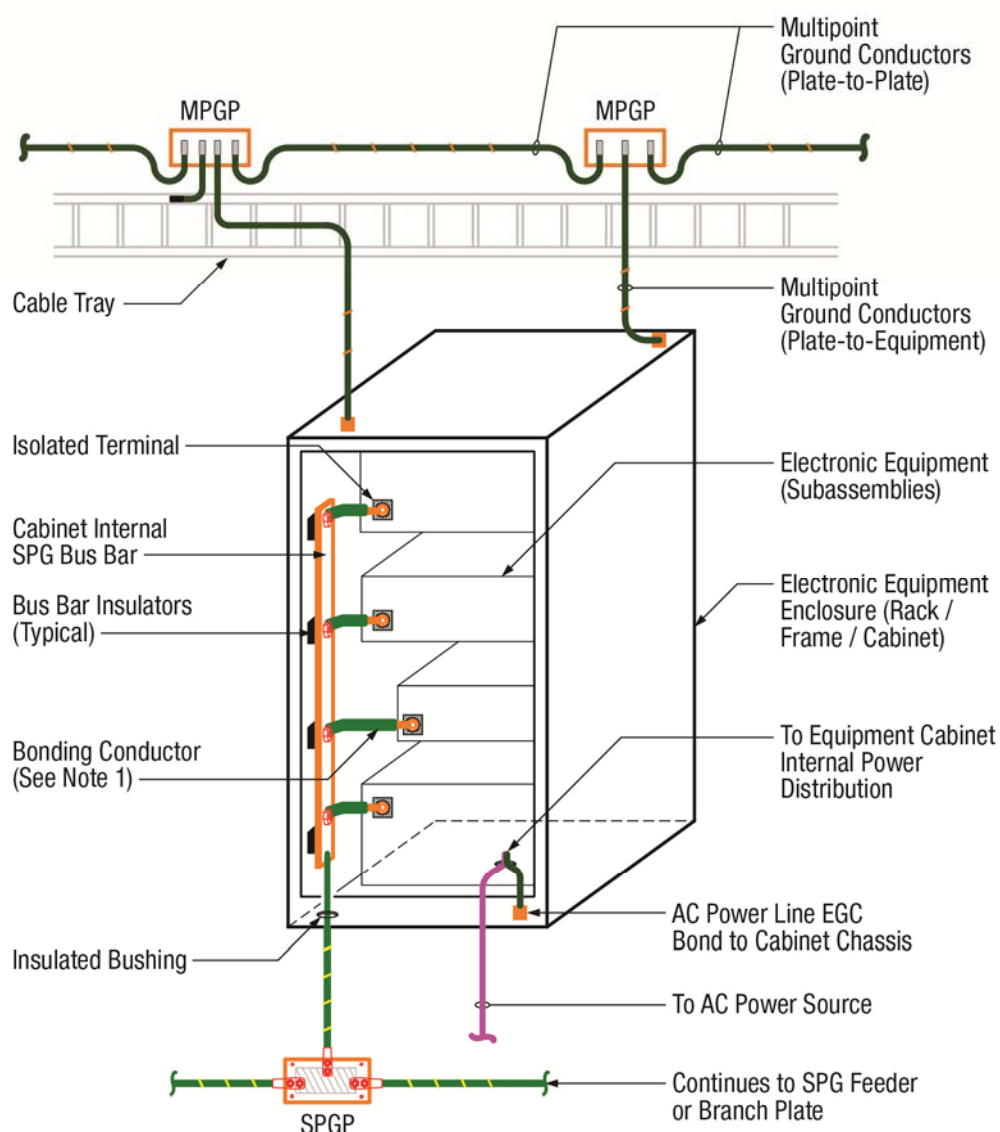
An insulated SPG terminal shall be provided on each electronic equipment case where an isolated signal reference is required. The SPG reference for the internal circuits shall be connected to the SPG terminal. This terminal shall be used to terminate cable shields as appropriate, and to connect the isolated signal ground of the electronic equipment to the SPG in the facility. A connector pin, screw, terminal strip, insulated stud, jack or feed-through, or an insulated wire are acceptable terminations if each terminal is clearly marked, labeled, or coded in a manner that does not interfere with its function. These marks, codes, or labels shall be permanently affixed and use green identification with yellow stripes. Wire insulation shall be green with a yellow tracer.

5.6.6.3.5 Connection of Electronic Equipment to the SPG

Each equipment SPG terminal shall be connected to the facility SPG in accordance with the following:

- a. Individually Mounted Equipment. Individual units or pieces of electronic equipment that should not be mounted with other electronic equipment due to their location or function shall have an insulated copper conductor bonded from SPG terminal as specified in paragraph 5.6.6.3.4 to the nearest SPG system. This conductor shall be sized in accordance with Table 3.
- b. SPG Bus Bar. If two or more units or pieces of electronic equipment are mounted together in a rack or cabinet, then a single-point ground bus bar shall be installed as shown in Figure 23. The bus bar shall be copper and shall provide a minimum cross-sectional area of 125,000 cmils, e.g., a 1x1/8-in. bus bar. The bus bar shall be drilled and tapped for No. 10 screws, and the holes shall be located as required by the relative location of the isolated SPG terminals on the electronic equipment. The bus bar shall be mounted on insulating supports that provide at least 10 MΩ resistance between the bus bar and the rack or cabinet.
- c. Interconnecting SPG Terminals to SPG Bus Bar. Each electronic equipment isolated SPG terminal shall be interconnected to the SPG bus bar by means of a solid conductor of sufficient cross-sectional area to provide a maximum resistance of 5 mΩ, or a flexible tinned copper bond jumper sized in accordance with Table 3. The bond jumper shall be insulated or mounted in such a manner to maintain the required degree of isolation between the reference conductor and the enclosure. The bond jumper shall be connected to the equipment SPG bus bar at a point nearest the equipment SPG terminal in order to minimize the conductor length. An insulated copper conductor shall be installed from the equipment SPG bus bar to the nearest SPG grounding system as illustrated in Figure 23.

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Note:

1. The conductor wire size for bonding conductors from electronic equipment to internal cabinet SPG bus bar shall be based on Table 3.

Figure 23. Single Point Ground Bus Bar Installation in Rack or Cabinet

5.6.7 Equipment Shielding Requirements

5.6.7.1 Control of Apertures

Unnecessary apertures shall be avoided. Only those shield openings required to achieve proper functioning and operation of the equipment may be provided. Controls, switches, and fuse holders shall be mounted such that metal-to-metal contact is maintained between the cover housing of the devices and the case. Metal control shafts shall be grounded in accordance with

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paragraph 5.6.7.2. Close-fitting metal sleeves peripherally bonded to the case shall be provided only where nonconductive control shafts are necessary. The length of the sleeve shall be no less than four times its diameter. Lights shall be filtered or shielded as needed to maintain the required degree of shielding effectiveness. Openings provided for enclosure ventilation and moisture drainage shall be configured to maintain the effectiveness of the overall enclosure shielding.

5.6.7.2 Metal Control Shafts

Metal control shafts shall be grounded to equipment cases through a low impedance path provided by close-fitting conductive gaskets, metal finger stock, or grounding nuts.

5.6.7.3 Shielded Compartments

Shields shall be bonded to the chassis for fault protection in accordance with section 4.2.

5.6.7.4 Gaskets for Shielding Systems

Conductive gaskets conforming to paragraph 5.6.5.5 may be provided at joints, seams, access covers, removable partitions, and other shield discontinuities to the extent necessary to provide interference-free operation of the equipment under normal use and environmental conditions. Finger stock used on doors, covers, or other closures subject to frequent openings shall be installed in a manner that permits routine cleaning and maintenance.

5.6.7.5 Filter Integration

Filters on power, control, and signal lines shall be installed in a manner that maintains the integrity of the shield. Alternating current power filters shall be shielded completely with the filter case grounded in accordance with paragraph 5.6.5.4. Filters for control and signal lines shall be placed as close as possible to the point of penetration of the case to avoid long, unprotected paths inside the equipment.

5.6.8 NAS Electronic Equipment - Electrostatic Discharge Protection

ESD protection shall be provided in accordance with section 5.8.

- a. Equipment Circuit Design and Layout. The design, layout, and packaging of assemblies, circuits, and components integrated into electrical and electronic equipment shall incorporate methods and techniques to reduce susceptibility to ESD.
- b. Component Protection. External protection shall be provided for integrated circuits, discrete components, and other parts not having internal ESD protection that are inherently susceptible to ESD. Protective components shall be installed as close as possible to the ESD susceptible item.
- c. ESD Withstand Requirements. In the installed and operational configuration equipment such as cabinets, enclosures, racks, controls, meters, displays, test points, and interfaces shall withstand a static discharge of 15,000 V in accordance with ANSI/ESDA/JEDEC JS-001, Standard for ESD Sensitivity Testing – Human Body Model (HBM). To successfully pass ESD testing requirements, the tested equipment shall not incur any operational upset, component, or assembly damage.

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5.6.9 Secure Facilities

In areas of facilities required to maintain communications security, equipment and power systems shall be grounded in accordance with NACSIM-5203 and MIL-HDBK-232A.

5.6.10 High RF Field Bonding Requirements

FAA facilities that are located in proximity to other facilities that generate high RF levels need additional shielding to protect personnel and sensitive equipment from these external RF sources. When a determination is made that the signal level is sufficient to cause concern, incorporate the following requirements:

Metal building components and attachments such as walls, roofs, floors, door and window frames, gratings and other metallic architectural features shall be bonded directly to structural steel or to reinforcing bar if structural steel is not present. Where direct bonding is not possible, indirect bonds with copper conductor shall be used. Removable or adjustable parts and objects shall be grounded with an appropriate type bond strap. Metal building components with a maximum dimension of 3 ft or less are exempt from the requirements of this paragraph.

5.7 Surge Protective Device (SPD) – Equipment Specification Requirements**5.7.1 General**

This section provides SPD performance requirements.

5.7.2 Surge Protective Device (SPD) for Power Distribution Equipment Protection

The SPD installation shall comply with the following:

- a. Application Listing. The SPD shall be listed in accordance with the latest UL 1449 Standard for SPDs.
- b. Integral Unit Mounted Assemblies. Panelboards and switchgear equipment with integral unit mounted SPD enclosures are permitted if the SPD and panelboard or switchgear integrated components are UL listed and recognized as an assembly.
- c. Enclosure Rating. The SPD components shall be housed in a single steel enclosure, and classified by NEMA as type-12 for indoor use, or type-4 for indoor or outdoor use.
- d. Enclosure Door Hardware. The enclosure door shall be hinged and electrically bonded with a bonding jumper connected to the enclosure. The internal components of the SPD, such as fusing, indicator lights, wiring, and protection elements, shall be accessible for inspection and replacement. The manufacturer's installation and maintenance instructions shall be provided with each SPD unit.
- e. SPD Accessories. Indicator lamps shall be provided for each power phase on the SPD enclosure cover. The lamps shall indicate visually the normal condition when power is applied to the SPD with the component fusing intact. Lamps shall be provided at a minimum service life of 50,000 hours, otherwise two lamps per phase shall be provided.
- f. Potting Material. The SPD enclosure shall be sealed at the power entry points with potting material in accordance with paragraph 4.6.2.3. The use of potting material within SPD components is prohibited, such that all SPD components are accessible at

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all times for visual inspection, evaluation, maintenance, or replacement by qualified FAA personnel.

- g. Conductor Terminations. Provide heavy-duty screw terminal studs or lugs for input and output conductor connections. The SPD phase and neutral terminals, when not connected, shall be electrically isolated from the enclosure by a minimum of 10 MΩ resistance measured at 100 Vdc.

5.7.2.1 SPD - Operational Requirements

The SPD equipment performance shall conform to Table 11, Table 12, and Table 13, and the following parameters:

- a. Maximum Continuous Operating Voltage. The MCOV is the maximum rms voltage an SPD can withstand while operating continuously at maximum temperature without degradation or change to any of its parameters greater than +/-10 percent. The MCOV shall be at least 10 percent above the nominal system voltage. Leakage current, as defined below, shall not be exceeded.
- b. Leakage Current. The dc leakage current shall be less than 1 mA for voltages at or below the dc voltage value of $1.414 \times \text{MCOV}$.
- c. Clamping Discharge Voltage. The CDV is the maximum voltage that appears across an SPD output terminal while conducting surge currents. To ensure performance in the linear region without impacting the device's lifetime performance, the CDV values measured at 3 kA for an 8/20 μs current impulse waveform shall not change more than 10 percent over the operating life of the SPD as defined in Table 11.
- d. Overshoot Voltage. Overshoot voltage is the surge voltage level that appears across the SPD terminals before the device turns on and clamps the surge to the specified voltage level. Overshoot voltage shall not exceed two times the SPD clamping voltage for more than 10 ns.
- e. Self-restoring Capability. The SPD shall automatically return to its off state after surge dissipation when line voltage returns to normal.
- f. Operating Lifetime. The SPD shall safely dissipate the number and amplitude of surges listed in Table 11.
- g. In-line Inductors. In-line inductance is not permitted, except from the inductance normally created by the power connection conductors.
- h. Overcurrent Protection. Fuses or circuit breakers that are part of an SPD installation shall be able to pass the surge currents specified in Table 11 without opening.
- i. Short Circuit Current Rating. The SPD short circuit current rating shall be greater than the power distribution system available short circuit current where the equipment is applied in the power distribution system.

5.7.2.1.1 SPD Equipment Performance Data - Surge Current Levels

Table 11 defines the line-to-ground, line-to-neutral, neutral-to-ground, and line-to-line surge current values, and number of surge occurrences for ac power distribution SPD equipment operating below 600 V. In this table, the 8/20 μs waveform defines a transient reaching peak

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value in 8 μ s and decaying to 50 percent of peak value 20 μ s after inception. These devices shall be able to tolerate surges of shorter duration without malfunction.

The following performance change measurements define SPD device failure modes. For the listed parameters, the clamping voltages for each device and assembly are measured at 1 kA and 10 kA for an 8/20 μ s current impulse waveform.

- a. Change in Clamping Voltage. Any change greater than 10 percent in the 8/20 μ s clamping voltage at 3 kA during service or when the pre-life service test and post-life or in-service test results are compared is a device failure. The pre-life test value shall be taken as the 100 percent value.
- b. Change in rms Voltage. Any change greater than 10 percent in the rms voltage required to drive 1 mA of rms current through the device when the pre-life service test and post-life or in-service test results are compared is a device failure. The pre-life test value will be taken as the 100 percent value.
- c. Change in dc Voltage. Any change greater than 10 percent in the dc voltage required to drive 1 mA dc through the device when the pre-life service test and the post-life or in-service test results are compared is a device failure. The pre-life test value will be taken as the 100 percent value.

Table 11. Power Distribution Equipment SPD – Surge Current Lifetime Rating

Surge Current Level Amplitude with an 8/20 μ s Waveform, See Note 1 (kA)	Number of Surges Lifetime for Any Facility Entrance SPD	Number of Surges Lifetime for Feeder and Branch Panelboard SPDs
10	1500	1000
20	700	500
30	375	250
40	50	25
50	8	1
60	6	N/A
70	4	N/A
100	2	N/A
200	1	N/A
Table Note: 1. Each level of surge current and the number of lifetime surges required represents a single lifetime of the SPD.		

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5.7.2.1.2 SPD - Slope Resistance

The purpose of this parameter is to establish a system that ensures SPD device coordination for equipment protection. The slope resistance R_{slope} , as calculated by the formula below shall comply with Table 12:

$$R_{\text{slope}} = (V_{10} - V_1)/9000$$

Where V_{10} is the clamping voltage measured at 10 kA for an 8/20 μs waveform and V_1 is the clamping voltage measured at 1 kA for an 8/20 μs waveform.

The values of V_{10} and V_1 shall be based on actual measured values of SPD performance testing and not calculated values.

Table 12. Power Distribution Equipment SPD - Slope Resistance (R_{slope})

Location	Slope Resistance Value
Any Facility Entrance	8 m Ω Maximum
Feeder and Branch Panelboards	30 m Ω +/- 15 m Ω

5.7.2.1.3 SPD - Voltage Protection Rating V_3

SPD voltage protection rating shall be based on actual measured values of SPD performance testing and not calculated values. Voltages to be achieved during testing at 3 kA for an 8/20 μs current impulse waveform are shown in Table 13. All voltages shall be measured at the device terminals. The 8/20 μs waveform shall not lead or lag the voltage waveform by more than 30 degrees.

Table 13. Power Distribution SPD Voltage (V_3) Protection Rating

Location	System Voltage (V)	SPD Voltage Protection Rating (V_3 per mode)	Limit
Facility Entrances	120/208 120/240	400 L-N, L-G 700 L-L	Maximum
	277/480	700 L-L, L-G	Maximum
	380 Delta	1200 L-L, L-G	Maximum
	480 Delta	1200 L-L, L-G	Maximum
Feeder and Branch Panelboards	120/208 120/240	475 L-N, L-G 775 L-L	+/- 45 V
	277/480	775 L-N, L-G 1275 L-L	+/- 45 V
	380 Delta	1275 L-L, L-G	+/- 45 V
	480 Delta	1275 L-L, L-G	+/- 45 V

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5.7.3 SPDs for NAS Electronic Equipment – Design and Procurement Requirements

Provide surge protection for NAS electronic equipment in accordance with paragraph 5.6.3.

5.7.4 SPD - Design Specification for Axial Cable Protection

The design analysis for axial-type cable transient protection shall address the critical RFs and cable insertion losses. Axial cable protection shall comply with the following:

- a. Testing. Performance testing shall be conducted to ensure that suppression components do not degrade signals or cause disruption to the electronic equipment.
- b. RF Signal Testing Criteria. The analyses shall address cable impedance, insertion loss, phase distortion, and system voltage standing wave ratio.
- c. Transient Protection for Electronic Equipment. SPD protection for coaxial, tri-axial, and twin-axial cables shall be provided at the facility entrance point and at the electronic equipment. The transient suppression shall be provided for each axial conductor and for shields that are not bonded directly to the electronic equipment chassis.

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5.8 Electrostatic Discharge (ESD) Protection – Interface and Specification Requirements**5.8.1 General**

This section provides performance and interface requirements for installation of ESD protective systems. ESD controlled areas shall be provided for operations, storage, repair, and maintenance spaces used for electrical and electronic equipment or subassemblies that are subject to damage from static electricity or ESD. NAS electrical and electronic equipment, subassemblies, and components subject to damage from exposure to electrostatic fields or ESD shall be protected as indicated herein. Approval of any exception to the guidance herein shall be by the OPR.

The requirements of this section are designed to reduce frequency and minimize effects of ESD events. Electronic circuitry that contains miniaturized or solid-state components shall be considered ESD susceptible.

5.8.2 Electrostatic Discharge (ESD) Sensitivity Classification

Classification of items as ESD sensitive shall be in accordance with the HBM testing procedures and requirements of ANSI/ESDA/JEDEC JS-001. Electronic parts, components, and assemblies shall be classified as either sensitive or supersensitive. Items that fail from ESD at 1,000 to 16,000 V shall be classified as ESD sensitive. Items that fail below 1,000 V shall be classified as supersensitive. Devices with a sensitivity of less than +/- 200 V require additional ESD protection measures beyond those specified in this standard. ESD susceptible items shall not be exposed to an electrostatic field greater than 100 V/m, nor located within 24 in. from known static generators or nonessential insulated materials.

5.8.3 Classification of Materials

Most materials and products that are used to control and prevent ESD are classified by their resistive properties as conductive or static dissipative. Antistatic materials are classified by their ability to avoid generating static electricity from triboelectric charging.

Materials used for construction of ESD protected areas (with the exception of antistatic materials) shall meet the resistive properties specified for type and use of the material.

5.8.3.1 Static Conductive Materials

Those materials with a surface resistivity less than 1.0×10^5 ohms per square when tested per ANSI/ESD STM11.11 shall be considered conductive. Conductive ESD control materials shall not be used for ESD control work surfaces, tabletop mats, floor mats, flooring, or carpeting where the risk of personnel contact with energized electrical or electronic equipment exists. Conductive ESD control materials shall not be used in any other application where their use could result in EMI or radio frequency interference (RFI) that would be created by rapid, high-voltage ESD spark discharges.

5.8.3.2 Electrostatic Shielding Materials

Electrostatic shielding materials are a subset of conductive materials with a surface resistance equal to or less than 1.0×10^3 ohms when tested per ANSI/ESD STM11.11. Electrostatic shielding materials are permitted as barriers for protection of ESD sensitive items from electrostatic fields.

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5.8.3.3 Electromagnetic Shielding Materials

Electromagnetic shielding materials with highly conductive surfaces less than 10 ohms, or composite materials that absorb and reflect electromagnetic radiation over a broad range of frequencies, are permitted for protection of ESD sensitive items from electromagnetic fields.

5.8.3.4 Static Dissipative Materials

Materials with a surface resistivity greater than 1.0×10^5 ohms per square but less than or equal to 1.0×10^{12} ohms per square when tested per ANSI/ESD STM11.11 are classified as static dissipative materials. Static dissipative materials with a surface resistance less than or equal to 1.0×10^9 ohms shall provide controlled bleed-off of accumulated static charges in ESD controlled areas. Static dissipative materials with a surface resistance of greater than 1.0×10^9 ohms are not permitted for applications where controlled bleed-off of accumulated static charges is required.

5.8.3.5 Antistatic Materials

Materials that inhibit or have a low propensity to generate static electricity from triboelectric charging shall be considered antistatic. Antistatic ESD control items and materials used for construction of ESD controlled areas shall not tribocharge to greater than ± 200 V when being used for their intended application. Antistatic materials with a surface resistance greater than 1×10^9 ohms shall not be used for ESD protective work at surfaces, tabletop mats, floor mats, flooring, and carpeting when charge dissipation is the primary consideration. If the surface resistance (R_{st}) of an antistatic material is greater than 10^{12} ohms, it shall be considered too resistive for use in ESD controlled areas. Use of antistatic items and materials that use hygroscopic surfactants that depend on ambient humidity to promote absorption of water is discouraged. Only antistatic materials that are intrinsically antistatic and retain their antistatic properties shall be used in ESD controlled areas.

5.8.3.6 Static-Generative Materials, Nonconductors, and Insulators

Materials having a surface resistance greater than 1.0×10^{12} ohms (ANSI/ESD STM11.11) shall be considered to be insulators and a potential source of triboelectric charging. These materials include common plastics, Plexiglas, Styrofoam, Teflon, nylon, rubber, untreated polyethylene, and polyurethane. Use of these materials shall be minimized where ESD sensitive items are located.

5.8.4 Hard and Soft Grounds**5.8.4.1 Hard Grounds**

Any item, material, or product that is a part of the ESD control system that is intentionally or unintentionally connected to an ESD ground, or connected directly to any SRS in the area served, but not to an SPG system, shall be considered to be hard grounded. Unless specified otherwise or approved by the OPR, all items that comprise the ESD control system shall be hard grounded, such as worksurfaces, cabinets, flooring, carpeting, and test equipment.

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5.8.4.2 Soft Grounds

A soft ground is an intentional connection to ground through a series current limiting resistor. Soft grounding shall only be used for personnel grounding skin contact devices, such as wrist straps, leg or ankle straps, conductive shoes, and heel or toe grounders. The nominal resistance of the resistor used for soft grounding of personnel shall be greater than 1.0×10^6 ohms unless otherwise approved by the OPR. All other elements of the ESD control system shall be hard grounded.

5.8.5 Protection of Electrostatic Discharge (ESD) Susceptible and Sensitive Items**5.8.5.1 Static Protected Zone**

A static protected zone shall be a volume or area where there is no direct contact between unprotected ESD sensitive items and electrostatic potentials greater than ± 200 V, electrostatic fields greater than 100 V/m, or radiated EMI and RFI produced by rapid high-voltage ESD spark discharges. Static protected zones shall be incorporated into the construction of ESD special protection areas, ESD protected storage areas, and ESD protected workstations.

5.8.5.2 ESD Special Protection Areas

Special protection areas shall be designated areas that require the following ESD control measures:

- a. Minimize triboelectric charging.
- b. Control bleed-off and dissipation of accumulated static charges.
- c. Neutralize charges.
- d. Minimize the effects of e-fields, h-fields, and EMI/RFI from ESD spark discharges.

Areas within a facility that shall be designated as ESD special protection areas are:

- a. Air Traffic Operations Areas. These include tower cab, TRACON, ARTCC control rooms, and automated flight service station (AFSS) areas.
- b. Electronic Equipment Rooms.
- c. Storage Areas. Areas to store ESD-susceptible components such as subassemblies and circuit cards.
- d. Computer/LAN Interface Areas. Areas that contain personal computers and LANs that are connected to or interface directly with NAS electronic equipment.
- e. Other Locations. Locations where jacks, plug-in connectors, or interfaces of ESD sensitive electronic equipment are exposed and vulnerable to ESD damage by direct human contact.

5.8.6 ESD Controls Required for ESD Special Protection Areas

The following ESD control measures shall be implemented in areas designated as ESD special protection areas.

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5.8.6.1 ESD Groundable Point (GP)

Each ESD control material, surface, or item used in an ESD controlled area shall have a designated GP to provide ease of connection to the nearest SRS.

5.8.6.2 Grounded Static Dissipative Surfaces

Work surfaces which include work surface laminates, paints and sealers, writing surfaces, tabletops, consoles, ESD protected workbenches, and tabletop mats shall be static dissipative and connected to an SRS in the area served, but not to an SPG system. The point-to-point resistance and surface-to-ground resistance of static dissipative work surfaces shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD S4.1).

5.8.6.3 Limiting the Use of Non-ESD Control Materials

Materials that will tribocharge, i.e., generate electrostatic potentials by contact and separation with themselves or other materials, shall not be used for construction in ESD special protection areas. Insulative materials and any other non-essential triboelectric charge generators that generate potentials in excess of ± 200 V are not permitted within 24 in. of ESD special protection areas.

5.8.6.4 Static Dissipative Chairs

Chairs provided for ESD special protection areas shall incorporate a continuous path between chair elements, such as the cushion and arm rests, to the ground points in the range of greater than 1.0×10^5 ohms to less than 1.0×10^9 ohms. The ground points for ESD chairs shall be static dissipative or conductive casters that provide electrical continuity from all elements of the chair to ESD control carpeting, tile, or floor mats. These ground points shall be properly bonded to any SRS in the area, but not to an SPG system. ESD control chairs shall be tested and meet the requirements of ANSI/ESD STM12.1.

5.8.6.5 Static Dissipative ESD Control Floor Coverings

Static dissipative ESD control floor coverings shall include static dissipative tile, carpeting, static limiting floor finishes, and floor mats. Floor coverings in ESD special protection areas shall have a point-to-point resistance and surface-to-ground resistance of greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD STM 7.1). These floor coverings shall be bonded to any SRS in the area served in accordance with paragraphs 5.8.6.1 and 5.8.9, but not an SPG system.

In circumstances involving extremely static sensitive equipment, a static conductive floor covering with a lower resistance limit of 2.5×10^4 ohms (UL 779) shall be provided when it is part of a system designed for ESD control for the equipment. The system design shall meet all requirements of this standard to produce an electrically safe working environment, and be approved by the OPR.

5.8.6.6 Relative Humidity Control

Relative humidity in ESD special protection areas shall be maintained within the range of 40 to 60 percent.

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5.8.7 ESD Signs, Labels, Cautions, and Warnings for ESD Protection Areas

ESD warning signs shall be posted in ESD special protection areas and other ESD controlled areas. Sign labels shall be marked with an ESD sensitive electronic device warning symbol and other warning and caution labeling information appropriate for personnel safety. ESD warning signs shall be colored yellow with black marking labels and lettering. ESD signs for exterior cabinets housing ESD sensitive electronic equipment shall be visible from at least 3 ft. The sign and labeling style and format shall be consistent, and comply with ANSI/ESD S8.1.

5.8.8 Electrostatic Discharge (ESD) Protective Storage Areas**5.8.8.1 Shelves, Bins, and Drawers**

Shelves, bins, and drawers shall be static dissipative and electrically continuous with the support structure for the storage shelves, bins, or containers.

5.8.8.2 Grounding

The storage container metal support structure shall have a GP connected to the nearest SRS in the area, but not to an SPG system. The resistance from the ground point of storage containers, shelving, cabinets, and bins used to store ESD sensitive items to the nearest SRS shall be less than 1 ohm.

5.8.8.3 Personnel Grounding

Wrist straps shall be equipped with 1 megohm or greater series resistance to protect personnel. Standard 0.157-in. banana jacks for personnel grounding wrist straps shall be connected to the ESD ground or directly to any SRS in the area served, but not to an SPG system. The resistance between the banana jack and the GP, and the GP to the nearest SRS, but not to an SRS system, shall be less than 1 ohm.

5.8.8.4 Materials Prohibited in ESD Protective Storage Areas

Static generative insulators materials are prohibited for construction in areas where ESD sensitive items will be stored. Materials that can generate potentials greater than +/-200 V shall be located a minimum of 24 in. from ESD protected storage areas.

5.8.8.5 Resistance to ESD Ground for Shelves, Drawers, and Bins

Surfaces and drawers of storage media shall be composed of static dissipative materials and shall conform to the resistance testing requirements for worksurfaces (ESD S4.1). The surface-to-surface resistance (R_{ts}) and surface-to-ground resistance (R_{tg}) from the shelves, bins, and drawers of storage containers used to store unprotected ESD sensitive items shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ESD ADV53.1).

5.8.8.6 Identification of ESD Protective Storage Areas

Boundaries of ESD protective storage areas shall be clearly identified. Boundaries of ESD protective storage areas shall extend a minimum of 24 in. beyond the area where ESD sensitive items are located and marked with yellow tape. Highly visible ESD warning signs that are colored yellow with black markings and lettering shall be posted at entrances to these areas. Signs shall include an ESD sensitive electronic device warning symbol and other warning and caution labeling information for personnel safety.

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5.8.9 Electrostatic Discharge (ESD) Control Flooring and Floor Coverings

ESD control floors and floor coverings shall have a point-to-point resistance and a surface-to-ground resistance of greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD STM7.1). ESD control flooring, floor coverings, and floor tile laminates include materials such as vinyl tile, vinyl sheet, carpet, carpet tile, and carpet tile with positioning buttons, but not the applied coatings on the material.

ESD control floors and floor coverings shall be installed, grounded, and initially tested by trained installers in accordance with the manufacturer's recommendations. A representative 10-ft-square section of the flooring system shall be tested and approved by the FAA personnel prior to installation of the full flooring system.

ESD control floors and floor coverings shall be bonded to the nearest SRS in the area served, but not to an SPG system, at a minimum of four locations. The installation methods and testing shall be in accordance with the manufacturer's installation recommendations.

5.8.9.1 Surface Resistance (R_{tt})

Surface resistance R_{tt} of ESD control floors, carpets, or floor mats shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD STM7.1). The system surface resistance shall be validated by testing. A minimum of five readings shall be taken at different locations on the floor surface and averaged together for each 500 ft², or fraction thereof, equivalent floor surface. These readings shall be recorded and documented in the Facility Reference Data File (FRDF).

5.8.9.2 Resistance Surface-to-Ground (R_{tg})

Resistance from the floor surface-to-ground R_{tg} of ESD control floors, carpets or floor mats shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ANSI/ESD STM7.1). The system shall be validated by testing. A minimum of five readings shall be taken at different locations on the floor surface and averaged together for each 500 ft², or fraction thereof, equivalent floor surface. These readings shall be recorded and documented in the FRDF.

5.8.9.3 Triboelectric Charging Limitation

ESD control floors, carpets, or floor mats shall limit and control generation and accumulation of static charges to less than +/-200 V in ESD controlled areas.

5.8.10 Electrostatic Discharge (ESD) Requirements for Raised Access Floor Systems**5.8.10.1 Resistance between Carpet Surface to Pedestal and Support Substructure**

The resistance between carpet tile surface and the raised access floor pedestal and panel support substructure shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms.

5.8.10.2 Contact Resistance between Panel to Access Floor Support Substructure

The contact resistance between the access floor panel system metal parts and the floor substructure shall be less than 10 ohms.

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5.8.10.3 Carpet Tile Installation on Raised Access Floor Panels

Install individual carpet tiles on raised floor panels with either permanent or releasable conductive adhesive depending on the application.

5.8.10.4 Grounding of Raised Access Floor System

A minimum of four connections shall be provided per 1,000 ft² of installed ESD control carpeting from the carpeting undersurface and conductive adhesive to the raised access floor panel support substructure. The connections and installation method shall be in accordance with the manufacturer's recommendations, and the testing requirements of paragraphs 5.8.10.1 and 5.8.10.2.

5.8.11 Electrostatic Discharge (ESD) Protective Worksurfaces

All worksurfaces, including consoles and ESD-protected workstations and writing surfaces in all areas designated as ESD special protection areas and static-safe zones shall be static dissipative materials or electrostatic dissipative laminates.

5.8.11.1 Requirements for ESD Protective Worksurfaces

Static dissipative worksurfaces shall be provided for new or upgrade facilities unless otherwise specified. Permanent static dissipative worksurfaces shall be connected to any SRS in the area served, but not to an SPG system. Permanent ESD protective static dissipative worksurfaces shall have a resistance greater than 1.0×10^6 ohms point-to-point (R_{tt}) and less than 1.0×10^9 ohms (ESD S4.1). Permanent ESD protective worksurfaces shall have a resistance from their surface to the groundable point (R_{tg}) greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ESD S4.1).

5.8.11.2 Worksurface Types

ESD protective worksurfaces used for ESD protected workstations shall meet the requirements of MIL-PRF-87893 *Performance Specification, Workstation, ESD Control*, and MIL-W-87893 *Military Specification, Workstation, ESD Control*.

5.8.11.2.1 Type I Worksurface - Hard

Type I worksurfaces shall be constructed of rigid static dissipative materials of any color having an average Shore D hardness in excess of 90. Two male or female 0.395-in. ground snap (female) or stud (male) fasteners shall be installed on both corners on one of the longest sides of the worksurface to accommodate the male or female snap or stud fastener of the common point grounding cord. The locations of the two snaps or studs shall be 2 in. from each corner.

5.8.11.2.2 [A5] Type II Worksurface - Soft

Type II worksurfaces shall be constructed of cushioned static dissipative materials of any color having an average Shore A (ATSM D2240) hardness between 45 and 85. Two male or female 0.395-in. ground snap (female) or stud (male) fasteners shall be installed on both corners on one of the longest sides of the worksurface to accommodate the male or female snap or stud fastener of the common point grounding cord. The locations of the two male or female snaps or studs shall be 2 in. from each corner. Low-density open-cell materials are not permitted for Type II worksurfaces.

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5.8.11.3 Static Dissipative Laminates

High-pressure, multilayer static dissipative laminates shall be used to cover surfaces such as plywood, fiber board, particle board, benchtops, countertops, and consoles in ESD controlled areas and special protection areas. Laminates shall include a buried conductive layer to provide for ease of grounding using a through-bolt pressure-type ESD grounding terminal.

5.8.11.4 Grounding of Laminated Surfaces

The resistance across the surface (R_{ts}) of the static dissipative laminate shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms. The resistance from the surface of the laminate to ground (R_{tg}) shall be greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms (ESD S4.1). The system shall be validated through testing. A minimum of five readings of each shall be taken and averaged together. These readings and averages shall be recorded in the FRDF.

5.8.12 Static Dissipative Coatings

Permanent clear or colored static dissipative coatings used in ESD controlled areas, including painted surfaces, shall have a point-to-point resistance greater than 1.0×10^6 ohms and less than 1.0×10^9 ohms.

5.8.13 Electrostatic Discharge (ESD) Protected Workstations

ESD protected workstations are workbenches used for the maintenance and repair of ESD sensitive equipment.

5.8.13.1 ESD Protected Workstation Minimum Requirements

ESD control items at an ESD protected workstation shall be connected to a common ESD system GP and bonded to any SRS in the area served, but not to an SPG system. ESD protected workstations shall be free from all nonessential static charge generators, and provide a means of personnel grounding. Workstations shall have a grounded static dissipative work surface, and grounded static dissipative ESD control floor or mat. Storage containers located at ESD protected workstations shall be provided with ESD protection and connected to the ESD system GP. Power outlets for ESD protected workstations shall be protected with a ground fault circuit interruption (GFCI) device to minimize the risk of electrical shock to grounded personnel.

5.8.13.2 Use of Ionization

Selective use of benchtop or area ionizers is permitted at ESD-protected workstations if static generative insulator items are deemed essential and cannot be removed from the ESD protected workstation area, or the grounding of mobile personnel is not possible or creates a safety hazard.

5.8.13.3 Identification of ESD Protected Workstations

Boundaries of ESD protected workstations shall be clearly identified with highly visible ESD warning signs. Boundaries of ESD protected workstations shall be identified with yellow tape marking labels. The ESD boundary shall extend a minimum of 24 in. beyond the area where ESD sensitive items are located.

ESD warning signs shall be posted in ESD special protection areas and other ESD controlled areas. Sign labels shall be marked with an ESD sensitive electronic device warning symbol and

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other warning and caution labeling information appropriate for personnel safety. ESD warning signs shall be colored yellow with black marking labels and lettering.

5.9 Electromagnetic Compatibility Requirements

5.9.1 General

A comprehensive plan for the application of this standard is required to ensure the compatible operation of equipment in complex systems. Considerations in this section shall be implemented to reduce susceptibility to emissions of electronic equipment.

5.9.2 [A6] Requirements

The emission and susceptibility limits contained in MIL-STD-461 shall be applied unless otherwise specified. An electromagnetic interference (EMI) Control and Test Plan shall be developed in accordance with MIL-HDBK-237 to ensure compliance with the applicable requirements. The plan shall include a verification matrix to track the satisfaction of requirements by test, analysis, or inspection.

5.9.3 Approval

Control and Test Plans shall be submitted to the OPR for approval.

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6 NOTES**6.1 Acronyms and Abbreviations**

The following are acronyms and abbreviations used in this standard.

A		
	A	Ampere
	ac	alternating current
	AFSS	automated flight service station (FAA Acronym)
	ANSI	American National Standards Institute
	ARTCC	Air Route Traffic Control Center
	ASSC	airport surface surveillance capability system
	ATCT	Airport Traffic Control Tower
	AWG	American Wire Gauge
C		
	CDV	clamping discharge voltage
	cmil	circular mils
	COTS	commercial off-the-shelf
D		
	dB	Decibel
	dc	direct current
	DEB	direct earth burial
	diam	Diameter
E		
	e.g.	for example
	EES	earth electrode system
	EGC	equipment grounding conductor
	EMI	electromagnetic interference
	EMT	electrical metallic tubing
	ESD	electrostatic discharge
	et al.	and others
	etc	et cetera
F		
	FAA	Federal Aviation Administration
	FRDF	facility reference data file (FAA Acronym)
	ft	foot (feet)
G		
	GEC	grounding electrode conductors
	GFCI	ground fault circuit interruption
	GP	groundable point
H		
	Hz	hertz
	HBM	human body model

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I		
	i.e.	that is
	IFR	Instrument Flight Rules (FAA Acronym)
	IMC	intermediate metal conduit
	in.	inch
	IEEE	Institute of Electrical and Electronics Engineers
K		
	kA	kiloampere
	kcmil	thousand circular mils
	kHz	kilohertz
L		
	LAN	local area network
	lb	pound
	LPGBS	Lightning Protection, Grounding, Bonding and Shielding
	L-G	Line-to-Ground
	L-L	Line-to-Line
	L-N	Line-to-Neutral
	LLWAS	low level wind shear alert system (FAA Acronym)
M		
	m	meter
	mm	millimeter
	mA	milliampere
	mΩ	milliohm
	MΩ	megohm
	MCOV	Maximum continuous operating voltage
	MHz	megahertz
	MPG	multipoint ground system
	MPGP	multipoint ground plate
	μs	microsecond
N		
	NAS	National Airspace System
	NAVAIDS	navigation aids
	NEC	National Electrical Code
	NEMA	National Electrical Manufacturers Association
	NFPA	National Fire Protection Association
	ns	nanosecond
O		
	OCPD	overcurrent protective device
	OM	outer marker (FAA Acronym)
	OPR	Office of Primary Responsibility
	Ω	ohm
P		
	PIV	peak inverse voltage
	PVC	polyvinyl chloride

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R		
	RF	radio frequency
	RGS	rigid galvanized steel
	RFI	radio-frequency interference
	RMC	rigid metal conduit
	rms	root-mean-square
	R _{slope}	slope resistance
	R _{tg}	surface-to-ground resistance
	R _{tt}	surface resistance
	RVR	runway visual range (FAA Acronym)
S		
	SDM	service disconnecting means
	SPD	surge protective device
	SPG	single point ground system
	SPGP	single point ground plate
	SRGG	signal reference ground grid
	SRGP	signal reference ground plane
	SRM	safety risk management
	SRS	signal reference structure
	SSC	system support center (FAA Acronym)
T		
	TELCO	telephone company (FAA Acronym)
	ton	unit of mass or weight
	TRACON	terminal radar approach control facility
	TVSS	transient voltage surge suppressors
U		
	UL	Underwriters Laboratories
	UPS	uninterruptible power supply
V		
	V	volt
	V _{dc}	volts direct current
	VOR	very high frequency (VHF) omni directional range (FAA Acronym)
W		
	λ	Frequency Wavelength

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6.2 Guidelines and Reference Notes**[A1] Paragraph 4.2.1.1**

See FAA-HDBK-010 for evaluation, inspection, and testing procedures.

[A2] Paragraph 4.2.3.4.1

See MIL-STD-889, paragraphs “Precautions and methods for joining” and “Recommended Treatments in Order of Protective Effectiveness” for additional guidance for completing bond joints where base metals for couples are not permitted in Table 1.

[A3] Paragraph 4.4.2

The site survey geotechnical investigation data and EES design configuration are expected to be documented and retained within the facility’s as-built documentation set, in accordance with FAA Order 630.45, Facility Reference Data File.

[A4] Paragraph 4.4.4.4

Access wells located in nontraffic areas should be medium duty rated per AASHTO H-20 design load criterion up to 40,000 lb. Access wells subject to vehicular traffic should be traffic rated per AASHTO M306 proof loading criterion up to 100,000 lb. Access wells subject to aircraft loading should be Airport rated per AASHTO M306 proof loading criterion up to 200,000 lb.

[A5] Paragraph 5.8.11.2.2

Guidance for measurement of material hardness properties is in ATSM-D2240, Standard Test Method for Rubber Property - Durometer Hardness, ASTM International, West Conshohocken, PA, 2015, www.astm.org.

[A6] Paragraph 5.9.2

Guidance for EMI protection is in MIL-HDBK-253, and for ESD in NFPA 77, DODHDBK-263, DOD-STD-1686, and IEEE 1100.

6.3 Version Cross-Reference

Due to the major reorganization of FAA-STD-019F it is not feasible to provide an exact cross-reference between this standard and the previous versions of FAA-STD-019. The OPR should be consulted for assistance in determining references to the original requirements in previous editions of FAA-STD-019.

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6.4 Bibliography

[B1] NFPA 70, National Electrical Code, National Fire Protection Association, Current Edition.

[B2] NFPA 75, Standard for the Fire Protection of Information Technology Equipment, National Fire Protection Association, Current Edition.

[B3] NFPA 780, Standard for the Installation of Lightning Protection Systems Handbook, National Fire Protection Association, Current Edition.

[B4] IEEE 1100, IEEE Recommended Practice for Powering and Grounding Electronic Equipment, Institute of Electrical and Electronics Engineers, Inc., Current Edition.

[B5] IEEE C2, National Electrical Safety Code, Institute of Electrical and Electronics Engineers, Inc., Current Edition.

[B6] MIL-HDBK-419, Department of Defense, Military Handbook: Grounding, Bonding, and Shielding for Electronic Equipments and Facilities, Volume I, Current Edition.

[B7] MIL-HDBK-419, Department of Defense, Military Handbook: Grounding, Bonding, and Shielding for Electronic Equipments and Facilities, Volume II, Current Edition.

[B8] MIL-HDBK-237, Department of Defense, Military Handbook: Electromagnetic Environmental Effects and Spectrum Supportability Guidance for the Acquisition Process, Current Edition.

[B9] MIL-STD-188-124, Department of Defense, Military Standard: Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems Including Ground Based Communications Electronics Facilities and Equipments, Current Edition.

[B10] MIL-STD-461, Department of Defense, Interface Standard: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, Current Edition.

[B11] MIL-STD-464, Department of Defense, Interface Standard: Electromagnetic Environmental Effects Requirements for Systems, Current Edition.

[B12] MIL-STD-889, Department of Defense, Military Standard: Dissimilar Metals, Current Edition.

[B13] MIL-STD-962, Department of Defense, Standard Practice: Format and Content, Current Edition.

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ATTACHMENT NO. 4

APPENDIX A – SITE SUPPLEMENTARY CONDITIONS

PART 1 - GENERAL

1.1 SECTION CONTENTS

- A. This Section contains Supplementary Conditions to the Contract for Construction, which is a requirement specific to this project site and location.

1.2 COORDINATION AND ACCESS TO SITE.

- A. General Area Requirements: Contractor shall confine all operations, activities, storage of materials, and on-site-parking within the designated areas as indicated at the pre-bid walk through. Additional space the Contractor deems necessary for the Work shall be obtained off-site at no additional cost to the Government.
 - 1. Access Route: Access to the site for the Contractor, sub-contractors, employees, deliveries, etc., shall be only via the exact authorized access route designated at the Pre-Construction Meeting.
 - 2. Driving or walking on airport runways, aprons, taxiways and ramps (Airports Operation Area, "AOA"), is strictly prohibited and would be deemed trespassing subject to prosecution.
 - 3. Vehicle Capacity: Vehicles transporting materials shall not be loaded beyond the capacity prescribed by Federal, State and Local law.
 - 4. Obstructions: Obstruction of existing roadways, driveways, parking lots, and airport pavement areas is prohibited.
- B. Airport Property Access: If access to anywhere within the airport security fence, other than the Project site and the designated access route, is required, the Contractor shall, with 48 hours minimum notice, coordinate with the RE/COR and request access permission. The RE/COR will provide communication and coordination with the FAA's Baton Rouge Air Traffic Control organization. The airport authority may grant specific incursion permission to the Contractor with conditions, locations and durations noted and may require full-time escort by airport security personnel. Written concurrence from the RE/COR is required prior to any incursion. If an AOA incursion or proximity is required for the Work, specific written permission from the RE/COR and FAA Air Traffic, is required for each and any proposed instance of AOA incursion, and specific obstruction warning flagging and lights on vehicles, driver training, and escort will be required.
- C. Work on Adjacent Properties: Coordination and notification of any work outside the area of work shown on the Drawings shall be provided at least 14 days in advance of the planned work.
- D. Damage to the Site or to Adjacent Properties: Damage caused by the Contractor's activities to existing paving, lawns, curbs, sidewalks, and interior/exterior of adjacent buildings shall be repaired to the original condition. All costs of repairs shall be paid by the Contractor. After notice to proceed and prior to the start of construction, the Contractor and RE/COR shall conduct joint inspections of the existing areas affected by and adjacent to the Construction. Existing damage/defects shall be noted and will be used as the basis for determination of damages caused by the Contractor's operations.
- E. Contractor's On-Site Storage: The Contractor shall assume full responsibility for the protection and safekeeping of products stored on the site.
- F. Government Access to Areas of Work: The Government reserves the right to enter areas of Work during the work for work inspections and for work administration and engineering functions. The Contractor shall cooperate and provide the FAA routes and means for access to all portions of the work.
- G. Work Hours: See Specifications Section 011000 "Summary of Work" for the days and hours within which on-site work can be done and for the provisions and arrangements necessary for off-hours work.
- H. Security Requirements: If requested by the RE/COR, the Contractor shall provide to the RE/COR, at least seven (7) days prior to Pre-Construction Meeting, a list of contractor's personnel who will require access to the Project site. The

list shall be kept current during project duration of work.

1. Submit the following data for all contractor/subcontractor personnel who will require access to the site:
 - a. Full Name
 - b. Social Security Number
 - c. Date of Birth
 - d. Current Residential Address.
 - e. Security Checks: Contractor's personnel may be subject to security check by the FAA. The Contractor shall promptly complete for each such employee any security forms furnished by the RE/COR.
2. Right to Search: The FAA Security reserves the right to search vehicles and persons on airport property. If in the judgment of authorized security personnel, cause to search a vehicle or person exists, such search will be made.

I. Motorized Equipment

1. Unattended Vehicles: Unattended vehicles inside or within 100 feet of FAA security fencing may be rendered immobile by removing the keys or by other suitable means.
2. Fire Extinguishers: Vehicles inside the airport security fence shall each have at least one portable fire extinguisher per vehicle, rating 10 BC.

1.3 TIME EXTENSIONS FOR SEVERE WEATHER

- A. General: This section specifies the criteria for Contract time extensions in accordance with the Contract provisions regarding weather-caused delays. In order for the RE/COR to recommend to the CO a time extension under these provisions, the following conditions must be satisfied:
 1. The weather event or conditions experienced at the project site causing delay must be more severe than statistical one-time-per-year severity per NOAA climate records or similar climate records.
 2. The severe weather must directly cause a delay to the completion of the project. The delay must be beyond the control and without fault or negligence of the contractor.
 3. Actual adverse weather delays must prevent work on critical activities (on the project construction critical path) for 50 percent or more of a Contractor's scheduled work day for each day of extension.

1.4 UTILITIES

- A. Protection of Existing Utilities and Cables: The location of existing utility lines, utility structures and all underground cables shown on the drawings are approximate. Prior to any trenching or excavating, the Contractor shall use whatever means necessary, including a cable locator, to locate existing utilities, cables, pipes or ducts. The Contractor shall stake or otherwise mark all utility or cable crossings and shall take great care in the excavation of these areas. The Contractor shall immediately repair any damage done by the Contractor, subcontractors, or suppliers to utilities or cable within the work area. In the event that the Contractor damages any existing utility lines or cable, report thereof shall be made immediately to the RE/COR, and the Contractor shall repair the damaged utility line by replacing the damaged portion to the nearest joints unless advised otherwise by the RE/COR.
- B. Utility Outages: For any required utility outage that will affect services beyond the Project site the Contractor shall coordinate with, notify, and obtain written permission from local officials and the owners and users of other buildings and areas affected by the proposed outage. The RE/COR, ATCT Air Traffic Manager and SSC Manager shall be notified at least 14 days in advance of the proposed outage. The Contractor shall provide an operations plan for utility outages that details sequence of shutdown, construction, startup, and the time period of the outage

1.5 AIRPORT SPECIFIC REQUIREMENTS

- A. Equipment over Thirty Feet High: If cranes, hoists, lifts or equipment over thirty (30) feet high are required, the Contractor shall:
 1. Submittal: A detailed plan and schedule for any work involving equipment over thirty feet high shall be submitted at the Pre-Construction Meeting for approval. After approval, the Contractor is responsible for all airspace notification and management and marking of all machinery and/or equipment which may impact the flight procedures at the

Airport. The location of the Crane shall be noted on the Contractor's site plan which shall be on the abandoned roadway adjacent to the facility. The RE/COR shall submit a completed FAA Air Space Study Form 7460-1.

2. If deviation from the approved high-equipment plan is required, delays for obtaining additional required approvals shall not be cause for extension of the Contract time.
3. Marking: The Contractor shall provide international orange and white checkered obstruction flags and flashing red obstruction lights, on the highest part of any equipment or machinery that extends, at any time, above 30 vertical feet above ground elevation at greater than 20 feet from the exterior face of the ATCT.
4. The crane for setting the roofing materials in place shall not be more than 95 feet high, unless approvals are obtained and written permission is provided by the RE/COR.
5. The work involving tall equipment shall only be performed in accordance with the detailed work plan pre-approved in writing by the RE/COR and only after the following items are satisfied:
 - a. "VISUAL FLIGHT RULES": Visual flight rules (VFR) conditions must prevail as determined by local FAA Airport Traffic Controllers and/or airport operating personnel.
 - b. "NOTAMS": A "NOTICE TO AIRMEN" (NOTAM) concerning the construction has been requested by the Contractor and issued by local FAA Air Traffic Controllers and/or the FAA Airports Division utilizing FAA Form 7460-1 (Air Space Study)

- B. Airport Security Fencing: Breaks in security fencing due to the Contractor's operations shall be repaired and/or replaced immediately so that no breach of physical security is present.

1.6 MISCELLANEOUS WORK RESTRICTIONS AND REQUIREMENTS

- A. Blasting: No blasting is permitted on this site.
- B. No asbestos containing materials (ACM) shall be incorporated into the new Work.
 1. Provide letters of certification at completion certifying that no asbestos was used.
- C. Lead-free materials.
 1. Provide letters of certification for the project at completion certifying that only lead-free paints, plumbing materials and flashings, etc. were used on this project.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 007301

ATTACHMENT NO. 5

ATTACHMENT

EOSH IMPACTS

Project:

**Lubbock TRACON and ATCT
7001 N. Martin Luther King Blvd
Lubbock, TX 79403**

Engineer / Routing Code:	Jelani Jones / AJW-2C11C
Manager / Routing Code:	Kevin Miles / AJW-2C11C
SECM (District):	Lenny Ramos / AJW- C21A
SECM (District):	Sammy Herrell / AJW- C21A
EOSH Coordinator:	Hudson Varner / AJW-2C15H

EOSH IMPACTS

1. *Compressed Gases:*

Compressed gases may be utilized during the welding process of this project. Workers in charge of the oxygen or fuel-gas supply equipment, including generators and oxygen or fuel-gas distributions shall be instructed and judged as being competent by their employers for this work before being left in charge. Rules and regulations covering the operation and maintenance of oxygen or fuel-gas supply equipment shall be readily available. All welding activities should conform to the Engineering Services SOP for Welding and Compressed Gas.

2. *Concrete and Masonry Work:*

When providing project oversight pouring/placing or demolishing concrete the employees shall wear all required Personal Protective Equipment to reduce eye, skin, face, and head injury. All regulations will be followed according to OSHA 1926, Subpart Q. It is recommended that the employees wear pants and long sleeve shirts and don the proper hand, foot, eye, and face protection.

3. *Cranes, Derricks, Lifts, and Hoists:*

Employees or contractors that operate cranes, derricks, lifts, and hoists must complete specialized training for certification and authorization. All cranes onsite shall meet or exceed OSHA 29 CFR 1926, Subpart N. The crane service company shall have a licensed operator, crane inspection information, proper crane setup, proper rigging and lifting equipment, and follow and stay within all lifting charts. The crane company will need to have a certified rigger onsite with proper communication between them and the operator (radios and hand signals). When utilizing cranes, derricks, lift, and hoists be aware of obstacles and obstructions including electrical power lines and ditches or trenches. Proper fall protection must be utilized when occupying such equipment.

4. *Employee Health (First Aid / Blood Borne Pathogen):*

When first aid situations arise, local emergency response systems shall be the primary source of emergency first aid. Ensure a viable and reliable source to contact first responders is present and functional within the worksite and ensure employees or contractors be properly instructed in how to access the system, e.g., by dialing 911. If working in rural areas where there is no coverage by a local emergency medical response system, make provisions for acceptable emergency transportation. Ensure that job sites or vehicles have a properly stocked and approved first aid kit.

To ensure compliance with FAA Blood Borne Pathogen rules and regulations make sure of the following;

- Appropriate engineering and work practice controls are in place.
- Ensure that appropriate personal protective equipment is available at the project site.
- Ensure the worksite is maintained in a clean and sanitary condition.
- Any spills of blood or other potentially infectious material on work surfaces are cleaned with an appropriate disinfectant.

All incidents resulting in first aid treatment should be reported in the same manner as any other occupational injury or illness as described in FAA Order 3900.19B, Chapter 7, Mishap Reporting and Investigation.

If you require further assistance with respect to first aid or blood borne pathogen requirements, please refer to FAA Order 3900.19B, Chapter 17 - Bloodborne Pathogens Control Program, FAA Order 3900.19B, Chapter 22 - First Aid Program, PASS CBA, Article 52, Section 15, NATCA CBA, Article 53, Section 5, OSHA - 29 CFR 1910.1030 - Bloodborne pathogens, , PASS CBA, Article 52, Sections 8 and 15, NATCA CBA, Article 53, Sections 5 and 7, and OSHA - 29 CFR 1910.151 - Medical and First Aid.

5. *Equipment Disposal:*

Equipment to be removed contains nonhazardous materials. All disposal of the excessed equipment shall comply with 40 CFR Parts 260 - 266 and FAA Order 4600.27C, *Personal Property Management*.

6. *Excavations, Trenching, or Boring:*

All excavations, trenches, and boring activities shall adhere to the OSHA regulations within 29 CFR 1926, Subpart P. Employees should be aware of the hazards of open trenches, operation of vehicles and machinery near excavations, and familiar with trench protective systems.

7. *Fall Protection:*

A safety net, guardrails, or personal fall arrest/restraint system should be used to protect employees working at heights greater than four (4) feet or near an unprotected edge. The employee/contractor should follow all OSHA regulations and FAA order 3900.63, Fall Protection Program. The possible use of ladders and lifts are the existing fall hazards for this project. Ensure ladders are inspected before use.

The use of buckets trucks, cherry pickers, and personnel lifts require specific training on that piece of equipment. The employee/contractor should follow the manufacturer's instructions for safe operations. The use of a Personal Fall Arrest System may be required for safe operation at heights while elevated work platform is in use.

8. *Fire and Explosion Hazards:*

Fire and explosion hazards are prevalent in virtually every job site. Maintain effective fire protection and prevention programs at the job site throughout all phases of the construction, repair, alteration, or demolition work. Ensure the availability of proper fire protection and suppression equipment throughout each phase of the project. Guidance on fire and explosion hazards on the job site can be found within 29 CFR 1910 Subparts E, G, H, L, N, Q, R and Z, 29 CFR 1926 Subparts C, D, F, H, J, K, R, S, T and U and FAA Order 3900.19B, Chapter 24.

9. *Fire Life Safety:*

An emergency action plan should be established to identify exit routes and means of egress in case of an emergency. Good housekeeping practices are required to ensure a safe means of egress and to eliminate a possible fuel source for fires. For additional reference regarding fire life safety, refer to OSHA CFR 1910 Subpart L.

10. Hazard Communication:

- Familiarize yourself with the applicable FAA and OSHA standards regarding hazard communication.
- Obtain from SSC or create a list of the hazardous chemicals in the workplace.
- Obtain safety data sheets for all chemical substances in the workplace.
- Ensure that all containers are labeled.
- Request and review the District SSC Written Hazard Communication Programs.

Guidance on Hazard Communication include, FAA Order 3900.19B, Chapter 19, FAA Order 6000.54, Airway Facilities Hazard Communication Program, PASS CBA, Article 52, Section 10, and OSHA - 29 CFR 1910.1200 - Hazard Communication. If you need further assistance regarding hazard communication, contact the District Safety and Environmental Compliance Manager (SECM) or EOSH contract support staff at the pertinent Technical Support Center (TSC).

11. Hazardous Energy (Construction):

Based on the parameters of the project, lockout/tag out is required. The contractor/employee is responsible for creating equipment specific lockout/tag out procedures for this project. Refer to the Engineering Services Standard Operating Procedures (SOP) Hazardous Energy for work requirements regarding lockout / tag out. For reference regarding hazardous energy lockout / tag out, refer to OSHA (29 CFR 1910.147 and 1960) and by FAA Order 3900.19B.

12. Hearing Conservation:

Based on the project parameters, the potential for employees or the contractor to be exposed to high intensity and frequent high levels of noise exist. When conducting project oversight, ensure the use of appropriate personal protective equipment (PPE) to reduce noise level exposure of the employee or contractor. When the lack of suitable determination for the selection of proper PPE is not offered, ensure the most stringent PPE is available. This would include the use of ear plugs and ear muffs in combination. Utilize PPE when noise levels become uncomfortable for the individual. For further guidance regarding hearing conservation, refer to OSHA 1910 Subpart G and FAA Order 3900.19B, Chapter 21, Hearing Conservation Program.

13. Housekeeping

- During the course of construction, alteration, or repairs maintain the following:
- Form and scrap lumber with protruding nails, and all other debris, shall be kept cleared from work areas, passageways, and stairs, in and around buildings or other structures.
- Walkways shall be kept clear of obstructions.
- Combustible scrap and debris shall be removed at regular intervals during the course of construction.
- Containers shall be provided for the collection and separation of waste, trash, oily and used rags, and other refuse.
- Containers used for garbage and other oily, flammable, or hazardous wastes, such as caustics, acids, harmful dusts, etc. shall be equipped with covers.
- Garbage and other waste shall be disposed of at frequent and regular intervals.

14. *Lead Based Paint:*

As currently scoped, the project should not impact potential lead bearing surfaces. All demolition debris assumed to have LBP should be disposed of appropriately. Provide documentation for the disposal of all demolition debris.

15. *Lightning Safety:*

Know your local weather patterns and if lightning is observed, avoid water, open areas, metal objects, and take shelter in a building or vehicle. Suspend outdoor activities for 30 minutes after the last observed lightning or thunder. When working with power equipment, ensure the use of lightning arresters.

Ensure FAA-STD-019, Lighting and Surge Protection, Grounding, Bonding and Shielding for Facilities and Electronic Equipment is followed for installation of new equipment.

16. *NEPA:*

The project qualifies for a Categorical Exclusion, per FAA Order 1050.1F, Paragraph 5-6.4.f., and 5-6.4.o.

17. *Personal Protective Equipment (PPE):*

Following review of the project scope of work, the EOSH Coordinator has determined that PPE is required for this project. PPE should consist of gloves, hard hats, hearing protection, reflective vests, respiratory protection, safety glasses, and safety boots / shoes. OSHA 1926 Subpart E and FAA Order 3900.19B JC Supplement; Personal Protective Equipment Program provides guidance and instructions on the selection, use, and maintenance of PPE.

18. *Post Construction Lockout / Tag out (LOTO) Plan:*

The designer/contractor will develop a site-specific LOTO plan for existing equipment modifications and new installation. This plan will be based on manufacturers recommended procedures and site-specific switch locations and conditions. The plan will follow the standard FAA LOTO format.

19. *Slips, Trips & Falls:*

- Wear proper footwear with slip-resistant soles.
- Ensure that work environments are properly maintained through good housekeeping practices.
- Keeping walking areas free of electrical cords and wires.
- Provide sufficient lighting in walkways, eliminating uneven floor surfaces.
- Pay attention to your surroundings.

Guidance on slips, trips, and falls can be found within 29 CFR 1910 Subpart D- Walking Working Surfaces, 29 CFR 1926.500 (Subpart X)-Ladders, ANSI A1264.1 Safety Requirements for Workplace Floor and Wall Openings, Stairs and Railing Systems, and FAA Order 3900.19B, Chapter 10.

20. *Thermal Stress:*

Exposure to extreme heat or cold may result in occupational illnesses or injury. Ensure proper clothing, hydration and work practices are utilized to minimize the effects of thermal stress.

Check local weather conditions prior to site activities and if questions arise concerning thermal stress, contact an EOSH coordinator.

21. Two Person Rule

To comply with OSHA regulations and FAA orders, a “Two Person Rule” will be implemented, which prohibits employees from working alone under certain situations where there are employees working at heights, where employees are working with electrical systems over 50v, where employees are at risk of electrocution, or where medical emergency response is not readily available, must be trained in first aid and CPR. In each case, the second person must be trained in first aid and CPR.

22. Walking-Working Surfaces:

The employer should protect their employees from floor openings when working on the jobsite. OSHA 1910, Subpart D specifies worker safety and eliminating falls from stairs, scaffolding, ladders, and working platforms by outlining handrail requirements, tread heights, safe ladder usage, and the proper selection of fall protection methods. OSHA 1910.22 provides guidance on how to assist in the elimination of potential hazardous conditions by practicing good housekeeping and keeping aisles and passageways free of any clutter, materials, or debris. FAA Order 3900.63 covers all walking and working surfaces and fall protection requirements for construction and installation projects within the FAA. If not specified, use the more stringent of the two sources for fall protection requirements (e.g. duty to provide fall protection).

23. General:

The SSC and District shall provide Safety Data Sheets (SDS) for hazardous materials already present in the workplace. Contractors shall identify and provide SDS’s for all hazardous materials brought into the work area by themselves or their sub- contractors. All Personal Protective Equipment shall be worn at all times to protect from head, eye, face, and foot injuries. Please contact any of the following personnel if any environmental, health or safety issues arise:

District

SECM/EPS	Lenny Ramos	817-858-7450
SECM/EPS	Sammy Herrell	318-469-2567
EOSH Coordinator	Hudson Varner	817-222-5279

24. PRE-CONSTRUCTION CHECKLIST:

This checklist (see Attachments) is intended to be used as a tool by RE/COTRs, designated facility POCS, or SSC managers who oversee construction and maintenance activity that potentially have EOSH related impacts on AT/AF operations. This tool shall be used, as appropriate, during critical phases of construction and maintenance activities (e.g. the pre-construction meeting, 30-60 days prior to commencement of work, weekly/daily construction meetings, etc.). Emphasis should be placed on using this checklist as a tool to assess as well as reassess hazards as the project progresses.

Specifically, this checklist is intended to:

- Promote sensitivity to potential EOSH hazards associated with projects and stress the importance of not disrupting NAS operations. Assist in identifying and validating potential project hazards and associated risks
- Assist in preventing safety and health incidents/accidents and facility shutdowns
- Ensure appropriate contractor measures and controls are in place to address potential project hazards
- Facilitate discussion with the contractor regarding plans to prevent minimize potential incidents/accidents
- Enhance coordination between EOSH professionals, project personnel and contractors
- Facilitate review of critical FAA EOSH procedures with contractors
- Raise EOSH awareness

This checklist relies on the training and professional judgment of the user. EOSH personnel should be consulted as needed.

A facility POC with a thorough understanding of facility procedures and equipment considerations should participate in the site walk-through.

ATTACHMENT NO. 6

COVID-19 REQUIRMENTS

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. Contractor shall provide all submittals prior to NTP.
- B. The CVSP shall be implemented at the CORs/COs discretion, and will be based on current COVID levels
- C. Shared use of trailer between FAA and Contractor personnel is not permitted.
- D. All meetings must take place virtually where practicable.
- E. 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.

- F. Use of trailer restrooms are highly encouraged. Trailer restroom must have a hand washing station and must be equipped with an exhaust fan.
- G. FAA is using data from CDC website <https://covid.cdc.gov/covid-data-tracker/#dataatracker-home> 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 CDC website or other official data that is available.
- H. 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.

APPENDIX A - COVID-19 Wellness Self-Check

In order to stop the spread of COVID-19, it is imperative that we all continue to monitor and assess our health, on a daily basis.

Before you leave for the FAA facility each day, it is an expectation of the agency that you should take your temperature. Additionally, you must review the following health questionnaire.

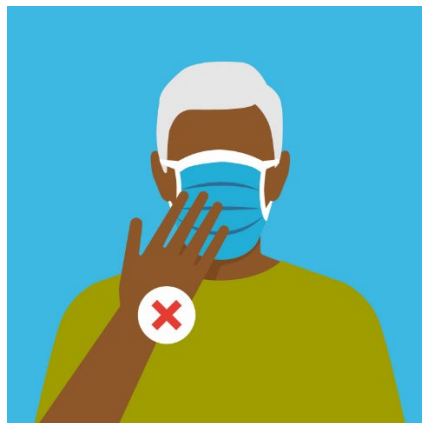
If you answer “YES” to one or more (or any combination) of these questions, you must NOT enter any FAA facility but you are not required to submit this document to your manager.

COVID-19 Wellness Self-Check

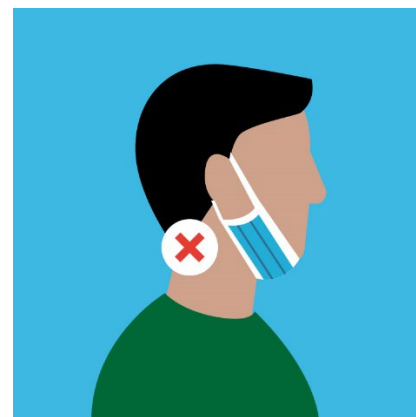
1. Is your temperature at or more than 100.4 degrees F (38.0 degrees C)? [YES / NO]
2. Do you have any of the following symptoms?
 - Fever or chills [YES / NO]
 - Cough or shortness of breath or difficulty breathing [YES / NO]
 - Muscle pain [YES / NO]
 - Headache [YES / NO]
 - Sore throat [YES / NO]
 - New loss of taste or smell [YES / NO]
3. Within the last 14 days, have you been in close contact (within six (6) feet of someone who has an active case of laboratory-confirmed COVID-19? [YES / NO]
4. Within the last 14 days, have you been in close contact (within six (6) feet of someone who is ill, or demonstrates any of the above symptoms? [YES / NO]
5. In the last 14 days, have you received instructions from a public health authority to self-observe, self-isolate, or self-quarantine? [YES / NO]

If you are unable to enter the facility based on the questionnaire above, you must notify your supervisor as soon as possible. Should you receive a laboratory confirmation of a COVID-19 diagnosis (positive test for SARS-CoV2), you must contact your supervisor to discuss next steps and provide information related to any potential exposure to other FAA employees or facility occupants.

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

END OF SECTION