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Letting August 5, 2022

Notice to Bidders, Specifications and Proposal



**Illinois Department
of Transportation**

Springfield, Illinois 62764

**Contract No. UN062
University of Illinois-Willard Airport
Savoy, Illinois
Champaign County
Illinois Project No. CMI-4793
AIP Project No. 3-17-0016-TBD**



1. **TIME AND PLACE OF OPENING BIDS.** Electronic bids are to be submitted to the electronic bidding system (iCX-Integrated Contractors Exchange). All bids must be submitted to the iCX system prior to 12:00 p.m. on August 5, 2022, at which time the bids will be publicly opened from the iCX SecureVault.
2. **DESCRIPTION OF WORK.** The proposed improvement is identified and advertised for bids in the Invitation for Bids as:

**Contract No. UN062
University of Illinois-Willard Airport
Savoy, Illinois
Champaign County
Illinois Project No. CMI-4793
AIP Project No. 3-17-0016-TBD**

Midfield Intersection Reconfiguration

For engineering information, please contact Christopher B. Groth, P.E. of Crawford, Murphy & Tilly, Inc. at 217.572.1101.

3. INSTRUCTIONS TO BIDDERS.

- (a) This Notice, the invitation for bids, proposal, letter of award, contract form, payment bond and performance bond, Specifications, Supplemental Specifications, Special Provisions, general and detailed plans, *Manual for Documentation of Airport Materials*, *Airport Construction Documentation Manual*, and any Agreements that are required to complete the construction of the work in an acceptable manner, including authorized extensions thereof, all of which constitute one instrument, shall become part of the contract. Bidders are cautioned to read and examine carefully all documents, to make all required inspections, and to inquire or seek explanation of the same prior to submission of a bid.
- (b) State law, and, if the work is to be paid wholly or in part with Federal-aid funds, Federal law requires the bidder to make various certifications as a part of the proposal and contract. By execution and submission of the proposal, the bidder makes the certification contained therein. A false or fraudulent certification shall, in addition to all other remedies provided by law, be a breach of contract and may result in termination of the contract.

4. **AWARD CRITERIA AND REJECTION OF BIDS.** This contract will be awarded within 90 calendar days to the lowest responsive and responsible bidder considering conformity with the terms and conditions established by the Department in the rules, Invitation for Bids and contract documents. The issuance of plans and proposal forms for bidding based upon a prequalification rating shall not be the sole determinant of responsibility. The Department reserves the right to determine responsibility at the time of award, to reject any or all proposals, to readvertise the proposed improvement, and to waive technicalities.

5. **PRE-BID CONFERENCE.** A voluntary pre-bid meeting will be held on Tuesday, July 26, 2022 at 01:30 PM in the Airport conference room, second floor of the terminal building at the University of Illinois – Willard Airport, 11 Airport Rd, Savoy, IL 61874.

6.

6. **DISADVANTAGED BUSINESS POLICY.** The DBE goal for this contract is 7.0%.

7. **SPECIFICATIONS AND DRAWINGS.** The work shall be done in accordance with the Specifications, the Special Provisions dated June 10, 2022, and the Construction Plans dated June 10, 2022 as approved by the Illinois Department of Transportation, Division of Aeronautics.

8. BIDDING REQUIREMENTS AND BASIS OF AWARD. When alternates are included in the proposal, the following shall apply:

a. Additive Alternates

(1) Bidders must submit a bid for the Base Bid and for all Additive Alternates.

(2) Award of this contract will be made to the lowest responsible qualified bidder computed as follows:

The lowest aggregate amount of (i) the Base Bid plus (ii) any Additive Alternate(s) which the Department elects to award based on the availability of funding.

Award of this contract will be limited to the following bid alternate combinations:

- I. Base Bid
- II. Base Bid + Additive Alternate 1
- III. Base Bid + Additive Alternate 1 + Additive Alternate 2
- IV. Base Bid + Additive Alternate 1 + Additive Alternate 2 + Additive Alternate 3

The Department may elect not to award any Additive Alternates. In that case, award will be to the lowest responsible qualified bidder of the Base Bid.

b. Optional Alternates

(1) Bidders must submit a bid for the Base Bid and for either Alternate A or Alternate B or for both Alternate A and Alternate B.

(2) Award of this contract will be made to the lowest responsible qualified bidder computed as follows:

The lower of the aggregate of either (i) the Base Bid plus Alternate A or (ii) the Base Bid plus Alternate B.

9. CONTRACT TIME. The Contractor shall complete all work within the specified contract time. Any calendar day extension beyond the specified contract time must be fully justified, requested by the Contractor in writing, and approved by the Engineer, or be subject to liquidated damages.

The contract time for this contract is 152 calendar days.

10. INDEPENDENT WEIGHT CHECKS. The Department reserves the right to conduct random unannounced independent weight checks on any delivery for bituminous, aggregate or other pay item for which the method of measurement for payment is based on weight. The weight checks will be accomplished by selecting, at random, a loaded truck and obtaining a loaded and empty weight on an independent scale. In addition, the department may perform random weight checks by obtaining loaded and empty truck weights on portable scales operated by department personnel.

11. MATERIAL COST ADJUSTMENTS. Federal Aviation Administration rules prohibit the use of escalation clauses for materials. Therefore, the Illinois Department of Transportation, Division of Aeronautics cannot offer any material cost adjustment provisions for projects that utilize Federal Funds.

12. GOOD FAITH COMPLIANCE. The Illinois Department of Transportation has made a good faith effort to include all statements, requirements, and other language required by federal and state law and by various offices within federal and state governments whether that language is required by law or not. If anything of this nature has been left out or if additional language etc. is later required, the bidder/contractor shall cooperate fully with the Department to modify the contract or bid documents to correct the deficiency. If the change results in increased operational costs, the Department shall reimburse the contractor for such costs as it may find to be reasonable.

By Order of the
Illinois Department of Transportation

Omer Osman,
Secretary

ILLINOIS DEPARTMENT OF TRANSPORTATION
DIVISION OF AERONAUTICS

REQUIRED CONTRACT PROVISIONS FOR STATE FUNDED AIRPORT CONSTRUCTION PROJECTS

The following provisions are State of Illinois requirements and are in addition to the REQUIRED CONTRACT PROVISIONS FOR AIRPORT IMPROVEMENT PROGRAM AND FOR OBLIGATED SPONSORS

DISADVANTAGED BUSINESS POLICY

NOTICE: This proposal contains the special provision entitled "Disadvantaged Business Participation." Inclusion of this Special Provision in this contract satisfies the obligations of the Department of Transportation under federal law as implemented by 49 CFR 23 and under the Illinois "Minority and Female Business Enterprise Act."

POLICY: It is public policy that the businesses defined in 49 CFR Part 23 shall have the maximum opportunity to participate in the performance of contracts financed in whole or in part with State or Federal funds. Consequently, the requirements of 49 CFR Part 23 apply to this contract.

OBLIGATION: The Contractor agrees to ensure that the businesses defined in 49 CFR Part 23 have the maximum opportunity to participate in the performance of this contract. In this regard, the Contractor shall take all necessary and reasonable steps, in accordance with 49 CFR Part 23, to ensure that the said businesses have the maximum opportunity to compete for and perform portions of this contract. The Contractor shall not discriminate on the basis of race, color, national origin, or sex in the selection and retention of subcontractors, including procurement of materials and leases of equipment.

The Contractor shall include the above Policy and Obligation statements of this Special Provision in every subcontract, including procurement of materials and leases of equipment.

DBE/WBE CONTRACTOR FINANCE PROGRAM: On contracts where a loan has been obtained through the DBE/WBE Contractor Finance Program, the Contractor shall cooperate with the Department by making all payments due to the DBE/WBE Contractor by means of a two-payee check payable to the Lender (Bank) and the Borrower (DBE/WBE Contractor).

BREACH OF CONTRACT: Failure to carry out the requirements set forth above and in the Special Provision shall constitute a breach of contract and may result in termination of the contract or liquidated damages as provided in the special provision.

SPECIAL PROVISION FOR DISADVANTAGED BUSINESS ENTERPRISE PARTICIPATION (BDE)

Effective: September 1, 2000

Revised: March 2, 2019

FEDERAL OBLIGATION. The Department of Transportation, as a recipient of federal financial assistance, is required to take all necessary and reasonable steps to ensure nondiscrimination in the award and administration of contracts. Consequently, the federal regulatory provisions of 49 CFR Part 26 apply to this contract concerning the utilization of disadvantaged business enterprises. For the purposes of this Special Provision, a disadvantaged business enterprise (DBE) means a business certified by the Department in accordance with the requirements of 49 CFR Part 26 and listed in the Illinois Unified Certification Program (IL UCP) DBE Directory.

STATE OBLIGATION. This Special Provision will also be used by the Department to satisfy the requirements of the Business Enterprise for Minorities, Females, and Persons with Disabilities Act, 30 ILCS 575. When this Special Provision is used to satisfy state law requirements on 100 percent state-funded contracts, the federal government has no involvement in such contracts (not a federal-aid contract) and no responsibility to oversee the implementation of this Special Provision by the Department on those contracts. DBE participation on 100 percent state-funded contracts will not be credited toward fulfilling the Department's annual overall DBE goal required by the US Department of Transportation to comply with the federal DBE program requirements.

CONTRACTOR ASSURANCE. The Contractor makes the following assurance and agrees to include the assurance in each subcontract the Contractor signs with a subcontractor.

The Contractor, subrecipient, or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of contracts funded in whole or in part with federal or state funds. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate, which may include, but is not limited to:

- (a) Withholding progress payments;
- (b) Assessing sanctions;
- (c) Liquidated damages; and/or
- (d) Disqualifying the Contractor from future bidding as non-responsible.

OVERALL GOAL SET FOR THE DEPARTMENT. As a requirement of compliance with 49 CFR Part 26, the Department has set an overall goal for DBE participation in its federally assisted contracts. That goal applies to all federal-aid funds the Department will expend in its federally assisted contracts for the subject reporting fiscal year. The Department is required to make a good faith effort to achieve the overall goal. The dollar amount paid to all approved DBE companies performing work called for in this contract is eligible to be credited toward fulfillment of the Department's overall goal.

CONTRACT GOAL TO BE ACHIEVED BY THE CONTRACTOR. This contract includes a specific DBE utilization goal established by the Department. The goal has been included because the Department has determined the work of this contract has subcontracting opportunities that may be suitable for performance by DBE companies. The determination is based on an assessment of the type of work, the location of the work, and the availability of DBE companies to do a part of the work. The assessment indicates, in the absence of unlawful discrimination and in an arena of fair and open competition, DBE companies can be expected to perform 7.0% of the work. This percentage is set as the DBE participation goal for this contract. Consequently, in addition to the other award criteria established for this contract, the Department will only award this contract to a bidder who makes a good faith effort to meet this goal of DBE participation in the performance of the work. A bidder makes a good faith effort for award consideration if either of the following is done in accordance with the procedures set for in this Special Provision:

- (a) The bidder documents enough DBE participation has been obtained to meet the goal or,
- (b) The bidder documents a good faith effort has been made to meet the goal, even though the effort did not succeed in obtaining enough DBE participation to meet the goal.

DBE LOCATOR REFERENCES. Bidders shall consult the IL UCP DBE Directory as a reference source for DBE-certified companies. In addition, the Department maintains a letting and item specific DBE locator information system whereby DBE companies can register their interest in providing quotes on particular bid items advertised for letting. Information concerning DBE companies willing to quote work for particular contracts may be obtained by contacting the Department's Bureau of Small Business Enterprises at telephone number (217) 785-4611, or by visiting the Department's website at:
<http://www.idot.illinois.gov/doing-business/certifications/disadvantaged-business-enterprise-certification/il-ucp-directory/index>.

BIDDING PROCEDURES. Compliance with this Special Provision is a material bidding requirement and failure of the bidder to comply will render the bid not responsive.

The bidder shall submit a DBE Utilization Plan (form SBE 2026), and a DBE Participation Statement (form SBE 2025) for each DBE company proposed for the performance of work to achieve the contract goal, with the bid. If the Utilization Plan indicates the contract goal will not be met, documentation of good faith efforts shall also be submitted. The documentation of good faith efforts must include copies of each DBE and non-DBE subcontractor quote submitted to the bidder when a non-DBE subcontractor is selected over a DBE for work on the contract. The required forms and documentation must be submitted as a single .pdf file using the "Integrated Contractor Exchange (iCX)" application within the Department's "EBids System".

The Department will not accept a Utilization Plan if it does not meet the bidding procedures set forth herein and the bid will be declared not responsive. In the event the bid is declared not responsive, the Department may elect to cause the forfeiture of the penal sum of the bidder's proposal guaranty and may deny authorization to bid the project if re-advertised for bids.

GOOD FAITH EFFORT PROCEDURES. The contract will not be awarded until the Utilization Plan is approved. All information submitted by the bidder must be complete, accurate and adequately document enough DBE participation has been obtained or document the good faith efforts of the bidder, in the event enough DBE participation has not been obtained, before the Department will commit to the performance of the contract by the bidder. The Utilization Plan will be approved by the Department if the Utilization Plan documents sufficient commercially useful DBE work to meet the contract goal or the bidder submits sufficient documentation of a good faith effort to meet the contract goal pursuant to 49 CFR Part 26, Appendix A. This means the bidder must show that all necessary and reasonable steps were taken to achieve the contract goal. Necessary and reasonable steps are those which, by their scope, intensity and appropriateness to the objective, could reasonably be expected to obtain sufficient DBE participation, even if they were not successful. The Department will consider the quality, quantity, and intensity of the kinds of efforts the bidder has made. Mere *pro forma* efforts, in other words efforts done as a matter of form, are not good faith efforts; rather, the bidder is expected to have taken genuine efforts that would be reasonably expected of a bidder actively and aggressively trying to obtain DBE participation sufficient to meet the contract goal.

- (a) The following is a list of types of action that the Department will consider as part of the evaluation of the bidder's good faith efforts to obtain participation. These listed factors are not intended to be a mandatory checklist and are not intended to be exhaustive. Other factors or efforts brought to the attention of the Department may be relevant in appropriate cases and will be considered by the Department.

- (1) Soliciting through all reasonable and available means (e.g. attendance at pre-bid meetings, advertising and/or written notices) the interest of all certified DBE companies that have the capability to perform the work of the contract. The bidder must solicit this interest within sufficient time to allow the DBE companies to respond to the solicitation. The bidder must determine with certainty if the DBE companies are interested by taking appropriate steps to follow up initial solicitations.

(2) Selecting portions of the work to be performed by DBE companies in order to increase the likelihood that the DBE goals will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate DBE participation, even when the Contractor might otherwise prefer to perform these work items with its own forces.

(3) Providing interested DBE companies with adequate information about the plans, specifications, and requirements of the contract in a timely manner to assist them in responding to a solicitation.

(4) a. Negotiating in good faith with interested DBE companies. It is the bidder's responsibility to make a portion of the work available to DBE subcontractors and suppliers and to select those portions of the work or material needs consistent with the available DBE subcontractors and suppliers, so as to facilitate DBE participation. Evidence of such negotiation includes the names, addresses, and telephone numbers of DBE companies that were considered; a description of the information provided regarding the plans and specifications for the work selected for subcontracting; and evidence as to why additional agreements could not be reached for DBE companies to perform the work.

b. A bidder using good business judgment would consider a number of factors in negotiating with subcontractors, including DBE subcontractors, and would take a firm's price and capabilities as well as contract goals into consideration. However, the fact that there may be some additional costs involved in finding and using DBE companies is not in itself sufficient reason for a bidder's failure to meet the contract DBE goal, as long as such costs are reasonable. Also the ability or desire of a bidder to perform the work of a contract with its own organization does not relieve the bidder of the responsibility to make good faith efforts. Bidders are not, however, required to accept higher quotes from DBE companies if the price difference is excessive or unreasonable. In accordance with the above Bidding Procedures, the documentation of good faith efforts must include copies of each DBE and non-DBE subcontractor quotes submitted to the bidder when a non-DBE subcontractor was selected over a DBE for work on the contract.

(5) Not rejecting DBE companies as being unqualified without sound reasons based on a thorough investigation of their capabilities. The bidder's standing within its industry, membership in specific groups, organizations, or associations and political or social affiliations (for example union vs. non-union employee status) are not legitimate causes for the rejection or non-solicitation of bids in the bidder's efforts to meet the project goal.

(6) Making efforts to assist interested DBE companies in obtaining bonding, lines of credit, or insurance as required by the recipient or Contractor.

(7) Making efforts to assist interested DBE companies in obtaining necessary equipment, supplies, materials, or related assistance or services.

(8) Effectively using the services of available minority/women community organizations; minority/women contractors' groups; local, state, and federal minority/women business assistance offices; and other organizations as allowed on a case-by-case basis to provide assistance in the recruitment and placement of DBE companies.

(b) If the Department determines the bidder has made a good faith effort to secure the work commitment of DBE companies to meet the contract goal, the Department will award the contract provided it is otherwise eligible for award. If the Department determines the bidder has failed to meet the requirements of this Special Provision or that a good faith effort has not been made, the Department will notify the responsible company official designated in the Utilization Plan that the bid is not responsive. The notification will also include a statement of reasons for the adverse determination. If the Utilization Plan is not approved because it is deficient as a technical matter, unless waived by the Department, the bidder will be notified and will be allowed no more than a five calendar day period to cure the deficiency.

(c) The bidder may request administrative reconsideration of an adverse determination by emailing the Department at "DOT.DBUEP@illinois.gov" within the five calendar days after the receipt of the notification of the determination. The determination shall become final if a request is not made on or before the fifth calendar day. A request may provide additional written documentation or argument concerning the issues raised in the determination statement of reasons, provided the documentation and arguments address efforts made prior to submitting the bid. The request will be reviewed by the Department's Reconsideration Officer. The Reconsideration Officer will extend an opportunity to the bidder to meet in person to consider all issues of documentation and whether the bidder made a good faith effort to meet the goal. After the review by the Reconsideration Officer, the bidder will be sent a written decision within ten working days after receipt of the request for reconsideration, explaining the basis for finding that the bidder did or did not meet the goal or make adequate good faith efforts to do so. A final decision by the Reconsideration Officer that a good faith effort was made shall approve the Utilization Plan submitted by the bidder and shall clear the contract for award. A final decision that a good faith effort was not made shall render the bid not responsive.

CALCULATING DBE PARTICIPATION. The Utilization Plan values represent work anticipated to be performed and paid for upon satisfactory completion. The Department is only able to count toward the achievement of the overall goal and the contract goal the value of payments made for the work actually performed by DBE companies. In addition, a DBE must perform a commercially useful function on the contract to be counted. A commercially useful function is generally performed when the DBE is responsible for the work and is carrying out its responsibilities by actually performing, managing, and supervising the work involved. The Department and Contractor are governed by the provisions of 49 CFR Part 26.55(c) on questions of commercially useful functions as it affects the work. Specific counting guidelines are provided in 49 CFR Part 26.55, the provisions of which govern over the summary contained herein.

(a) DBE as the Contractor: 100 percent goal credit for that portion of the work performed by the DBE's own forces, including the cost of materials and supplies. Work that a DBE subcontracts to a non-DBE does not count toward the DBE goals.

- (b) DBE as a joint venture Contractor: 100 percent goal credit for that portion of the total dollar value of the contract equal to the distinct, clearly defined portion of the work performed by the DBE's own forces.
- (c) DBE as a subcontractor: 100 percent goal credit for the work of the subcontract performed by the DBE's own forces, including the cost of materials and supplies, excluding the purchase of materials and supplies or the lease of equipment by the DBE subcontractor from the Contractor or its affiliates. Work that a DBE subcontractor in turn subcontracts to a non-DBE does not count toward the DBE goal.
- (d) DBE as a trucker: 100 percent goal credit for trucking participation provided the DBE is responsible for the management and supervision of the entire trucking operation for which it is responsible. At least one truck owned, operated, licensed, and insured by the DBE must be used on the contract. Credit will be given for the following:
 - (1) The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the contract.
 - (2) The DBE may also lease trucks from a non-DBE firm, including from an owner-operator. The DBE who leases trucks from a non-DBE is entitled to credit only for the fee or commission it receives as a result of the lease arrangement.
- (e) DBE as a material supplier:
 - (1) 60 percent goal credit for the cost of the materials or supplies purchased from a DBE regular dealer.
 - (2) 100 percent goal credit for the cost of materials or supplies obtained from a DBE manufacturer.
 - (3) 100 percent credit for the value of reasonable fees and commissions for the procurement of materials and supplies if not a DBE regular dealer or DBE manufacturer.

CONTRACT COMPLIANCE. Compliance with this Special Provision is an essential part of the contract. The Department is prohibited by federal regulations from crediting the participation of a DBE included in the Utilization Plan toward either the contract goal or the Department's overall goal until the amount to be applied toward the goals has been paid to the DBE. The following administrative procedures and remedies govern the compliance by the Contractor with the contractual obligations established by the Utilization Plan. After approval of the Utilization Plan and award of the contract, the Utilization Plan and individual DBE Participation Statements become part of the contract. If the Contractor did not succeed in obtaining enough DBE participation to achieve the advertised contract goal, and the Utilization Plan was approved and contract awarded based upon a determination of good faith, the total dollar value of DBE work calculated in the approved Utilization Plan as a percentage of the awarded contract value shall become the amended contract goal. All work indicated for performance by an approved DBE shall be performed, managed, and supervised by the DBE executing the DBE Participation Commitment Statement.

- (a) **NO AMENDMENT.** No amendment to the Utilization Plan may be made without prior written approval from the Department's Bureau of Small Business Enterprises. All requests for amendment to the Utilization Plan shall be emailed to the Department at DOT.DBEP@illinois.gov.
- (b) **CHANGES TO WORK.** Any deviation from the DBE condition-of-award or contract plans, specifications, or special provisions must be approved, in writing, by the Department as provided elsewhere in the Contract. The Contractor shall notify affected DBEs in writing of any changes in the scope of work which result in a reduction in the dollar amount condition-of-award to the contract. Where the revision includes work committed to a new DBE subcontractor, not previously involved in the project, then a Request for Approval of Subcontractor, Department form BC 260A or AER 260A, must be signed and submitted. If the commitment of work is in the form of additional tasks assigned to an existing subcontract, a new Request for Approval of Subcontractor will not be required. However, the Contractor must document efforts to assure the existing DBE subcontractor is capable of performing the additional work and has agreed in writing to the change.
- (c) **SUBCONTRACT.** The Contractor must provide copies of DBE subcontracts to the Department upon request. Subcontractors shall ensure that all lower tier subcontracts or agreements with DBEs to supply labor or materials be performed in accordance with this Special Provision.
- (d) **ALTERNATIVE WORK METHODS.** In addition to the above requirements for reductions in the condition of award, additional requirements apply to the two cases of Contractor-initiated work substitution proposals. Where the contract allows alternate work methods which serve to delete or create underruns in condition of award DBE work, and the Contractor selects that alternate method or, where the Contractor proposes a substitute work method or material that serves to diminish or delete work committed to a DBE and replace it with other work, then the Contractor must demonstrate one of the following:
 - (1) The replacement work will be performed by the same DBE (as long as the DBE is certified in the respective item of work) in a modification of the condition of award; or

(2) The DBE is aware its work will be deleted or will experience underruns and has agreed in writing to the change. If this occurs, the Contractor shall substitute other work of equivalent value to a certified DBE or provide documentation of good faith efforts to do so; or

(3) The DBE is not capable of performing the replacement work or has declined to perform the work at a reasonable competitive price. If this occurs, the Contractor shall substitute other work of equivalent value to a certified DBE or provide documentation of good faith efforts to do so.

(e) TERMINATION AND REPLACEMENT PROCEDURES. The Contractor shall not terminate or replace a DBE listed on the approved Utilization Plan, or perform with other forces work designated for a listed DBE except as provided in this Special Provision. The Contractor shall utilize the specific DBEs listed to perform the work and supply the materials for which each is listed unless the Contractor obtains the Department's written consent as provided in subsection (a) of this part. Unless Department consent is provided for termination of a DBE subcontractor, the Contractor shall not be entitled to any payment for work or material unless it is performed or supplied by the DBE in the Utilization Plan.

As stated above, the Contractor shall not terminate or replace a DBE subcontractor listed in the approved Utilization Plan without prior written consent. This includes, but is not limited to, instances in which the Contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm. Written consent will be granted only if the Bureau of Small Business Enterprises agrees, for reasons stated in its concurrence document, that the Contractor has good cause to terminate or replace the DBE firm. Before transmitting to the Bureau of Small Business Enterprises any request to terminate and/or substitute a DBE subcontractor, the Contractor shall give notice in writing to the DBE subcontractor, with a copy to the Bureau, of its intent to request to terminate and/or substitute, and the reason for the request. The Contractor shall give the DBE five days to respond to the Contractor's notice. The DBE so notified shall advise the Bureau and the Contractor of the reasons, if any, why it objects to the proposed termination of its subcontract and why the Bureau should not approve the Contractor's action. If required in a particular case as a matter of public necessity, the Bureau may provide a response period shorter than five days.

For purposes of this paragraph, good cause includes the following circumstances:

- (1) The listed DBE subcontractor fails or refuses to execute a written contract;
- (2) The listed DBE subcontractor fails or refuses to perform the work of its subcontract in a way consistent with normal industry standards. Provided, however, that good cause does not exist if the failure or refusal of the DBE subcontractor to perform its work on the subcontract results from the bad faith or discriminatory action of the Contractor;
- (3) The listed DBE subcontractor fails or refuses to meet the Contractor's reasonable, nondiscriminatory bond requirements;
- (4) The listed DBE subcontractor becomes bankrupt, insolvent, or exhibits credit unworthiness;
- (5) The listed DBE subcontractor is ineligible to work on public works projects because of suspension and debarment proceedings pursuant to 2 CFR Parts 180, 215 and 1200 or applicable state law.
- (6) The Contractor has determined the listed DBE subcontractor is not a responsible contractor;
- (7) The listed DBE subcontractor voluntarily withdraws from the projects and provides written notice to the Contractor of its withdrawal;
- (8) The listed DBE is ineligible to receive DBE credit for the type of work required;
- (9) A DBE owner dies or becomes disabled with the result that the listed DBE subcontractor is unable to complete its work on the contract;
- (10) Other documented good cause that compels the termination of the DBE subcontractor. Provided, that good cause does not exist if the Contractor seeks to terminate a DBE it relied upon to obtain the contract so that the Contractor can self-perform the work for which the DBE contractor was engaged or so that the Contractor can substitute another DBE or non-DBE contractor after contract award.

When a DBE is terminated or fails to complete its work on the Contract for any reason, the Contractor shall make a good faith effort to find another DBE to substitute for the original DBE to perform at least the same amount of work under the contract as the terminated DBE to the extent needed to meet the established Contract goal. The good faith efforts shall be documented by the Contractor. If the Department requests documentation under this provision, the Contractor shall submit the documentation within seven days, which may be extended for an additional seven days if necessary at the request of the Contractor. The Department will provide a written determination to the Contractor stating whether or not good faith efforts have been demonstrated.

(f) FINAL PAYMENT. After the performance of the final item of work or delivery of material by a DBE and final payment therefore to the DBE by the Contractor, but not later than 30 calendar days after payment has been made by the Department to the Contractor for such work or material, the Contractor shall submit a DBE Payment Agreement on Department form SBE 2115 to the Resident Engineer. If full and final payment has not been made to the DBE, the DBE Payment Agreement shall indicate whether a disagreement as to the payment required exists between the Contractor and the DBE or if the Contractor believes the work has not been satisfactorily

completed. If the Contractor does not have the full amount of work indicated in the Utilization Plan performed by the DBE companies indicated in the Utilization Plan and after good faith efforts are reviewed, the Department may deduct from contract payments to the Contractor the amount of the goal not achieved as liquidated and ascertained damages. The Contractor may request an administrative reconsideration of any amount deducted as damages pursuant to subsection (h) of this part.

(g) **ENFORCEMENT.** The Department reserves the right to withhold payment to the Contractor to enforce the provisions of this Special Provision. Final payment shall not be made on the contract until such time as the Contractor submits sufficient documentation demonstrating achievement of the goal in accordance with this Special Provision or after liquidated damages have been determined and collected.

(h) **RECONSIDERATION.** Notwithstanding any other provision of the contract, including but not limited to Article 109.09 of the Standard Specifications, the Contractor may request administrative reconsideration of a decision to deduct the amount of the goal not achieved as liquidated damages. A request to reconsider shall be delivered to the Contract Compliance Section and shall be handled and considered in the same manner as set forth in paragraph (c) of "Good Faith Effort Procedures" of this Special Provision, except a final decision that a good faith effort was not made during contract performance to achieve the goal agreed to in the Utilization Plan shall be the final administrative decision of the Department. The result of the reconsideration process is not administratively appealable to the U.S. Department of Transportation.

SPECIAL PROVISION FOR WEEKLY DBE TRUCKING REPORTS (BDE)

Effective: June 2, 2012

Revised: November 1, 2021

The Contractor shall submit a weekly report of Disadvantaged Business Enterprise (DBE) trucks hired by the Contractor or subcontractors (i.e. not owned by the Contractor or subcontractors) that are used for DBE goal credit.

The report shall be submitted to the Resident Engineer on Division of Aeronautics Form "AER 723" within ten business days following the reporting period. The reporting period shall be Sunday through Saturday for each week reportable trucking activities occur.

Any costs associated with providing weekly DBE trucking reports shall be considered as included in the contract unit prices bid for the various items of work involved and no additional compensation will be allowed.

SPECIAL PROVISION FOR SUBCONTRACTOR MOBILIZATION PAYMENTS

Effective: November 2, 2017

Revised: April 1, 2019

To account for the preparatory work and the operations necessary for the movement of subcontractor personnel, equipment, supplies, and incidentals to the project site and for all other work or operations that must be performed or costs incurred when beginning work approved for subcontracting according to the Specifications, the Contractor shall make a mobilization payment to each subcontractor.

This mobilization payment shall be made at least seven days prior to the subcontractor starting work. The amount paid shall be at the following percentage of the amount of the subcontract reported on form AER 260A submitted for the approval of the subcontractor's work.

Value of Subcontract Reported on Form AER 260A	Mobilization Percentage
Less than \$10,000	25%
\$10,000 to less than \$20,000	20%
\$20,000 to less than \$40,000	18%
\$40,000 to less than \$60,000	16%
\$60,000 to less than \$80,000	14%
\$80,000 to less than \$100,000	12%
\$100,000 to less than \$250,000	10%
\$250,000 to less than \$500,000	9%
\$500,000 to \$750,000	8%
Over \$750,000	7%

The mobilization payment to the subcontractor is an advance payment of the reported amount of the subcontract and is not a payment in addition to the amount of the subcontract; therefore, the amount of the advance payment will be deducted from future progress payments.

This provision shall be incorporated directly or by reference into each subcontract approved by the Department.

SPECIAL PROVISION FOR PAYMENTS TO SUBCONTRACTORS

Effective: November 2, 2017

Federal regulations found at 49 CFR §26.29 mandate the Department to establish a contract clause to require Contractors to pay subcontractors for satisfactory performance of their subcontracts and to set the time for such payments.

State law also addresses the timing of payments to be made to subcontractors and material suppliers. Section 7 of the Prompt Payment Act, 30 ILCS 540/7, requires that when a Contractor receives any payment from the Department, the Contractor shall make corresponding, proportional payments to each subcontractor and material supplier performing work or supplying material within 15 calendar days after receipt of the Department payment. Section 7 of the Act further provides that interest in the amount of two percent per month, in addition to the payment due, shall be paid to any subcontractor or material supplier by the Contractor if the payment required by the Act is withheld or delayed without reasonable cause. The Act also provides that the time for payment required and the calculation of any interest due applies to transactions between subcontractors and lower-tier subcontractors and material suppliers throughout the contracting chain.

This Special Provision establishes the required federal contract clause, and adopts the 15 calendar day requirement of the State Prompt Payment Act for purposes of compliance with the federal regulation regarding payments to subcontractors. This contract is subject to the following payment obligations.

When progress payments are made to the Contractor according to the Specifications, the Contractor shall make a corresponding payment to each subcontractor and material supplier in proportion to the work satisfactorily completed by each subcontractor and for the material supplied to perform any work of the contract. The proportionate amount of partial payment due to each subcontractor and material supplier throughout the contracting chain shall be determined by the quantities measured or otherwise determined as eligible for payment by the Department and included in the progress payment to the Contractor. Subcontractors and material suppliers shall be paid by the Contractor within 15 calendar days after the receipt of payment from the Department. The Contractor shall not hold retainage from the subcontractors. These obligations shall also apply to any payments made by subcontractors and material suppliers to their subcontractors and material suppliers; and to all payments made to lower tier subcontractors and material suppliers throughout the contracting chain. Any payment or portion of a payment subject to this provision may only be withheld from the subcontractor or material supplier to whom it is due for reasonable cause. If reasonable cause is asserted, written notice shall be provided to the applicable subcontractor and/or material supplier and the Engineer within five days of the Contractor receiving payment. The written notice shall identify the contract number, the subcontract or material purchase agreement, a detailed reason for refusal, the value of payment being withheld, and the specific remedial actions required of the subcontractor and/or material supplier so that payment can be made.

This Special Provision does not create any rights in favor of any subcontractor or material supplier against the State or authorize any cause of action against the State on account of any payment, nonpayment, delayed payment, or interest claimed by application of the State Prompt Payment Act. The Department will not approve any delay or postponement of the 15 day requirement except for reasonable cause shown after notice and hearing pursuant to Section 7(b) of the State Prompt Payment Act. State law creates other and additional remedies available to any subcontractor or material supplier, regardless of tier, who has not been paid for work properly performed or material furnished. These remedies are a lien against public funds set forth in Section 23(c) of the Mechanics Lien Act, 770 ILCS 60/23(c), and a recovery on the Contractor's payment bond according to the Public Construction Bond Act, 30 ILCS 550.

SPECIAL PROVISION FOR SUBCONTRACTOR AND DBE PAYMENT REPORTING (BDE)

Effective: April 2, 2018

Subcontractor and Disadvantaged Business Enterprise Payment Reporting

The Contractor shall report all payments made to the following parties:

- (a) first tier subcontractors;
- (b) lower tier subcontractors affecting disadvantaged business enterprise (DBE) goal credit;
- (c) material suppliers or trucking firms that are part of the Contractor's submitted DBE utilization plan.

The report shall be made through the Department's on-line subcontractor payment reporting system within 21 days of making the payment.

SPECIAL PROVISION FOR ADDITIONAL STATE REQUIREMENTS FOR FEDERAL-AID CONSTRUCTION CONTRACTS

Effective: February 1, 1969

Revised: January 1, 2017

EQUAL EMPLOYMENT OPPORTUNITY

In the event of the Contractor's noncompliance with the provisions of this Equal Employment Opportunity Clause, the Illinois Human Rights Act, or the Illinois Department of Human Rights Rules and Regulations, the Contractor may be declared ineligible for future contracts or subcontracts with the State of Illinois or any of its political sub-divisions or municipal corporations, and the contract may be cancelled or voided in whole or in part, and such other sanctions or penalties may be imposed or remedies invoked as provided by statute or regulation.

During the performance of this Contract, the Contractor agrees as follows:

- (1) That it will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, marital status, order of protection status, national origin or ancestry, citizenship status, age, physical or mental disability

unrelated to ability, military status, or an unfavorable discharge from military service; and further that it will examine all job classifications to determine if minority persons or women are underutilized and will take appropriate affirmative action to rectify any such underutilization.

(2) That, if it hires additional employees in order to perform this contract or any portion hereof, it will determine the availability (in accordance with the Illinois Department of Human Rights Rules and Regulations) of minorities and women in the area(s) from which it may reasonably recruit and it will hire for each job classification for which employees are hired in such a way that minorities and women are not underutilized.

(3) That, in all solicitations or advertisements for employees placed by it or on its behalf, it will state that all applicants will be afforded equal opportunity without discrimination because of race, color, religion, sex, sexual orientation, marital status, order of protection status, national origin or ancestry, citizenship status, age, physical or mental disability unrelated to ability, military status, or an unfavorable discharge from military service.

(4) That it will send to each labor organization or representative of workers with which it has or is bound by a collective bargaining or other agreement or understanding, a notice advising such labor organization or representative of the Contractor's obligations under the Illinois Human Rights Act and the Illinois Department of Human Rights Rules and Regulations. If any labor organization or representative fails or refuses to cooperate with the Contractor in its efforts to comply with such Act and Rules and Regulations, the Contractor will promptly so notify the Illinois Department of Human Rights and IDOT and will recruit employees from other sources when necessary to fulfill its obligations thereunder.

(5) That it will submit reports as required by the Illinois Department of Human Rights Rules and Regulations, furnish all relevant information as may from time to time be requested by the Illinois Department of Human Rights or IDOT, and in all respects comply with the Illinois Human Rights Act and the Illinois Department of Human Rights Rules and Regulations.

(6) That it will permit access to all relevant books, records, accounts, and work sites by personnel of IDOT and the Illinois Department of Human Rights for purposes of investigation to ascertain compliance with the Illinois Human Rights Act and the Illinois Department of Human Rights Rules and Regulations.

(7) That it will include verbatim or by reference the provisions of this clause in every subcontract it awards under which any portion of the contract obligations are undertaken or assumed, so that the provisions will be binding upon the subcontractor. In the same manner as with other provisions of this contract, the Contractor will be liable for compliance with applicable provisions of this clause by subcontractors; and further it will promptly notify IDOT and the Illinois Department of Human Rights in the event any subcontractor fails or refuses to comply with these provisions. In addition, the Contractor will not utilize any subcontractor declared by the Illinois Human Rights Commission to be ineligible for contracts or subcontracts with the State of Illinois or any of its political subdivisions or municipal corporations.

SPECIAL PROVISION FOR NPDES CERTIFICATION

In accordance with the provisions of the Illinois Environmental Protection Act, the Illinois Pollution Control Board Rules and Regulations (35 Ill. Adm. Code, Subtitle C, Chapter I), and the Clean Water Act, and the regulations thereunder, this certification is required for all construction contracts that will result in the disturbance of one or more acres total land area.

The bidder certifies under penalty of law that he/she understands the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR100000) that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

The Airport Owner or its Agent will:

- 1) prepare, sign and submit the Notice of Intent (NOI)
- 2) conduct site inspections and complete and file the inspection reports
- 3) submit Incidence of Non-Compliance (ION) forms
- 4) submit Notice of Termination (NOT) form

Prior to the issuance of the Notice-to-Proceed, for each erosion control measure identified in the Storm Water Pollution Prevention Plan, the contractor or subcontractor responsible for the control measure(s) must sign the above certification (forms to be provided by the Department).

SPECIAL PROVISION FOR COMPLETION TIME VIA CALENDAR DAYS

It being understood and agreed that the completion within the time limit is an essential part of the contract, the bidder agrees to complete the work within 152 calendar days, unless additional time is granted by the Engineer in accordance with the provisions of the specifications. In case of failure to complete the work on or before the time named herein, or within such extra time as may have been

allowed by extensions, the bidder agrees that the Department of Transportation shall withhold from such sum as may be due him/her under the terms of this contract, the costs, as set forth in Section 80-08 Failure to Complete on Time of the Specifications, which costs shall be considered and treated not as a penalty but as damages due to the State from the bidder by reason of the failure of the bidder to complete the work within the time specified in the contract.

State of Illinois
Department of Transportation

SPECIAL PROVISION
FOR
SECTION 80 PROSECUTION AND PROGRESS

80-08 FAILURE TO COMPLETE ON TIME.

ADD:

Schedule of Deductions for Each Day of Overrun in Contract Time			
Original Contract Amount		Daily Charges	
From More Than	To and Including	Calendar Day	Work Day
\$ 0	\$ 100,000	\$ 475	\$ 675
100,000	500,000	750	1,050
500,000	1,000,000	1,025	1,425
1,000,000	3,000,000	1,275	1,725
3,000,000	6,000,000	1,425	2,000
6,000,000	12,000,000	2,300	3,450
12,000,000	And over	6,775	9,525

APPENDIX A – FEDERAL AVIATION ADMINISTRATION (FAA) REQUIRED CONTRACT PROVISIONS

A1 ACCESS TO RECORDS AND REPORTS

A1.1 CONTRACT CLAUSE

ACCESS TO RECORDS AND REPORTS

The Contractor must maintain an acceptable cost accounting system. The Contractor agrees to provide the sponsor, the Federal Aviation Administration, and the Comptroller General of the United States or any of their duly authorized representatives, access to any books, documents, papers, and records of the contractor which are directly pertinent to the specific contract for the purpose of making audit, examination, excerpts and transcriptions. The Contractor agrees to maintain all books, records and reports required under this contract for a period of not less than three years after final payment is made and all pending matters are closed.

A2 AFFIRMATIVE ACTION REQUIREMENTS

A2.1 SOLICITATION CLAUSE

NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITY

1. The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.
2. The goals and timetables for minority and female participation, expressed in percentage terms for the contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

The following goal for female utilization in each construction craft and trade shall apply to all Contractors holding Federal and federally-assisted construction contracts and subcontracts in excess of \$10,000. The goal is applicable to the Contractor's total on-site construction workforce, regardless of whether or not part of that workforce is performing work on a Federal, federally assisted or nonfederally related construction contract or subcontract.

AREA COVERED (STATEWIDE)

Goals for Women apply nationwide.

	GOAL
<u>Economic Area</u> (percent)	Goal (percent)
Female Utilization.....	6.9

Until further notice, the following goals for minority utilization in each construction craft and trade shall apply to all Contractors holding Federal and federally-assisted construction contracts and subcontracts in excess of \$10,000 to be performed in the respective geographical areas. The goals are applicable to the Contractor's total on-site construction workforce, regardless of whether or not part of that workforce is performing work on a Federal, federally-assisted or nonfederally related construction contract or subcontract.

<u>Economic Area</u> (percent)	Goal
056 Paducah, KY: Non-SMSA Counties - IL - Hardin, Massac, Pope KY - Ballard, Caldwell, Calloway, Carlisle, Crittenden, Fulton, Graves, Hickman, Livingston, Lyon, McCracken, Marshall	5.2
080 Evansville, IN: Non-SMSA Counties - IL - Edwards, Gallatin, Hamilton, Lawrence, Saline, Wabash, White IN - Dubois, Knox, Perry, Pike, Spencer KY - Hancock, Hopkins, McLean, Mublenberg, Ohio, Union, Webster	3.5
081 Terre Haute, IN: Non-SMSA Counties - IL - Clark, Crawford IN - Parke	2.5
083 Chicago, IL: SMSA Counties: 1600 Chicago, IL - IL - Cook, DuPage, Kane, Lake, McHenry, Will	19.6
3740 Kankakee, IL - IL - Kankakee	9.1

Non-SMSA Counties	18.4
IL - Bureau, DeKalb, Grundy, Iroquois, Kendall, LaSalle, Livingston, Putnam	
IN - Jasper, Laporte, Newton, Pulaski, Starke	
084 Champaign - Urbana, IL:	
SMSA Counties:	
1400 Champaign - Urbana - Rantoul, IL - IL - Champaign	7.8
Non-SMSA Counties -	4.8
IL - Coles, Cumberland, Douglas, Edgar, Ford, Piatt, Vermilion	
085 Springfield - Decatur, IL:	
SMSA Counties:	
2040 Decatur, IL - IL - Macon	7.6
7880 Springfield, IL - IL - Menard, Sangamon	4.5
Non-SMSA Counties	4.0
IL - Cass, Christian, Dewitt, Logan, Morgan, Moultrie, Scott, Shelby	
086 Quincy, IL:	
Non-SMSA Counties	3.1
IL - Adams, Brown, Pike	
MO - Lewis, Marion, Pike, Ralls	
087 Peoria, IL:	
SMSA Counties:	
1040 Bloomington - Normal, IL - IL - McLean	2.5
6120 Peoria, IL - IL - Peoria, Tazewell, Woodford	4.4
Non-SMSA Counties -	3.3
IL - Fulton, Knox, McDonough, Marshall, Mason, Schuyler, Stark, Warren	
088 Rockford, IL:	
SMSA Counties:	
6880 Rockford, IL - IL - Boone, Winnebago	6.3
Non-SMSA Counties -	4.6
IL - Lee, Ogle, Stephenson	
098 Dubuque, IA:	
Non-SMSA Counties -	0.5
IL - JoDavieess	
IA - Atlamakee, Clayton, Delaware, Jackson, Winnesheik	
WI - Crawford, Grant, Lafayette	
099 Davenport, Rock Island, Moline, IA - IL:	
SMSA Counties:	
1960 Davenport, Rock Island, Moline, IA - IL - IL - Henry, Rock Island	4.6
IA - Scott	
Non-SMSA Counties -	3.4
IL - Carroll, Hancock, Henderson, Mercer, Whiteside	
IA - Clinton, DesMoines, Henry, Lee, Louisa, Muscatine	
MO - Clark	
107 St. Louis, MO:	
SMSA Counties:	
7040 St. Louis, MO - IL - IL - Clinton, Madison, Monroe, St. Clair	14.7
MO - Franklin, Jefferson, St. Charles, St. Louis, St. Louis City	
Non-SMSA Counties -	11.4
IL - Alexander, Bond, Calhoun, Clay, Effingham, Fayette, Franklin, Greene, Jackson, Jasper, Jefferson, Jersey, Johnson, Macoupin, Marion, Montgomery, Perry, Pulaski, Randolph, Richland, Union, Washington,	

Wayne, Williamson
MO - Bollinger, Butler, Cape Girardeau, Carter, Crawford, Dent, Gasconade,
Iron, Lincoln, Madison, Maries, Mississippi, Montgomery, Perry, Phelps,
Reynolds, Ripley, St. Francois, St. Genevieve, Scott, Stoddard, Warren,
Washington, Wayne

These goals are applicable to all of the contractor's construction work (whether or not it is Federal or federally-assisted) performed in the covered area. If the contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs (OFCCP) within 10 working days of award of any construction subcontract in excess of \$10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

4. As used in this notice and in the contract resulting from this solicitation, the "covered area" is Savoy, Illinois; Champaign County.

A3 BREACH OF CONTRACT TERMS

A3.1 CONTRACT CLAUSE

This provision is required for all contracts that exceed the simplified acquisition threshold as stated in 2 CFR Part 200, Appendix II (A). This threshold is occasionally adjusted for inflation and is now equal to \$150,000.

BREACH OF CONTRACT TERMS

Any violation or breach of terms of this contract on the part of the contractor or its subcontractors may result in the suspension or termination of this contract or such other action that may be necessary to enforce the rights of the parties of this agreement.

Owner will provide the Contractor written notice that describes the nature of the breach and corrective actions the Contractor must undertake in order to avoid termination of the contract. Owner reserves the right to withhold payments to Contractor until such time the Contractor corrects the breach or the Owner elects to terminate the contract. The Owner's notice will identify a specific date by which the Contractor must correct the breach. Owner may proceed with termination of the contract if the Contractor fails to correct the breach by deadline indicated in the Owner's notice.

The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder are in addition to, and not a limitation of, any duties, obligations, rights and remedies otherwise imposed or available by law.

A4 BUY AMERICAN PREFERENCE

A4.1 CONTRACT CLAUSE

- (a) The Aviation Safety and Capacity Expansion Act of 1990 provides that preference be given to steel and manufactured products produced in the United States when funds are expended pursuant to a grant issued under the Airport Improvement Program (AIP).
- (b) Any and all steel products used in the performance of this contract by the Contractor, subcontractors, producers, and suppliers are required to adhere to the Illinois Steel Products Procurement Act, which requires that all steel items be of 100 percent domestic origin and manufacture. Any products listed under the Federal Aviation Administration's (FAA) nationwide approved list of "Equipment Meeting Buy American Requirements" shall be deemed as meeting the requirements of the Illinois Steel Products Procurement Act.
- (c) The successful bidder will be required to assure that only domestic steel and domestically manufactured products will be used by the Contractor, subcontractors, producers, and suppliers in the performance of this contract. The North American Free Trade Agreement (NAFTA) specifically excluded federal grant programs such as the AIP. Therefore, NAFTA does not change the requirement to comply with the Buy American requirement in the Act. Exceptions to this are for products, other than steel, that:
 - (1) the FAA has determined, under the Aviation Safety and Capacity Expansion Act of 1990, are not produced in the United States in sufficient and reasonably available quantities or of a satisfactory quality;
 - (2) the FAA has determined, under the Aviation Safety and Capacity Expansion Act of 1990, that domestic preference would be inconsistent with the public interest;
 - (3) the FAA has determined that inclusion of domestic material will increase the cost of the overall project contract by more than 25 percent; or

- (4) the FAA has determined, under the Aviation Safety and Capacity Expansion Act of 1990,
- (i) the cost of components and subcomponents produced in the United States is more than 60 percent of the cost of all components of the facility or equipment, and
 - (ii) final assembly of the facility or equipment has occurred in the United States.

The FAA must grant waivers for any items that are included in these above exceptions. Bidders can review items already approved under the FAA nationwide approved list of "Equipment Meeting Buy American Requirements" on the FAA website, which do not require a specific FAA waiver.

All waivers are the responsibility of the Contractor, must be obtained prior to the Notice to Proceed, and must be submitted to the Illinois Division of Aeronautics for review and approval before being forwarded to the FAA. Any products used on the project that cannot meet the domestic requirement, and for which a waiver prior to the Notice to Proceed was not obtained, will be rejected for use and subject to removal and replacement with no additional compensation, and the contractor deemed non-responsive.

A5 CIVIL RIGHTS - GENERAL

A5.1 CONTRACT CLAUSE

GENERAL CIVIL RIGHTS PROVISIONS

The contractor agrees to comply with pertinent statutes, Executive Orders and such rules as are promulgated to ensure that no person shall, on the grounds of race, creed, color, national origin, sex, age, or disability be excluded from participating in any activity conducted with or benefiting from Federal assistance.

This provision binds the contractor and sub-tier contractors from the bid solicitation period through the completion of the contract. This provision is in addition to that required of Title VI of the Civil Rights Act of 1964.

A6 CIVIL RIGHTS – TITLE VI ASSURANCE

A6.1 CONTRACT CLAUSE

A6.1.1 Title VI Solicitation Notice

Title VI Solicitation Notice:

The University of Illinois, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 U.S.C. §§ 2000d to 2000d-4) and the Regulations, hereby notifies all bidders that it will affirmatively ensure that any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award.

A6.1.2 Title VI Clauses for Compliance with Nondiscrimination Requirements

Compliance with Nondiscrimination Requirements

During the performance of this contract, the contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "contractor") agrees as follows:

Compliance with Regulations: The contractor (hereinafter includes consultants) will comply with the Title VI List of Pertinent Nondiscrimination Acts And Authorities, as they may be amended from time to time, which are herein incorporated by reference and made a part of this contract.

Non-discrimination: The contractor, with regard to the work performed by it during the contract, will not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The contractor will not participate directly or indirectly in the discrimination prohibited by the Nondiscrimination Acts and Authorities, including employment practices when the contract covers any activity, project, or program set forth in Appendix B of 49 CFR part 21.

Solicitations for Subcontracts, Including Procurements of Materials and Equipment: In all solicitations, either by competitive bidding, or negotiation made by the contractor for work to be performed under a subcontract, including procurements of materials, or leases of equipment, each potential subcontractor or supplier will be notified by the contractor of the contractor's obligations under this contract and the Nondiscrimination Acts And Authorities on the grounds of race, color, or national origin.

Information and Reports: The contractor will provide all information and reports required by the Acts, the Regulations, and directives issued pursuant thereto and will permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the sponsor or the Federal Aviation Administration to be pertinent to ascertain compliance with such Nondiscrimination Acts And Authorities and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish the information, the contractor will so certify to the sponsor or the Federal Aviation Administration, as appropriate, and will set forth what efforts it has made to obtain the information.

Sanctions for Noncompliance: In the event of a contractor's noncompliance with the Non-discrimination provisions of this contract, the sponsor will impose such contract sanctions as it or the Federal Aviation Administration may determine to be appropriate, including, but not limited to:

- a. Withholding payments to the contractor under the contract until the contractor complies; and/or
- b. Cancelling, terminating, or suspending a contract, in whole or in part.

Incorporation of Provisions: The contractor will include the provisions of paragraphs one through six in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Acts, the Regulations and directives issued pursuant thereto. The contractor will take action with respect to any subcontract or procurement as the sponsor or the Federal Aviation Administration may direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, that if the contractor becomes involved in, or is threatened with litigation by a subcontractor, or supplier because of such direction, the contractor may request the sponsor to enter into any litigation to protect the interests of the sponsor. In addition, the contractor may request the United States to enter into the litigation to protect the interests of the United States.

A6.1.3 Title VI List of Pertinent Nondiscrimination Acts and Authorities

Title VI List of Pertinent Nondiscrimination Acts and Authorities

During the performance of this contract, the contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the “contractor”) agrees to comply with the following non-discrimination statutes and authorities; including but not limited to:

- Title VI of the Civil Rights Act of 1964 (42 U.S.C. § 2000d *et seq.*, 78 stat. 252), (prohibits discrimination on the basis of race, color, national origin); 49 CFR part 21 (Non-discrimination In Federally-Assisted Programs of The Department of Transportation—Effectuation of Title VI of The Civil Rights Act of 1964);
- The Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, (42 U.S.C. § 4601), (prohibits unfair treatment of persons displaced or whose property has been acquired because of Federal or Federal-aid programs and projects);
- Section 504 of the Rehabilitation Act of 1973, (29 U.S.C. § 794 *et seq.*), as amended, (prohibits discrimination on the basis of disability); and 49 CFR part 27;
- The Age Discrimination Act of 1975, as amended, (42 U.S.C. § 6101 *et seq.*), (prohibits discrimination on the basis of age);
- Airport and Airway Improvement Act of 1982, (49 USC § 471, Section 47123), as amended, (prohibits discrimination based on race, creed, color, national origin, or sex);
- The Civil Rights Restoration Act of 1987, (PL 100-209), (Broadened the scope, coverage and applicability of Title VI of the Civil Rights Act of 1964, The Age Discrimination Act of 1975 and Section 504 of the Rehabilitation Act of 1973, by expanding the definition of the terms “programs or activities” to include all of the programs or activities of the Federal-aid recipients, sub-recipients and contractors, whether such programs or activities are Federally funded or not);
- Titles II and III of the Americans with Disabilities Act of 1990, which prohibit discrimination on the basis of disability in the operation of public entities, public and private transportation systems, places of public accommodation, and certain testing entities (42 U.S.C. §§ 12131 – 12189) as implemented by Department of Transportation regulations at 49 CFR parts 37 and 38;
- The Federal Aviation Administration’s Non-discrimination statute (49 U.S.C. § 47123) (prohibits discrimination on the basis of race, color, national origin, and sex);
- Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which ensures non-discrimination against minority populations by discouraging programs, policies, and activities with disproportionately high and adverse human health or environmental effects on minority and low-income populations;
- Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency, and resulting agency guidance, national origin discrimination includes discrimination because of limited English proficiency (LEP). To ensure compliance with Title VI, you must take reasonable steps to ensure that LEP persons have meaningful access to your programs (70 Fed. Reg. at 74087 to 74100);
- Title IX of the Education Amendments of 1972, as amended, which prohibits you from discriminating because of sex in education programs or activities (20 U.S.C. 1681 *et seq.*).

A7 CLEAN AIR AND WATER POLLUTION CONTROL

A7.1 CONTRACT CLAUSE

This provision is required for all contracts and lower tier contracts that exceed \$150,000.

CLEAN AIR AND WATER POLLUTION CONTROL

Contractor agrees to comply with all applicable standards, orders, and regulations issued pursuant to the Clean Air Act (42 U.S.C. § 740-7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. § 1251-1387). The Contractor agrees to report any violation to the Owner immediately upon discovery. The Owner assumes responsibility for notifying the Environmental Protection Agency (EPA) and the Federal Aviation Administration.

Contractor must include this requirement in all subcontracts that exceeds \$150,000.

A8 CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS

A8.1 CONTRACT CLAUSE

This provision applies to all contracts and lower tier contracts that exceed \$100,000, and employ laborers, mechanics, watchmen, and guards.

CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS

1. Overtime Requirements.

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic, including watchmen and guards, in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

2. Violation; Liability for Unpaid Wages; Liquidated Damages.

In the event of any violation of the clause set forth in paragraph (1) of this clause, the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (1) of this clause, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (1) of this clause.

3. Withholding for Unpaid Wages and Liquidated Damages.

The Federal Aviation Administration (FAA) or the Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph 2 of this clause.

4. Subcontractors.

The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraphs (1) through (4) and also a clause requiring the subcontractor to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (1) through (4) of this clause.

A9 COPELAND "ANTI-KICKBACK" ACT

A9.1 CONTRACT CLAUSE

COPELAND "ANTI-KICKBACK" ACT

Contractor must comply with the requirements of the Copeland "Anti-Kickback" Act (18 U.S.C. 874 and 40 U.S.C. 3145), as supplemented by Department of Labor regulation 29 CFR part 3. Contractor and subcontractors are prohibited from inducing, by any means, any person employed on the project to give up any part of the compensation to which the employee is entitled. The Contractor and each Subcontractor must submit to the Owner, a weekly statement on the wages paid to each employee performing on covered work during the prior week. Owner must report any violations of the Act to the Federal Aviation Administration.

A10 DAVIS-BACON REQUIREMENTS

A10.1 CONTRACT CLAUSE

DAVIS-BACON REQUIREMENTS

1. Minimum Wages

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by the Secretary of Labor under the Copeland Act (29 CFR Part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalent thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided*, that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under (1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can easily be seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, D.C. 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (1)(ii)(B) or (C) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, *Provided*, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2 Withholding.

The Federal Aviation Administration or the sponsor shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of work, all or part of the wages required by the contract, the Federal Aviation Administration may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual costs incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to the Federal Aviation Administration. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/esa/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the Federal Aviation Administration if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit them to the applicant, sponsor, or owner, as the case may be, for transmission to the Federal Aviation Administration, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, sponsor, or owner).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under 29 CFR § 5.5(a)(3)(ii), the appropriate information is being maintained under 29 CFR § 5.5 (a)(3)(i) and that such information is correct and complete;

(2) That each laborer and mechanic (including each helper, apprentice and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations 29 CFR Part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (3)(i) of this section available for inspection, copying or transcription by authorized representatives of the sponsor, the Federal Aviation Administration or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the contractor, sponsor, applicant or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and Trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate that is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal Employment Opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

5. Compliance with Copeland Act Requirements.

The contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.

6. Subcontracts.

The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR Part 5.5(a)(1) through (10) and such other clauses as the Federal Aviation Administration may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR Part 5.5.

7. Contract Termination: Debarment.

A breach of the contract clauses in paragraph 1 through 10 of this section may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance With Davis-Bacon and Related Act Requirements.

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.

9. Disputes Concerning Labor Standards.

Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6 and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

10. Certification of Eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

A11 DEBARMENT AND SUSPENSION

A11.1 CONTRACT CLAUSE

A11.1.1 Bidder or Offeror Certification

CERTIFICATION OF OFFERER/BIDDER REGARDING DEBARMENT

By submitting a bid/proposal under this solicitation, the bidder or offeror certifies that neither it nor its principals are presently debarred or suspended by any Federal department or agency from participation in this transaction.

A11.1.2 Lower Tier Contract Certification

CERTIFICATION OF LOWER TIER CONTRACTORS REGARDING DEBARMENT

The successful bidder, by administering each lower tier subcontract that exceeds \$25,000 as a "covered transaction", must verify each lower tier participant of a "covered transaction" under the project is not presently debarred or otherwise disqualified from participation in this federally assisted project. The successful bidder will accomplish this by:

1. Checking the System for Award Management at website: <http://www.sam.gov>
2. Collecting a certification statement similar to the Certificate Regarding Debarment and Suspension (Bidder or Offeror), above.
3. Inserting a clause or condition in the covered transaction with the lower tier contract

If the FAA later determines that a lower tier participant failed to disclose to a higher tier participant that it was excluded or disqualified at the time it entered the covered transaction, the FAA may pursue any available remedies, including suspension and debarment of the non-compliant participant.

A12 DISADVANTAGED BUSINESS ENTERPRISE

A12.1 REQUIRED PROVISIONS

A12.1.1 Solicitation Language (Solicitations that include a Project Goal)

The Owner's award of this contract is conditioned upon Bidder or Offeror satisfying the good faith effort requirements of 49 CFR §26.53.

As a condition of bid responsiveness, the Bidder or Offeror must submit the following information with their proposal on the forms provided herein:

- (1) The names and addresses of Disadvantaged Business Enterprise (DBE) firms that will participate in the contract;
- (2) A description of the work that each DBE firm will perform;
- (3) The dollar amount of the participation of each DBE firm listed under (1)
- (4) Written statement from Bidder or Offeror that attests their commitment to use the DBE firm(s) listed under (1) to meet the Owner's project goal;

- (5) If Bidder or Offeror cannot meet the advertised project DBE goal; evidence of good faith efforts undertaken by the Bidder or Offeror as described in appendix A to 49 CFR Part 26.

A12.1.2 Solicitation Language (Race/Gender Neutral Means)

The requirements of 49 CFR part 26 apply to this contract. It is the policy of the University of Illinois to practice nondiscrimination based on race, color, sex or national origin in the award or performance of this contract. The Owner encourages participation by all firms qualifying under this solicitation regardless of business size or ownership.

A12.1.3 Prime Contracts (Projects covered by DBE Program)

DISADVANTAGED BUSINESS ENTERPRISES

Contract Assurance (§ 26.13) - The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR part 26 in the award and administration of Department of Transportation-assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the Owner deems appropriate, which may include, but is not limited to:

- 1) Withholding monthly progress payments;
- 2) Assessing sanctions;
- 3) Liquidated damages; and/or
- 4) Disqualifying the Contractor from future bidding as non-responsible.

A13 DISTRACTED DRIVING

A13.1 CONTRACT CLAUSE

TEXTING WHEN DRIVING

In accordance with Executive Order 13513, "Federal Leadership on Reducing Text Messaging While Driving" (10/1/2009) and DOT Order 3902.10 "Text Messaging While Driving" (12/30/2009), the FAA encourages recipients of Federal grant funds to adopt and enforce safety policies that decrease crashes by distracted drivers, including policies to ban text messaging while driving when performing work related to a grant or sub-grant.

In support of this initiative, the Owner encourages the Contractor to promote policies and initiatives for its employees and other work personnel that decrease crashes by distracted drivers, including policies that ban text messaging while driving motor vehicles while performing work activities associated with the project. The Contractor must include the substance of this clause in all sub-tier contracts exceeding \$3,500 and involve driving a motor vehicle in performance of work activities associated with the project.

A14 ENERGY CONSERVATION REQUIREMENTS

A14.1 CONTRACT CLAUSE

ENERGY CONSERVATION REQUIREMENTS

Contractor and Subcontractor agree to comply with mandatory standards and policies relating to energy efficiency as contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 U.S.C. 6201 *et seq.*).

A15 EQUAL EMPLOYMENT OPPORTUNITY (E.E.O.)

A15.1 MANDATORY CONTRACT CLAUSE

A15.1.1 E.E.O. Contract Clause

EQUAL OPPORTUNITY CLAUSE

During the performance of this contract, the contractor agrees as follows:

- (1) The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identify or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
- (2) The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.
- (3) The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5) The contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance: *Provided, however,* That in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency the contractor may request the United States to enter into such litigation to protect the interests of the United States.

A 15.1.2 EEO Specification

STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS

1. As used in these specifications:

- a. "Covered area" means the geographical area described in the solicitation from which this contract resulted;
- b. "Director" means Director, Office of Federal Contract Compliance Programs (OFCCP), U.S. Department of Labor, or any person to whom the Director delegates authority;
- c. "Employer identification number" means the Federal social security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941;
- d. "Minority" includes:
 - (1) Black (all) persons having origins in any of the Black African racial groups not of Hispanic origin);
 - (2) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin regardless of race);
 - (3) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
 - (4) American Indian or Alaskan native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

2. Whenever the contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3. If the contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors shall be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved plan is individually required to comply with its obligations under the EEO clause and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4. The contractor shall implement the specific affirmative action standards provided in paragraphs 7a through 7p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing construction work in a geographical area where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

5. Neither the provisions of any collective bargaining agreement nor the failure by a union with whom the contractor has a collective bargaining agreement to refer either minorities or women shall excuse the contractor's obligations under these specifications, Executive Order 11246 or the regulations promulgated pursuant thereto.

6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees shall be employed by the contractor during the training period and the contractor shall have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees shall be trained pursuant to training programs approved by the U.S. Department of Labor.
7. The contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The contractor shall document these efforts fully and shall implement affirmative action steps at least as extensive as the following:
- a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the contractor's employees are assigned to work. The contractor, where possible, will assign two or more women to each construction project. The contractor shall specifically ensure that all foremen, superintendents, and other onsite supervisory personnel are aware of and carry out the contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
 - b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.
 - c. Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source, or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the contractor by the union or, if referred, not employed by the contractor, this shall be documented in the file with the reason therefore along with whatever additional actions the contractor may have taken.
 - d. Provide immediate written notification to the Director when the union or unions with which the contractor has a collective bargaining agreement has not referred to the contractor a minority person or female sent by the contractor, or when the contractor has other information that the union referral process has impeded the contractor's efforts to meet its obligations.
 - e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the contractor's employment needs, especially those programs funded or approved by the Department of Labor. The contractor shall provide notice of these programs to the sources compiled under 7b above.
 - f. Disseminate the contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
 - g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination, or other employment decisions including specific review of these items with onsite supervisory personnel such as superintendents, general foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
 - h. Disseminate the contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the contractor's EEO policy with other contractors and subcontractors with whom the contractor does or anticipates doing business.
 - i. Direct its recruitment efforts, both oral and written, to minority, female, and community organizations, to schools with minority and female students; and to minority and female recruitment and training organizations serving the contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the contractor shall send written notification to organizations, such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
 - j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of a contractor's workforce.
 - k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.
 - l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel, for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
 - m. Ensure that seniority practices, job classifications, work assignments, and other personnel practices do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the contractor's obligations under these specifications are being carried out.
 - n. Ensure that all facilities and company activities are non-segregated except that separate or single user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
 - o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the contractor's EEO policies and affirmative action obligations.

8. Contractors are encouraged to participate in voluntary associations, which assist in fulfilling one or more of their affirmative action obligations (7a through 7p). The efforts of a contractor association, joint contractor union, contractor community, or other similar groups of which the contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under 7a through 7p of these specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the contractor. The obligation to comply, however, is the contractor's and failure of such a group to fulfill an obligation shall not be a defense for the contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, if the particular group is employed in a substantially disparate manner (for example, even though the contractor has achieved its goals for women generally,) the contractor may be in violation of the Executive Order if a specific minority group of women is underutilized.

10. The contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

11. The contractor shall not enter into any subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

12. The contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

13. The contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

14. The contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government, and to keep records. Records shall at least include for each employee, the name, address, telephone number, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

A16 FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)

A16.1 CONTRACT CLAUSE

All contracts and subcontracts that result from this solicitation incorporate by reference the provisions of 29 CFR part 201, the Federal Fair Labor Standards Act (FLSA), with the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part time workers.

The contractor has full responsibility to monitor compliance to the referenced statute or regulation. The contractor must address any claims or disputes that arise from this requirement directly with the U.S. Department of Labor – Wage and Hour Division.

A17 LOBBYING AND INFLUENCING FEDERAL EMPLOYEES

A17.1 CONTRACT CLAUSE

This provision is required for all contracts that exceed \$100,000.

CERTIFICATION REGARDING LOBBYING

The bidder or offeror certifies by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Bidder or Offeror, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, sub-grants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

A18 PROHIBITION of SEGREGATED FACILITIES

A18.1 CONTRACT CLAUSE

PROHIBITION of SEGREGATED FACILITIES

(a) The Contractor agrees that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The Contractor agrees that a breach of this clause is a violation of the Equal Opportunity clause in this contract.

(b) "Segregated facilities," as used in this clause, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees, that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex, or national origin because of written or oral policies or employee custom. The term does not include separate or single-user rest rooms or necessary dressing or sleeping areas provided to assure privacy between the sexes.

(c) The Contractor shall include this clause in every subcontract and purchase order that is subject to the Equal Opportunity clause of this contract.

A19 OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

A19.1 CONTRACT CLAUSE

All contracts and subcontracts that result from this solicitation incorporate by reference the requirements of 29 CFR Part 1910 with the same force and effect as if given in full text. Contractor must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. The Contractor retains full responsibility to monitor its compliance and their subcontractor's compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (29 CFR Part 1910). Contractor must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

A20 PROCUREMENT OF RECOVERED MATERIALS

A20.1 CONTRACT CLAUSE

Procurement of Recovered Materials

Contractor and subcontractor agree to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act, and the regulatory provisions of 40 CFR Part 247. In the performance of this contract and to the extent practicable, the Contractor and subcontractors are to use of products containing the highest percentage of recovered materials for items designated by the Environmental Protection Agency (EPA) under 40 CFR Part 247 whenever:

- a) The contract requires procurement of \$10,000 or more of a designated item during the fiscal year; or,

The contractor has procured \$10,000 or more of a designated item using Federal funding during the previous fiscal year.

The list of EPA-designated items is available at www.epa.gov/epawaste/conservation/tools/cpg/products/.

Section 6002(c) establishes exceptions to the preference for recovery of EPA-designated products if the contractor can demonstrate the item is:

- a) Not reasonably available within a timeframe providing for compliance with the contract performance schedule;
- b) Fails to meet reasonable contract performance requirements; or
- c) Is only available at an unreasonable price.

A21 RIGHT TO INVENTIONS

A21.1 CONTRACT CLAUSE

RIGHTS TO INVENTIONS

Contracts or agreements that include the performance of experimental, developmental, or research work must provide for the rights of the Federal Government and the Owner in any resulting invention as established by 37 CFR part 401, Rights to Inventions Made by Non-profit Organizations and

Small Business Firms under Government Grants, Contracts, and Cooperative Agreements. This contract incorporates by reference the patent and inventions rights as specified within in the 37 CFR §401.14. Contractor must include this requirement in all sub-tier contracts involving experimental, developmental or research work.

A22 SEISMIC SAFETY

A22.1 CONTRACT CLAUSE

A22.1.1 Construction Contracts

Seismic Safety

The contractor agrees to ensure that all work performed under this contract, including work performed by subcontractors, conforms to a building code standard that provides a level of seismic safety substantially equivalent to standards established by the National Earthquake Hazards Reduction Program (NEHRP). Local building codes that model their code after the current version of the International Building Code (IBC) meet the NEHRP equivalency level for seismic safety.

A23 TAX DELINQUENCY AND FELONY CONVICTIONS

A23.1 CONTRACT CLAUSE

CERTIFICATION OF OFFERER/BIDDER REGARDING TAX DELINQUENCY AND FELONY CONVICTIONS

Certifications

- 1) The applicant represents that it is not a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.
- 2) The applicant represents that it is not a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

Note

If an applicant cannot comply with either of the above representations, the applicant is ineligible to receive an award unless the sponsor has received notification from the agency suspension and debarment official (SDO) that the SDO has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore must provide information to the owner about its tax liability or conviction to the Owner, who will then notify the FAA Airports District Office, which will then notify the agency's SDO to facilitate completion of the required considerations before award decisions are made.

The applicant agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification in all lower tier subcontracts.

Term Definitions

Felony conviction: Felony conviction means a conviction within the preceding twenty-four (24) months of a felony criminal violation under any Federal law and includes conviction of an offense defined in a section of the U.S. code that specifically classifies the offense as a felony and conviction of an offense that is classified as a felony under 18 U.S.C. § 3559.

Tax Delinquency: A tax delinquency is any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

A24 TERMINATION OF CONTRACT

A24.1 CONTRACT CLAUSE

A24.1.1 Termination for Convenience

Termination for Convenience (Construction & Equipment Contracts)

The Owner may terminate this contract in whole or in part at any time by providing written notice to the Contractor. Such action may be without cause and without prejudice to any other right or remedy of Owner. Upon receipt of a written notice of termination, except as explicitly directed by the Owner, the Contractor shall immediately proceed with the following obligations regardless of any delay in determining or adjusting amounts due under this clause:

1. Contractor must immediately discontinue work as specified in the written notice.
2. Terminate all subcontracts to the extent they relate to the work terminated under the notice.
3. Discontinue orders for materials and services except as directed by the written notice.

4. Deliver to the owner all fabricated and partially fabricated parts, completed and partially completed work, supplies, equipment and materials acquired prior to termination of the work and as directed in the written notice.
5. Complete performance of the work not terminated by the notice.
6. Take action as directed by the owner to protect and preserve property and work related to this contract that Owner will take possession.

Owner agrees to pay Contractor for:

- a) completed and acceptable work executed in accordance with the contract documents prior to the effective date of termination;

documented expenses sustained prior to the effective date of termination in performing work and furnishing labor, materials, or equipment as required by the contract documents in connection with uncompleted work;

reasonable and substantiated claims, costs and damages incurred in settlement of terminated contracts with Subcontractors and Suppliers; and reasonable and substantiated expenses to the contractor directly attributable to Owner's termination action

Owner will not pay Contractor for loss of anticipated profits or revenue or other economic loss arising out of or resulting from the Owner's termination action.

The rights and remedies this clause provides are in addition to any other rights and remedies provided by law or under this contract.

A24.1.2 Termination for Default

Termination for Default (Construction)

Section 80-09 of FAA Advisory Circular 150/5370-10 establishes conditions, rights and remedies associated with Owner termination of this contract due default of the Contractor.

A25 TRADE RESTRICTION CERTIFICATION

A25.1 CONTRACT CLAUSE

TRADE RESTRICTION CERTIFICATION

By submission of an offer, the Offeror certifies that with respect to this solicitation and any resultant contract, the Offeror -

- a. is not owned or controlled by one or more citizens of a foreign country included in the list of countries that discriminate against U.S. firms as published by the Office of the United States Trade Representative (U.S.T.R.);
- b. has not knowingly entered into any contractor subcontract for this project with a person that is a citizen or national of a foreign country included on the list of countries that discriminate against U.S. firms as published by the U.S.T.R; and
- c. has not entered into any subcontract for any product to be used on the Federal on the project that is produced in a foreign country included on the list of countries that discriminate against U.S. firms published by the U.S.T.R.

This certification concerns a matter within the jurisdiction of an agency of the United States of America and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code, Section 1001.

The Offeror/Contractor must provide immediate written notice to the Owner if the Offeror/Contractor learns that its certification or that of a subcontractor was erroneous when submitted or has become erroneous by reason of changed circumstances. The Contractor must require subcontractors provide immediate written notice to the Contractor if at any time it learns that its certification was erroneous by reason of changed circumstances.

Unless the restrictions of this clause are waived by the Secretary of Transportation in accordance with 49 CFR 30.17, no contract shall be awarded to an Offeror or subcontractor:

- (1) who is owned or controlled by one or more citizens or nationals of a foreign country included on the list of countries that discriminate against U.S. firms published by the U.S.T.R. or
- (2) whose subcontractors are owned or controlled by one or more citizens or nationals of a foreign country on such U.S.T.R. list or
- (3) who incorporates in the public works project any product of a foreign country on such U.S.T.R. list;

Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by this provision. The knowledge and information of a contractor is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

The Offeror agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification without modification in all lower tier subcontracts. The contractor may rely on the certification of a prospective subcontractor that it is not a firm from a foreign country included on the list of countries that discriminate against U.S. firms as published by U.S.T.R, unless the Offeror has knowledge that the certification is erroneous.

This certification is a material representation of fact upon which reliance was placed when making an award. If it is later determined that the Contractor or subcontractor knowingly rendered an erroneous certification, the Federal Aviation Administration may direct through the Owner cancellation of the contract or subcontract for default at no cost to the Owner or the FAA.

A26 VETERAN'S PREFERENCE

A26.1 CONTRACT CLAUSE

VETERAN'S PREFERENCE

In the employment of labor (excluding executive, administrative, and supervisory positions), the contractor and all sub-tier contractors must give preference to covered veterans as defined within Title 49 United States Code Section 47112. Covered veterans include Vietnam-era veterans, Persian Gulf veterans, Afghanistan-Iraq war veterans, disabled veterans, and small business concerns (as defined by 15 U.S.C. 632) owned and controlled by disabled veterans. This preference only applies when there are covered veterans readily available and qualified to perform the work to which the employment relates.

SECTION III

SPECIAL PROVISIONS

FOR

MIDFIELD INTERSECTION RECONFIGURATION

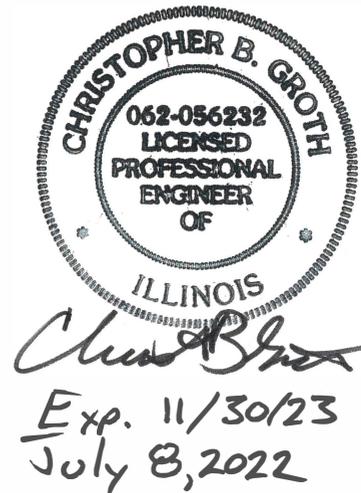
AT

UNIVERSITY OF ILLINOIS- WILLARD AIRPORT
SAVOY, ILLINOIS

IL. PROJECT NO. CMI-4793
AIP PROJECT NO. 3-17-0016-0XX

July 8, 2022

PREPARED BY:



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Part 1 – General Contract Provisions

Section 10 Definition of Terms

When the following terms are used in these specifications, in the contract, or in any documents or other instruments pertaining to construction where these specifications govern, the intent and meaning shall be defined as follows:

Paragraph Number	Term	Definition
10-01	AASHTO	The American Association of State Highway and Transportation Officials.
10-02	Access Road	The right-of-way, the roadway and all improvements constructed thereon connecting the airport to a public roadway.
10-03	Advertisement	A public announcement, as required by local law, inviting bids for work to be performed and materials to be furnished.
10-04	Airport	Airport means an area of land or water which is used or intended to be used for the landing and takeoff of aircraft; an appurtenant area used or intended to be used for airport buildings or other airport facilities or rights of way; airport buildings and facilities located in any of these areas, and a heliport.
10-05	Airport Improvement Program (AIP)	A grant-in-aid program, administered by the Federal Aviation Administration (FAA).
10-06	Air Operations Area (AOA)	The term air operations area (AOA) shall mean any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An air operation area shall include such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runway, taxiway, or apron.
10-07	Apron	Area where aircraft are parked, unloaded or loaded, fueled and/or serviced.
10-08	ASTM International (ASTM)	Formerly known as the American Society for Testing and Materials (ASTM).
10-09	Award	The Department’s notice to the lowest responsible and responsive bidder of the acceptance of the submitted bid subject to the approval and execution of a satisfactory contract, receipt of a payment and performance bond and compliance with such other conditions as may be specified or otherwise required by law.

Paragraph Number	Term	Definition
10-10	Bidder	Any individual, partnership, firm, or corporation, acting directly or through a duly authorized representative, who submits a proposal for the work contemplated.
10-11	Building Area	An area on the airport to be used, considered, or intended to be used for airport buildings or other airport facilities or rights-of-way together with all airport buildings and facilities located thereon.
10-12	Calendar Day	Every day shown on the calendar.
10-13	Certificate of Analysis (COA)	The COA is the manufacturer’s Certificate of Compliance (COC) including all applicable test results required by the specifications.
10-14	Certificate of Compliance (COC)	The manufacturer’s certification stating that materials or assemblies furnished fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer’s authorized representative.
10-14.1	Change Authorization	Only change orders, contract adjustment, and extra work identified on for AER 51 “Authorization of Contract Changes” and signed by the Department, represent authorized modifications to the contract.
10-15	Change Order	Formal, written directive issued to the Contractor or agreement that amends a contract in order to address contingencies affecting the performance and completion of the contract, including but not limited to such matters as extra work, design changes or alterations to the plans or specifications for which no special provision is included in the original contract. The work covered by a change order must be within the general scope of the contract. For work that would increase or decrease the total amount of award contract, or any major contract item, by more than 25%, reference 10-59 Supplemental Agreement.
10-16	Contract	<p>A written agreement between the Department and the Contractor that establishes the obligations of the parties including but not limited to performance of work, furnishing of labor, equipment and materials and the basis of payment.</p> <p>The awarded contract includes but may not be limited to: Advertisement, Contract form, Proposal, Performance bond, payment bond, General provisions, certifications and representations, Technical Specifications, Plans, Supplemental Provisions, standards incorporated by reference and issued addenda.</p>
10-16.1	Contract Adjustment	A written price adjustment that adds to or deducts from a contract in accordance with provisions included in the original contract, including, not limited to, increased or decreased quantities, incentives, changed conditions and the addition of missing pay items called for in the contract.

Paragraph Number	Term	Definition
10-17	Contract Item (Pay Item)	A specific unit of work for which a price is provided in the contract.
10-17.1	Contract Modification	A mutually agreed written change in the terms of the contract such as change orders and supplemental agreements.
10-18	Contract Time	The number of calendar days or working days, stated in the proposal, allowed for completion of the contract, including authorized time extensions. If a calendar date of completion is stated in the proposal, in lieu of a number of calendar or working days, the contract shall be completed by that date.
10-19	Contractor	The individual, partnership, firm, or corporation primarily liable for the acceptable performance of the work contracted and for the payment of all legal debts pertaining to the work who acts directly or through lawful agents or employees to complete the contract work.
10-20	Contractors Quality Control (QC) Facilities	The Contractor's QC facilities in accordance with the Contractor Quality Control Program (CQCP).
10-21	Contractor Quality Control Program (CQCP)	Details the methods and procedures that will be taken to assure that all materials and completed construction required by the contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors.
10-22	Control Strip	A demonstration by the Contractor that the materials, equipment, and construction processes results in a product meeting the requirements of the specification.
10-23	Construction Safety and Phasing Plan (CSPP)	The overall plan for safety and phasing of a construction project developed by the airport operator, or developed by the airport operator's consultant and approved by the airport operator. It is included in the invitation for bids and becomes part of the project specifications.
10-23.1	Department	The department of Transportation of the State of Illinois, acting as authorized agent, for the purposes of the prosecution of the project(s) of the Department when the State is the awarding authority.
10-23.2	Director	The director of the Office of Intermodal Project Implementation for the state of Illinois, Department of Transportation.
10-24	Drainage System	The system of pipes, ditches, and structures by which surface or subsurface waters are collected and conducted from the airport area.
10-25	Engineer	The Chief Engineer of Aeronautics for the State of Illinois, Department of Transportation to be responsible for engineering,

Paragraph Number	Term	Definition
		inspection, and/or observation of the contract work and acting directly or through an authorized representative.
10-26	Equipment	All machinery, together with the necessary supplies for upkeep and maintenance; and all tools and apparatus necessary for the proper construction and acceptable completion of the work.
10-27	Extra Work	An item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, but which is found by the Department to be essential and germane to the satisfactory completion of the contract within the intended scope of the contract as previously modified.
10-28	FAA	The Federal Aviation Administration. When used to designate a person, FAA shall mean the Administrator or their duly authorized representative.
10-29	Federal Specifications	The federal specifications and standards, commercial item descriptions, and supplements, amendments, and indices prepared and issued by the General Services Administration.
10-30	Force Account	<p>a. Contract Force Account - A method of payment that addresses extra work performed by the Contractor on a time and material basis.</p> <p>b. Department Force Account - Work performed for the project by the Department's employees.</p>
10-30.1	IDOT	The Illinois Department of Transportation
10-30.2	Inspector	An authorized representative of the Engineer/RPR assigned to make all necessary observations and/or observation of tests of the work performed or being performed, or of the materials furnished or being furnished by the contractor.
10-31	Intention of Terms	<p>Whenever, in these specifications or on the plans, the words “directed,” “required,” “permitted,” “ordered,” “designated,” “prescribed,” or words of like import are used, it shall be understood that the direction, requirement, permission, order, designation, or prescription of the Engineer and/or Resident Engineer (RE) is intended; and similarly, the words “approved,” “acceptable,” “satisfactory,” or words of like import, shall mean approved by, or acceptable to, or satisfactory to the Engineer and/or RE, subject in each case to the final determination of the Department.</p> <p>Any reference to a specific requirement of a numbered paragraph of the contract specifications or a cited standard shall be interpreted to include all general requirements of the entire section, specification item, or cited standard that may be pertinent to such specific reference.</p>

Paragraph Number	Term	Definition
10-32	Lighting	A system of fixtures providing or controlling the light sources used on or near the airport or within the airport buildings. The field lighting includes all luminous signals, markers, floodlights, and illuminating devices used on or near the airport or to aid in the operation of aircraft landing at, taking off from, or taxiing on the airport surface.
10-33	Major and Minor Contract Items	A major contract item shall be any item that is listed in the proposal, the total cost of which is equal to or greater than 20% of the total amount of the award contract. All other items shall be considered minor contract items.
10-34	Materials	Any substance specified for use in the construction of the contract work.
10-35	Modification of Standards (MOS)	Any deviation from standard specifications applicable to material and construction methods in accordance with FAA Order 5300.1.
10-36	Notice to Proceed (NTP)	A written notice to the Contractor to begin the actual contract work on a previously agreed to date. If applicable, the Notice to Proceed shall state the date on which the contract time begins.
10-37	Department	The term “Department” shall mean the party of the first part or the contracting agency signatory to the contract. Where the term “Department” is capitalized in this document, it shall mean airport Sponsor only. The Department for this project is the University of Illinois – Willard Airport.
10-38	Passenger Facility Charge (PFC)	Per 14 Code of Federal Regulations (CFR) Part 158 and 49 United States Code (USC) § 40117, a PFC is a charge imposed by a public agency on passengers enplaned at a commercial service airport it controls.
10-39	Pavement Structure	The combined surface course, base course(s), and subbase course(s), if any, considered as a single unit.
10-40	Payment bond	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will pay in full all bills and accounts for materials and labor used in the construction of the work.
10-41	Performance bond	The approved form of security furnished by the Contractor and their own surety as a guaranty that the Contractor will complete the work in accordance with the terms of the contract.
10-42	Plans	The official drawings or exact reproductions which show the location, character, dimensions and details of the airport and the work to be done and which are to be considered as a part of the contract, supplementary to the specifications. Plans may also be referred to as 'contract drawings.'

Paragraph Number	Term	Definition
10-43	Project	The agreed scope of work for accomplishing specific airport development with respect to a particular airport.
10-44	Proposal	The written offer of the bidder (when submitted on the approved proposal form) to perform the contemplated work and furnish the necessary materials in accordance with the provisions of the plans and specifications.
10-45	Proposal guaranty	The security furnished with a proposal to guarantee that the bidder will enter into a contract if their own proposal is accepted by the Department.
10-45.1	Progress Schedule	A schedule provided by the contractor showing the sequence of work. The schedule shall also indicate the individual rates and the number of calendar days estimated for the completion of each item in order to carry the project to completion within the contract time.
10-45.2	Project Engineer	The representative of the Department, whether employed directly by the Department or employed by an engineering firm retained by the Department, acting as the immediate supervisor of the Resident Engineer. The Project Engineer must be a Licensed Professional Engineer in the state of Illinois.
10-46	Quality Assurance (QA)	Department’s responsibility to assure that construction work completed complies with specifications for payment.
10-47	Quality Control (QC)	Contractor’s responsibility to control material(s) and construction processes to complete construction in accordance with project specifications.
10-48	Quality Assurance (QA) Inspector	An authorized representative of the Engineer and/or Resident Project Representative (RPR) assigned to make all necessary inspections, observations, tests, and/or observation of tests of the work performed or being performed, or of the materials furnished or being furnished by the Contractor.
10-49	Quality Assurance (QA) Laboratory	The official quality assurance testing laboratories of the Department or such other laboratories as may be designated by the Engineer or RE. May also be referred to as Engineer’s, Department’s, or QA Laboratory.
10-50	Resident Project Representative (RPR)	The individual, partnership, firm, or corporation duly authorized by the Department to be responsible for all necessary inspections, observations, tests, and/or observations of tests of the contract work performed or being performed, or of the materials furnished or being furnished by the Contractor, and acting directly or through an authorized representative. The Resident Engineer must meet the approval and qualification requirements set forth by the Department and reside on the construction site all times the Contractor is working.

Paragraph Number	Term	Definition
10-51	Runway	The area on the airport prepared for the landing and takeoff of aircraft.
10-52	Runway Safety Area (RSA)	A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to aircraft. See the construction safety and phasing plan (CSPP) for limits of the RSA.
10-53	Safety Plan Compliance Document (SPCD)	Details how the Contractor will comply with the CSPP.
10-54	Specifications	A part of the contract containing the written directions and requirements for completing the contract work. Standards for specifying materials or testing which are cited in the contract specifications by reference shall have the same force and effect as if included in the contract physically.
10-55	Sponsor	A Sponsor is defined in 49 USC § 47102(24) as a public agency that submits to the FAA for an AIP grant; or a private Department of a public-use airport that submits to the FAA an application for an AIP grant for the airport.
10-55.1	State	The State of Illinois.
10-55.2	Subcontractor	An individual, firm, partnership or corporation who, with the written consent of the Engineer, assume obligation for performing specified pay items for the contractor.
10-56	Structures	Airport facilities such as bridges; culverts; catch basins, inlets, retaining walls, cribbing; storm and sanitary sewer lines; water lines; underdrains; electrical ducts, manholes, handholes, lighting fixtures and bases; transformers; navigational aids; buildings; vaults; and, other manmade features of the airport that may be encountered in the work and not otherwise classified herein.
10-57	Subgrade	The soil that forms the pavement foundation.
10-58	Superintendent	The Contractor’s executive representative who is present on the work during progress, authorized to receive and fulfill instructions from the RPR, and who shall supervise and direct the construction.
10-59	Supplemental Agreement	A written agreement between the Contractor and the Department that establishes the basis of payment and contract time adjustment, if any, for the work affected by the supplemental agreement. A supplemental agreement is required if: (1) in scope work would increase or decrease the total amount of the awarded contract by more than 25%; (2) in scope work would increase or decrease the total of any major contract item by more than 25%; (3) work that is not within the scope of the originally awarded contract but is germane to it; or (4) adding or deleting of a major contract item.

Paragraph Number	Term	Definition
10-60	Surety	The corporation, partnership, or individual, other than the Contractor, executing payment or performance bonds that are furnished to the Department by the Contractor.
10-61	Taxilane	A taxiway designed for low speed movement of aircraft between aircraft parking areas and terminal areas.
10-62	Taxiway	The portion of the air operations area of an airport that has been designated by competent airport authority for movement of aircraft to and from the airport's runways, aircraft parking areas, and terminal areas.
10-63	Taxiway/Taxilane Safety Area (TSA)	A defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an aircraft. See the construction safety and phasing plan (CSPP) for limits of the TSA.
10-64	Work	The furnishing of all labor, materials, tools, equipment, and incidentals necessary or convenient to the Contractor's performance of all duties and obligations imposed by the contract, plans, and specifications.
10-65	Working day	A working day shall be any day other than a legal holiday, Saturday, or Sunday on which the normal working forces of the Contractor may proceed with regular work for at least six (6) hours toward completion of the contract. When work is suspended for causes beyond the Contractor's control, it will not be counted as a working day. Saturdays, Sundays and holidays on which the Contractor's forces engage in regular work will be considered as working days.

END OF SECTION 10

Section 20 Proposal Requirements and Conditions

20-01 Advertisement (Notice to Bidders). The Illinois Department of Transportation (IDOT) Transportation Procurement Bulletin (Bulletin) is the published source for this procurement action including the time & place of bidding, invitation to bids, notices, prequalification requirements, contract forms, bonds, plans, specifications, addendums and any other information necessary to prepare this bid.

20-02 Qualification of bidders. Each bidder shall submit evidence of competency and evidence of financial responsibility to perform the work to IDOT at the time of bid opening.

Evidence of competency, unless otherwise specified, shall consist of statements covering the bidder's past experience on similar work, and a list of equipment and a list of key personnel that would be available for the work.

Each bidder shall furnish the IDOT satisfactory evidence of their financial responsibility. Evidence of financial responsibility, unless otherwise specified, shall consist of a confidential statement or report of the bidder's financial resources and liabilities as of the last calendar year or the bidder's last fiscal year. Such statements or reports shall be certified by a public accountant. At the time of submitting such financial statements or reports, the bidder shall further certify whether their financial responsibility is approximately the same as stated or reported by the public accountant. If the bidder's financial responsibility has changed, the bidder shall qualify the public accountant's statement or report to reflect the bidder's true financial condition at the time such qualified statement or report is submitted to the Owner.

Unless otherwise specified, a bidder may submit evidence that they are prequalified with the State Highway Division and are on the current "bidder's list" of the state in which the proposed work is located. Evidence of State Highway Division prequalification may be submitted as evidence of financial responsibility in lieu of the certified statements or reports specified above.

20-03 Contents of proposal forms. Electronic bids are to be submitted to the electronic bidding system (iCX-Integrated Contractors Exchange). All bids must be submitted to the iCX system prior to 12:00 p.m. on the Letting Date, at which time the bids will be publicly opened from the iCX SecureVault.

The plans, specifications, and other documents designated shall be considered a part of the proposal whether attached or not.

20-04 Issuance of proposal forms. IDOT reserves the right to refuse to issue a proposal form to a prospective bidder if the bidder is in default for any of the following reasons:

- a. Failure to comply with any prequalification regulations of IDOT, if such regulations are cited, or otherwise included, in the proposal as a requirement for bidding.
- b. Failure to pay, or satisfactorily settle, all bills due for labor and materials on former contracts in force with the Owner at the time the Owner issues the proposal to a prospective bidder.
- c. Documented record of Contractor default under previous contracts with IDOT.
- d. Documented record of unsatisfactory work on previous contracts with IDOT.

20-05 Interpretation of estimated proposal quantities. An estimate of quantities of work to be done and materials to be furnished under these specifications is given in the proposal. It is the result of careful

calculations and is believed to be correct. It is given only as a basis for comparison of proposals and the award of the contract. The Department or IDOT does not expressly, or by implication, agree that the actual quantities involved will correspond exactly therewith; nor shall the bidder plead misunderstanding or deception because of such estimates of quantities, or of the character, location, or other conditions pertaining to the work. Payment to the Contractor will be made only for the actual quantities of work performed or materials furnished in accordance with the plans and specifications. It is understood that the quantities may be increased or decreased as provided in the Section 40, paragraph 40-02, Alteration of Work and Quantities, without in any way invalidating the unit bid prices.

20-06 Examination of plans, specifications, and site. The bidder is expected to carefully examine the site of the proposed work, the proposal, plans, specifications, and contract forms. Bidders shall satisfy themselves to the character, quality, and quantities of work to be performed, materials to be furnished, and to the requirements of the proposed contract. The submission of a proposal shall be prima facie evidence that the bidder has made such examination and is satisfied to the conditions to be encountered in performing the work and the requirements of the proposed contract, plans, and specifications.

20-07 Preparation of proposal. The bidder shall submit their proposal on the forms furnished by IDOT. All blank spaces in the proposal forms, unless explicitly stated otherwise, must be correctly filled in where indicated for each and every item for which a quantity is given. The bidder shall state the price (written in ink or typed) both in words and numerals which they propose for each pay item furnished in the proposal. In case of conflict between words and numerals, the words, unless obviously incorrect, shall govern.

The bidder shall correctly sign the proposal in ink. If the proposal is made by an individual, their name and post office address must be shown. If made by a partnership, the name and post office address of each member of the partnership must be shown. If made by a corporation, the person signing the proposal shall give the name of the state where the corporation was chartered and the name, titles, and business address of the president, secretary, and the treasurer. Anyone signing a proposal as an agent shall file evidence of their authority to do so and that the signature is binding upon the firm or corporation.

20-08 Responsive and responsible bidder. A responsive bid conforms to all significant terms and conditions contained in the Owner's invitation for bid. It is the Department's responsibility to decide if the exceptions taken by a bidder to the solicitation are material or not and the extent of deviation it is willing to accept.

A responsible bidder has the ability to perform successfully under the terms and conditions of a proposed procurement, as defined in 2 CFR § 200.318(h). This includes such matters as Contractor integrity, compliance with public policy, record of past performance, and financial and technical resources.

20-09 Irregular proposals. Proposals shall be considered irregular for the following reasons:

- a. If the proposal is on a form other than that furnished by IDOT, or if IDOT's form is altered, or if any part of the proposal form is detached.
- b. If there are unauthorized additions, conditional or alternate pay items, or irregularities of any kind that make the proposal incomplete, indefinite, or otherwise ambiguous.
- c. If the proposal does not contain a unit price for each pay item listed in the proposal, except in the case of authorized alternate pay items, for which the bidder is not required to furnish a unit price.
- d. If the proposal contains unit prices that are obviously unbalanced.
- e. If the proposal is not accompanied by the proposal guaranty specified by IDOT.
- f. If the applicable Disadvantaged Business Enterprise information is incomplete.

IDOT reserves the right to reject any irregular proposal and the right to waive technicalities if such waiver is in the best interest of the Owner and conforms to local laws and ordinances pertaining to the letting of construction contracts.

20-10 Bid guarantee. Each bid shall be accompanied by a bid bond in the form provided by the Department with the bid form package. The bid bond shall be made and tendered by a surety acceptable to IDOT in the amount stated in the Invitation for Bids.

20-11 Delivery of proposal. Bids shall be sealed and submitted in the manner specified or allowed by the Invitation for Bids. All bids shall be delivered and received by IDOT prior to the time and at the place specified in the Invitation for Bids. The date and time of receipt will be recorded. Bids will remain sealed and will be stored in a secure place until the date and time established for bid opening. The Department will not accept bids after the time stated in the Invitation for Bids.

20-12 Withdrawal or revision of proposals. An authorized agent of a bidder may change or withdraw a bid if written or in-person notice of the change or withdrawal is received by IDOT before the time specified for submission of bids.

20-13 Public opening of proposals. Proposals shall be opened, and read, publicly at the time and place specified in the advertisement. Bidders, their authorized agents, and other interested persons are invited to attend. Proposals that have been withdrawn (by written or telegraphic request) or received after the time specified for opening bids shall be returned to the bidder unopened.

20-14 Disqualification of bidders. A bidder shall be considered disqualified for any of the following reasons:

a. Submitting more than one proposal from the same partnership, firm, or corporation under the same or different name.

b. Evidence of collusion among bidders. Bidders participating in such collusion shall be disqualified as bidders for any future work of the Department until any such participating bidder has been reinstated by the Owner as a qualified bidder.

c. If the bidder is considered to be in “default” for any reason specified in the subsection 20-04 titled ISSUANCE OF PROPOSAL FORMS of this section.

20-15 Discrepancies and Omissions. A Bidder who discovers discrepancies or omissions with the project bid documents shall immediately notify the Department of the matter. A bidder that has doubt as to the true meaning of a project requirement may submit to the Department a written request for interpretation no later than 10 days prior to bid opening.

Any interpretation of the project bid documents by the Department will be by written addendum issued by the Owner. The Owner will not consider any instructions, clarifications or interpretations of the bidding documents in any manner other than written addendum.

END OF SECTION 20

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Section 30 Award and Execution of Contract

30-01 Consideration of proposals. After the proposals are publicly opened and read, they will be compared on the basis of the summation of the products obtained by multiplying the estimated quantities shown in the proposal by the unit bid prices. If a bidder's proposal contains a discrepancy between unit bid prices written in words and unit bid prices written in numbers, the unit bid price written in words shall govern.

Until the award of a contract is made, the Department reserves the right to reject a bidder's proposal for any of the following reasons:

a. If the proposal is irregular as specified in Section 20, paragraph 20-09, *Irregular Proposals*.

b. If the bidder is disqualified for any of the reasons specified Section 20, paragraph 20-14, *Disqualification of Bidders*.

In addition, until the award of a contract is made, the Department reserves the right to reject any or all proposals, waive technicalities, if such waiver is in the best interest of the Owner and is in conformance with applicable state and local laws or regulations pertaining to the letting of construction contracts; advertise for new proposals; or proceed with the work otherwise. All such actions shall promote the Department's best interests.

30-02 Award of contract. The award of a contract, if it is to be awarded, shall be made within 60 calendar days of the date specified for publicly opening proposals, unless otherwise specified herein.

If the Department elects to proceed with an award of contract, the Department will make award to the responsible bidder whose bid, conforming with all the material terms and conditions of the bid documents, is the lowest in price.

30-03 Cancellation of award. The Department reserves the right to cancel the award without liability to the bidder, except return of proposal guaranty, at any time before a contract has been fully executed by all parties and is approved by the Department in accordance with paragraph 30-07 *Approval of Contract*.

30-04 Return of proposal guaranty. All proposal guaranties, except those of the two lowest bidders, will be returned immediately after the Department has made a comparison of bids as specified in the paragraph 30-01, *Consideration of Proposals*. Proposal guaranties of the two lowest bidders will be retained by the Owner until such time as an award is made, at which time, the unsuccessful bidder's proposal guaranty will be returned. The successful bidder's proposal guaranty will be returned as soon as the Owner receives the contract bonds as specified in paragraph 30-05, *Requirements of Contract Bonds*.

30-05 Requirements of contract bonds. At the time of the execution of the contract, the successful bidder shall furnish IDOT a surety bond or bonds that have been fully executed by the bidder and the surety guaranteeing the performance of the work and the payment of all legal debts that may be incurred by reason of the Contractor's performance of the work. The surety and the form of the bond or bonds shall be acceptable to IDOT. Unless otherwise specified in this subsection, the surety bond or bonds shall be in a sum equal to the full amount of the contract.

30-06 Execution of contract. The successful bidder shall sign (execute) the necessary agreements for entering into the contract and return the signed contract to the Department, along with the fully executed surety bond or bonds specified in paragraph 30-05, *Requirements of Contract Bonds*, of this section, within 15 calendar days from the date mailed or otherwise delivered to the successful bidder.

30-07 Approval of contract. Upon receipt of the contract and contract bond or bonds that have been executed by the successful bidder, IDOT shall complete the execution of the contract in accordance with local laws or ordinances, and return the fully executed contract to the Contractor. Delivery of the fully executed contract to the Contractor shall constitute the Department's approval to be bound by the successful bidder's proposal and the terms of the contract.

30-08 Failure to execute contract. Failure of the successful bidder to execute the contract and furnish an acceptable surety bond or bonds within the period specified in paragraph 30-06, *Execution of Contract*, of this section shall be just cause for cancellation of the award and forfeiture of the proposal guaranty, not as a penalty, but as liquidated damages to the Department.

END OF SECTION 30

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Section 40 Scope of Work

40-01 Intent of contract. The intent of the contract is to provide for construction and completion, in every detail, of the work described. It is further intended that the Contractor shall furnish all labor, materials, equipment, tools, transportation, and supplies required to complete the work in accordance with the plans, specifications, and terms of the contract.

40-02 Alteration of work and quantities. The Department reserves the right to make such changes in quantities and work as may be necessary or desirable to complete, in a satisfactory manner, the original intended work. Unless otherwise specified in the Contract, the Department shall be and is hereby authorized to make, in writing, such in-scope alterations in the work and variation of quantities as may be necessary to complete the work, provided such action does not represent a significant change in the character of the work.

For purpose of this section, a significant change in character of work means: any change that is outside the current contract scope of work; any change (increase or decrease) in the total contract cost by more than 25%; or any change in the total cost of a major contract item by more than 25%.

Work alterations and quantity variances that do not meet the definition of significant change in character of work shall not invalidate the contract nor release the surety. Contractor agrees to accept payment for such work alterations and quantity variances in accordance with Section 90, paragraph 90-03, *Compensation for Altered Quantities*.

Should the value of altered work or quantity variance meet the criteria for significant change in character of work, such altered work and quantity variance shall be covered by a supplemental agreement. Supplemental agreements shall also require consent of the Contractor's surety and separate performance and payment bonds. If the Department and the Contractor are unable to agree on a unit adjustment for any contract item that requires a supplemental agreement, the Department reserves the right to terminate the contract with respect to the item and make other arrangements for its completion.

40-03 Omitted items. The Department may provide written notice to the Contractor to omit from the work any contract item that does not meet the definition of major contract item. Major contract items may be omitted by a supplemental agreement. Such omission of contract items shall not invalidate any other contract provision or requirement.

Should a contract item be omitted or otherwise ordered to be non-performed, the Contractor shall be paid for all work performed toward completion of such item prior to the date of the order to omit such item. Payment for work performed shall be in accordance with Section 90, paragraph 90-04, *Payment for Omitted Items*.

40-04 Extra work. Should acceptable completion of the contract require the Contractor to perform an item of work not provided for in the awarded contract as previously modified by change order or supplemental agreement, Department may issue a Change Order to cover the necessary extra work. Change orders for extra work shall contain agreed unit prices for performing the change order work in accordance with the requirements specified in the order, and shall contain any adjustment to the contract time that, in the Engineer's opinion, is necessary for completion of the extra work.

When determined by the Engineer to be in the Department's best interest, the Engineer may order the Contractor to proceed with extra work as provided in Section 90, paragraph 90-05, *Payment for Extra Work*. Extra work that is necessary for acceptable completion of the project, but is not within the general

scope of the work covered by the original contract shall be covered by a supplemental agreement as defined in Section 10, paragraph 10-59, *Supplemental Agreement*.

If extra work is essential to maintaining the project critical path, RPR may order the Contractor to commence the extra work under a Time and Material contract method. Once sufficient detail is available to establish the level of effort necessary for the extra work, the Department shall initiate a change order or supplemental agreement to cover the extra work.

Any claim for payment of extra work that is not covered by written agreement (change order or supplemental agreement) shall be rejected by the Department.

All contract modifications (change order or supplemental agreement) must be reviewed and approved by the Engineer.

40-05 Maintenance of traffic. It is the explicit intention of the contract that the safety of aircraft, as well as the Contractor's equipment and personnel, is the most important consideration. The Contractor shall maintain traffic in the manner detailed in the Construction Safety and Phasing Plan (CSPP).

a. It is understood and agreed that the Contractor shall provide for the free and unobstructed movement of aircraft in the air operations areas (AOAs) of the airport with respect to their own operations and the operations of all subcontractors as specified in Section 80, paragraph 80-04, *Limitation of Operations*. It is further understood and agreed that the Contractor shall provide for the uninterrupted operation of visual and electronic signals (including power supplies thereto) used in the guidance of aircraft while operating to, from, and upon the airport as specified in Section 70, paragraph 70-15, *Contractor's Responsibility for Utility Service and Facilities of Others*.

b. With respect to their own operations and the operations of all subcontractors, the Contractor shall provide marking, lighting, and other acceptable means of identifying personnel, equipment, vehicles, storage areas, and any work area or condition that may be hazardous to the operation of aircraft, fire-rescue equipment, or maintenance vehicles at the airport in accordance with the construction safety and phasing plan (CSPP) and the safety plan compliance document (SPCD).

c. When the contract requires the maintenance of an existing road, street, or highway during the Contractor's performance of work that is otherwise provided for in the contract, plans, and specifications, the Contractor shall keep the road, street, or highway open to all traffic and shall provide maintenance as may be required to accommodate traffic. The Contractor, at their expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel. The Contractor shall furnish, erect, and maintain barricades, warning signs, flag person, and other traffic control devices in reasonable conformity with the Manual on Uniform Traffic Control Devices (MUTCD) (<http://mutcd.fhwa.dot.gov/>), unless otherwise specified. The Contractor shall also construct and maintain in a safe condition any temporary connections necessary for ingress to and egress from abutting property or intersecting roads, streets or highways.

40-06 Removal of existing structures. All existing structures encountered within the established lines, grades, or grading sections shall be removed by the Contractor, unless such existing structures are otherwise specified to be relocated, adjusted up or down, salvaged, abandoned in place, reused in the work or to remain in place. The cost of removing such existing structures shall not be measured or paid for directly, but shall be included in the various contract items.

Should the Contractor encounter an existing structure (above or below ground) in the work for which the disposition is not indicated on the plans, the Resident Project Representative (RPR) shall be notified prior to disturbing such structure. The disposition of existing structures so encountered shall be immediately determined by the RPR in accordance with the provisions of the contract.

Except as provided in Section 40, paragraph 40-07, *Rights in and Use of Materials Found in the Work*, it is intended that all existing materials or structures that may be encountered (within the lines, grades, or

grading sections established for completion of the work) shall be used in the work as otherwise provided for in the contract and shall remain the property of the All contract modifications (change order or supplemental agreement) must be reviewed and approved by the Engineer. when so used in the work.

40-07 Rights in and use of materials found in the work. Should the Contractor encounter any material such as (but not restricted to) sand, stone, gravel, slag, or concrete slabs within the established lines, grades, or grading sections, the use of which is intended by the terms of the contract to be embankment, the Contractor may at their own option either:

- a. Use such material in another contract item, providing such use is approved by the Engineer and is in conformance with the contract specifications applicable to such use; or,
- b. Remove such material from the site, upon written approval of the Engineer; or
- c. Use such material for the Contractor's own temporary construction on site; or,
- d. Use such material as intended by the terms of the contract.

Should the Contractor wish to exercise option a., b., or c., the Contractor shall request the Engineer's approval in advance of such use.

Should the Engineer approve the Contractor's request to exercise option a., b., or c., the Contractor shall be paid for the excavation or removal of such material at the applicable contract price. The Contractor shall replace, at their expense, such removed or excavated material with an agreed equal volume of material that is acceptable for use in constructing embankment, backfills, or otherwise to the extent that such replacement material is needed to complete the contract work. The Contractor shall not be charged for use of such material used in the work or removed from the site.

Should the Engineer approve the Contractor's exercise of option a., the Contractor shall be paid, at the applicable contract price, for furnishing and installing such material in accordance with requirements of the contract item in which the material is used.

It is understood and agreed that the Contractor shall make no claim for delays by reason of their own exercise of option a., b., or c.

The Contractor shall not excavate, remove, or otherwise disturb any material, structure, or part of a structure which is located outside the lines, grades, or grading sections established for the work, except where such excavation or removal is provided for in the contract, plans, or specifications.

40-08 Final cleanup. Upon completion of the work and before acceptance and final payment will be made, the Contractor shall remove from the site all machinery, equipment, surplus and discarded materials, rubbish, temporary structures, and stumps or portions of trees. The Contractor shall cut all brush and woods within the limits indicated and shall leave the site in a neat and presentable condition. Material cleared from the site and deposited on adjacent property will not be considered as having been disposed of satisfactorily, unless the Contractor has obtained the written permission of the property All contract modifications (change order or supplemental agreement) must be reviewed and approved by the Engineer.

40-09 Safety plan compliance documentation (SPCD). Prior to the preconstruction conference, the Contractor shall submit a Safety Plan Compliance Document (SPCD) to the airport describing how he will comply with the requirements of the Federal Aviation Administration Advisory Circular plus the Construction Safety Phasing Plan (CSPP) and supplying any details that could not be determined before contract award. The SPCD must include a certification statement by the contractor that indicates he understands the operational safety requirements of the CSPP, that the Contractor has incorporated these requirements into their overall work plan and that the contractor will maintain the right of control for all means, methods and details of the work performed by the Contractor and any of his subcontractors within

the framework of the operational safety plan. The SPCD must be reviewed, approved and signed by the airport.

The contractor shall be fully aware and continuously monitor all requirements and activities for compliance with the contract documents and the current Federal Aviation Administration Advisory Circular 150/5370-2, Operational Safety on Airports During Construction.

Ten (10) days prior to the commencement of each phase, the Contractor shall submit an updated Safety Plan Compliance Document for that phase that meets the requirements of the current Federal Aviation Administration Advisory Circular 150/5370-2, Operational Safety on Airports During Construction. The updated SCPD shall detail implementation of the construction haul routes, procedures utilized by the contractor to eliminate conflicts between construction operations and aircraft traffic shall be included.

Changes to the CSPP may require aeronautical review by the Department through FAA's Obstruction Elevation/Airport Airspace Analysis (OE/AAA) system. Modification of the CSPP and/or the critical points shown in the contract documents will require airspace approval from the Department and/or the FAA and may require the Contractor to submit FAA Form 7460 for approval.

The contractor shall not be entitled to any extra compensation due to delays or inconveniences caused by said necessary methods, procedures, and measured to protect air traffic.

END OF SECTION 40

Section 50 Control of Work

50-01 Authority of the Engineer. The Engineer has final authority regarding the interpretation of project specification requirements. The Engineer shall determine acceptability of the quality of materials furnished, method of performance of work performed, and the manner and rate of performance of the work. The Engineer does not have the authority to accept work that does not conform to specification requirements.

The contract does not require the Engineer to provide the Contractor with direction or advice on how to do the work. If the Engineer approves or recommends any method or manner for the work, the approval or recommendation shall not guarantee following the method or manner will result in compliance with the contract, relieve the Contractor of the risks and obligations of the contract or create liability for the Department.

The Resident Engineer does not have the authority to accept work that does not conform to specification requirements. The Resident Engineer does not have the authority to modify the contract documents without the approval of the Department.

50-02 Conformity with plans and specifications. All work and all materials furnished shall be in reasonably close conformity with the lines, grades, grading sections, cross-sections, dimensions, material requirements, and testing requirements that are specified (including specified tolerances) in the contract, plans, or specifications.

If the Engineer finds the materials furnished, work performed, or the finished product not within reasonably close conformity with the plans and specifications, but that the portion of the work affected will, in their opinion, result in a finished product having a level of safety, economy, durability, and workmanship acceptable to the Department, the Engineer will advise the Department of their determination that the affected work be accepted and remain in place. The RPR will document the determination and recommend to the Department a basis of acceptance that will provide for an adjustment in the contract price for the affected portion of the work. Changes in the contract price must be covered by contract change order or supplemental agreement as applicable.

If the RPR finds the materials furnished, work performed, or the finished product are not in reasonably close conformity with the plans and specifications and have resulted in an unacceptable finished product, the affected work or materials shall be removed and replaced or otherwise corrected by and at the expense of the Contractor in accordance with the RPR's written orders.

The term "reasonably close conformity" shall not be construed as waiving the Contractor's responsibility to complete the work in accordance with the contract, plans, and specifications. The term shall not be construed as waiving the RPR's responsibility to insist on strict compliance with the requirements of the contract, plans, and specifications during the Contractor's execution of the work, when, in the RPR's opinion, such compliance is essential to provide an acceptable finished portion of the work.

The term "reasonably close conformity" is also intended to provide the RPR with the authority, after consultation with the Sponsor and FAA, to use sound engineering judgment in their determinations to accept work that is not in strict conformity, but will provide a finished product equal to or better than that required by the requirements of the contract, plans and specifications.

The RPR will not be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction or the safety precautions incident thereto.

50-03 Coordination of contract, plans, and specifications. The contract, plans, specifications, and all referenced standards cited are essential parts of the contract requirements. If electronic files are provided and used on the project and there is a conflict between the electronic files and hard copy plans, the hard copy plans shall govern. 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. In case of discrepancy, calculated dimensions will govern over scaled dimensions; contract technical specifications shall govern over contract general provisions, plans, cited standards for materials or testing, and cited advisory circulars (ACs); contract general provisions shall govern over plans, cited standards for materials or testing, and cited ACs; plans shall govern over cited standards for materials or testing and cited ACs. If any paragraphs contained in the Special Provisions conflict with General Provisions or Technical Specifications, the Special Provisions shall govern.

From time to time, discrepancies within cited testing standards occur due to the timing of the change, edits, and/or replacement of the standards. If the Contractor discovers any apparent discrepancy within standard test methods, the Contractor shall immediately ask the Engineer for an interpretation and decision, and such decision shall be final.

The Contractor shall not take advantage of any apparent error or omission on the plans or specifications. In the event the Contractor discovers any apparent error or discrepancy, Contractor shall immediately notify the Department or the designated representative in writing requesting their written interpretation and decision.

50-04 List of Special Provisions. Not Used.

50-05 Cooperation of Contractor. The Contractor shall be supplied with five hard copies or an electronic PDF of the plans and specifications. The Contractor shall have available on the construction site at all times one hardcopy each of the plans and specifications. Additional hard copies of plans and specifications may be obtained by the Contractor for the cost of reproduction.

The Contractor shall give constant attention to the work to facilitate the progress thereof, and shall cooperate with the RPR and their inspectors and with other Contractors in every way possible. The Contractor shall have a competent superintendent on the work at all times who is fully authorized as their agent on the work. The superintendent shall be capable of reading and thoroughly understanding the plans and specifications and shall receive and fulfill instructions from the RPR or their authorized representative.

50-06 Cooperation between Contractors. The Department reserves the right to contract for and perform other or additional work on or near the work covered by this contract.

When separate contracts are let within the limits of any one project, each Contractor shall conduct the work not to interfere with or hinder the progress of completion of the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other as directed.

Each Contractor involved shall assume all liability, financial or otherwise, in connection with their own contract and shall protect and hold harmless the Department from any and all damages or claims that may arise because of inconvenience, delays, or loss experienced because of the presence and operations of other Contractors working within the limits of the same project.

The Contractor shall arrange their work and shall place and dispose of the materials being used to not interfere with the operations of the other Contractors within the limits of the same project. The Contractor shall join their work with that of the others in an acceptable manner and shall perform it in proper sequence to that of the others.

50-07 Construction layout and stakes. The RPR shall establish necessary horizontal and vertical control. The establishment of Survey Control and/or reestablishment of survey control shall be by a State Licensed Land Surveyor. Contractor is responsible for preserving integrity of horizontal and vertical

controls established by RPR. In case of negligence on the part of the Contractor or their employees, resulting in the destruction of any horizontal and vertical control, the resulting costs will be deducted as a liquidated damage against the Contractor.

Prior to the start of construction, the Contractor will check all control points for horizontal and vertical accuracy and certify in writing to the RPR that the Contractor concurs with survey control established for the project. All lines, grades and measurements from control points necessary for the proper execution and control of the work on this project will be provided to the RPR. The Contractor is responsible to establish all layout required for the construction of the project.

Copies of survey notes will be provided to the RPR for each area of construction and for each placement of material as specified to allow the RPR to make periodic checks for conformance with plan grades, alignments and grade tolerances required by the applicable material specifications. Surveys will be provided to the RPR prior to commencing work items that cover or disturb the survey staking. Survey(s) and notes shall be provided in the following format(s): Land .xml compatible with AutoCad.dwg.

Laser, GPS, String line, or other automatic control shall be checked with temporary control as necessary. In the case of error, on the part of the Contractor, their surveyor, employees or subcontractors, resulting in established grades, alignment or grade tolerances that do not concur with those specified or shown on the plans, the Contractor is solely responsible for correction, removal, replacement and all associated costs at no additional cost to the contract.

No direct payment will be made, unless otherwise specified in contract documents, for this labor, materials, or other expenses. The cost shall be included in the price of the bid for the various items of the Contract.

50-08 Authority and duties of Quality Assurance (QA) inspectors. QA inspectors shall be authorized to inspect all work done and all material furnished. Such QA inspection may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials to be used. QA inspectors are not authorized to revoke, alter, or waive any provision of the contract. QA inspectors are not authorized to issue instructions contrary to the plans and specifications or to act as foreman for the Contractor.

QA Inspectors are authorized to notify the Contractor or their representatives of any failure of the work or materials to conform to the requirements of the contract, plans, or specifications and to reject such nonconforming materials in question until such issues can be referred to the Engineer for a decision.

50-09 Inspection of the work. All materials and each part or detail of the work shall be subject to inspection. The RPR shall be allowed access to all parts of the work and shall be furnished with such information and assistance by the Contractor as is required to make a complete and detailed inspection.

If the Engineer requests it, the Contractor, at any time before acceptance of the work, shall remove or uncover such portions of the finished work as may be directed. After examination, the Contractor shall restore said portions of the work to the standard required by the specifications. Should the work thus exposed or examined prove acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be paid for as extra work; but should the work so exposed or examined prove unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed will be at the Contractor's expense.

Provide advance written notice to the Engineer of work the Contractor plans to perform each week and each day. Any work done or materials used without written notice and allowing opportunity for inspection by the RPR may be ordered removed and replaced at the Contractor's expense.

Should the contract work include relocation, adjustment, or any other modification to existing facilities, not the property of the (contract) Department, authorized representatives of the Departments of such facilities shall have the right to inspect such work. Such inspection shall in no sense make any facility owner a party to the contract, and shall in no way interfere with the rights of the parties to this contract.

50-10 Removal of unacceptable and unauthorized work. All work that does not conform to the requirements of the contract, plans, and specifications will be considered unacceptable, unless otherwise determined acceptable by the Engineer as provided in paragraph 50-02, *Conformity with Plans and Specifications*.

Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner in accordance with the provisions of Section 70, paragraph 70-14, *Contractor's Responsibility for Work*.

No removal work made under provision of this paragraph shall be done without lines and grades having been established by the RPR. Work done contrary to the instructions of the RPR, work done beyond the lines shown on the plans or as established by the RPR, except as herein specified, or any extra work done without authority, will be considered as unauthorized and will not be paid for under the provisions of the contract. Work so done may be ordered removed or replaced at the Contractor's expense.

Upon failure on the part of the Contractor to comply with any order of the RPR made under the provisions of this subsection, the RPR will have authority to cause unacceptable work to be remedied or removed and replaced; and unauthorized work to be removed and recover the resulting costs as a liquidated damage against the Contractor.

50-11 Load restrictions. The Contractor shall comply with all legal load restrictions in the hauling of materials on public roads beyond the limits of the work. A special permit will not relieve the Contractor of liability for damage that may result from the moving of material or equipment.

The operation of equipment of such weight or so loaded as to cause damage to structures or to any other type of construction will not be permitted. Hauling of materials over the base course or surface course under construction shall be limited as directed. No loads will be permitted on a concrete pavement, base, or structure before the expiration of the curing period. The Contractor, at their own expense, shall be responsible for the repair to equal or better than preconstruction conditions of any damage caused by the Contractor's equipment and personnel.

50-12 Maintenance during construction. The Contractor shall maintain the work during construction and until the work is accepted. Maintenance shall constitute continuous and effective work prosecuted day by day, with adequate equipment and forces so that the work is maintained in satisfactory condition at all times.

In the case of a contract for the placing of a course upon a course or subgrade previously constructed, the Contractor shall maintain the previous course or subgrade during all construction operations.

All costs of maintenance work during construction and before the project is accepted shall be included in the unit prices bid on the various contract items, and the Contractor will not be paid an additional amount for such work.

50-13 Failure to maintain the work. Should the Contractor at any time fail to maintain the work as provided in paragraph 50-12, *Maintenance during Construction*, the RPR shall immediately notify the Contractor of such noncompliance. Such notification shall specify a reasonable time within which the Contractor shall be required to remedy such unsatisfactory maintenance condition. The time specified will give due consideration to the exigency that exists.

Should the Contractor fail to respond to the RPR's notification, the Engineer may suspend any work necessary for the Department to correct such unsatisfactory maintenance condition, depending on the exigency that exists. Any maintenance cost incurred by the Department, shall be recovered as a liquidated damage against the Contractor.

50-14 Partial acceptance. If at any time during the execution of the project the Contractor substantially completes a usable unit or portion of the work, the occupancy of which will benefit the Department, the

Contractor may request the Engineer to make final inspection of that unit. If the Engineer finds upon inspection that the unit has been satisfactorily completed in compliance with the contract, the Engineer may accept it as being complete, and the Contractor may be relieved of further responsibility for that unit. Such partial acceptance and beneficial occupancy by the Owner shall not void or alter any provision of the contract.

50-15 Final acceptance. Upon due notice from the Contractor of presumptive completion of the entire project, the Engineer and Department will make an inspection. If all construction provided for and contemplated by the contract is found to be complete in accordance with the contract, plans, and specifications, such inspection shall constitute the final inspection. The Engineer shall notify the Contractor in writing of final acceptance as of the date of the final inspection.

If, however, the inspection discloses any work, in whole or in part, as being unsatisfactory, the RPR will notify the Contractor and the Contractor shall correct the unsatisfactory work. Upon correction of the work, another inspection will be made which shall constitute the final inspection, provided the work has been satisfactorily completed. In such event, the Engineer will make the final acceptance and notify the Contractor in writing of this acceptance as of the date of final inspection.

50-16 Claims for adjustment and disputes. If for any reason the Contractor deems that additional compensation is due for work or materials not clearly provided for in the contract, plans, or specifications or previously authorized as extra work, the Contractor shall notify the Engineer in writing of their intention to claim such additional compensation before the Contractor begins the work on which the Contractor bases the claim. If such notification is not given or the Engineer is not afforded proper opportunity by the Contractor for keeping strict account of actual cost as required, then the Contractor hereby agrees to waive any claim for such additional compensation. Such notice by the Contractor and the fact that the Engineer has kept account of the cost of the work shall not in any way be construed as proving or substantiating the validity of the claim. When the work on which the claim for additional compensation is based has been completed, the Contractor shall, within 10 calendar days, submit a written claim to the Engineer who will present it to the Owner for consideration in accordance with local laws or ordinances.

Nothing in this subsection shall be construed as a waiver of the Contractor's right to dispute final payment based on differences in measurements or computations.

END OF SECTION 50

Section 60 Control of Materials

60-01 Source of supply and quality requirements. The materials used in the work shall conform to the requirements of the contract, plans, and specifications. Unless otherwise specified, such materials that are manufactured or processed shall be new (as compared to used or reprocessed).

In order to expedite the inspection and testing of materials, the Contractor shall furnish documentation to the Engineer as to the origin, composition, and manufacture of all materials to be used in the work. Documentation shall be furnished promptly after execution of the contract but, in all cases, prior to delivery of such materials.

At the Engineer's option, materials may be approved at the source of supply before delivery. If it is found after trial that sources of supply for previously approved materials do not produce specified products, the Contractor shall furnish materials from other sources.

The Contractor shall furnish airport lighting equipment that meets the requirements of the specifications; and is listed in AC 150/5345-53, *Airport Lighting Equipment Certification Program and Addendum*, that is in effect on the date of advertisement.

60-02 Samples, tests, and cited specifications. All materials used in the work shall be inspected, tested, and approved by the Engineer before incorporation in the work unless otherwise designated. Any work in which untested materials are used without approval or written permission of the Engineer shall be performed at the Contractor's risk. Materials found to be unacceptable and unauthorized will not be paid for and, if directed by the Engineer, shall be removed at the Contractor's expense.

Unless otherwise designated, quality assurance tests will be made by and at the expense of the Engineer in accordance with the cited standard methods of ASTM, American Association of State Highway and Transportation Officials (AASHTO), federal specifications, Commercial Item Descriptions, and all other cited methods, which are current on the date of advertisement for bids.

The testing organizations performing on-site quality assurance field tests shall have copies of all referenced standards on the construction site for use by all technicians and other personnel. Unless otherwise designated, samples for quality assurance will be taken by a qualified representative of the Engineer. All materials being used are subject to inspection, test, or rejection at any time prior to or during incorporation into the work. Copies of all tests will be furnished to the Contractor's representative at their request after review and approval of the Engineer.

A copy of all Contractor QC test data shall be provided to the Engineer daily, along with printed reports, in an approved format, on a weekly basis. After completion of the project, and prior to final payment, the Contractor shall submit a final report to the Engineer showing all test data reports, plus an analysis of all results showing ranges, averages, and corrective action taken on all failing tests.

60-03 Certification of compliance/analysis (COC/COA). The Engineer may permit the use, prior to sampling and testing, of certain materials or assemblies when accompanied by manufacturer's COC stating that such materials or assemblies fully comply with the requirements of the contract. The certificate shall be signed by the manufacturer. Each lot of such materials or assemblies delivered to the work must be accompanied by a certificate of compliance in which the lot is clearly identified. The COA is the manufacturer's COC and includes all applicable test results.

Materials or assemblies used on the basis of certificates of compliance may be sampled and tested at any time and if found not to be in conformity with contract requirements will be subject to rejection whether in place or not.

The form and distribution of certificates of compliance shall be as approved by the Engineer.

When a material or assembly is specified by “brand name or equal” and the Contractor elects to furnish the specified “or equal,” the Contractor shall be required to furnish the manufacturer’s certificate of compliance for each lot of such material or assembly delivered to the work. Such certificate of compliance shall clearly identify each lot delivered and shall certify as to:

- a. Conformance to the specified performance, testing, quality or dimensional requirements; and,
- b. Suitability of the material or assembly for the use intended in the contract work.

The Engineer shall be the sole judge as to whether the proposed “or equal” is suitable for use in the work.

The Engineer reserves the right to refuse permission for use of materials or assemblies on the basis of certificates of compliance.

60-04 Plant inspection. The Engineer or their authorized representative may inspect, at its source, any specified material or assembly to be used in the work. Manufacturing plants may be inspected from time to time for the purpose of determining compliance with specified manufacturing methods or materials to be used in the work and to obtain samples required for acceptance of the material or assembly.

Should the RPR conduct plant inspections, the following conditions shall exist:

- a. The RPR shall have the cooperation and assistance of the Contractor and the producer with whom the Contractor has contracted for materials.
- b. The RPR shall have full entry at all reasonable times to such parts of the plant that concern the manufacture or production of the materials being furnished.
- c. If required by the RPR, the Contractor shall arrange for adequate office or working space that may be reasonably needed for conducting plant inspections. Place office or working space in a convenient location with respect to the plant.

It is understood and agreed that the Engineer shall have the right to retest any material that has been tested and approved at the source of supply after it has been delivered to the site. The RPR shall have the right to reject only material which, when retested, does not meet the requirements of the contract, plans, or specifications.

60-05 Engineer/ Resident Project Representative (RPR) field office. The Contractor shall provide dedicated space for the use of the engineer, RPR, and inspectors, as a field office for the duration of the project. This space shall be located conveniently near the construction and shall be separate from any space used by the Contractor. The Contractor shall furnish water, sanitary facilities, heat, air conditioning, and electricity.

60-06 Storage of materials. Materials shall be stored to assure the preservation of their quality and fitness for the work. Stored materials, even though approved before storage, may again be inspected prior to their use in the work. Stored materials shall be located to facilitate their prompt inspection. The Contractor shall coordinate the storage of all materials with the Engineer. Materials to be stored on airport property shall not create an obstruction to air navigation nor shall they interfere with the free and unobstructed movement of aircraft. Unless otherwise shown on the plans and/or CSPP, the storage of materials and the location of the Contractor’s plant and parked equipment or vehicles shall be as directed by the Engineer. Private property shall not be used for storage purposes without written permission of the Department or lessee of such property. The Contractor shall make all arrangements and bear all expenses

for the storage of materials on private property. Upon request, the Contractor shall furnish the Engineer a copy of the property Department's permission.

All storage sites on private or airport property shall be restored to their original condition by the Contractor at their expense, except as otherwise agreed to (in writing) by the Department or lessee of the property.

60-07 Unacceptable materials. Any material or assembly that does not conform to the requirements of the contract, plans, or specifications shall be considered unacceptable and shall be rejected. The Contractor shall remove any rejected material or assembly from the site of the work, unless otherwise instructed by the Engineer.

Rejected material or assembly, the defects of which have been corrected by the Contractor, shall not be returned to the site of the work until such time as the RPR has approved its use in the work.

60-08 Owner furnished materials. The Contractor shall furnish all materials required to complete the work, except those specified, if any, to be furnished by the Department. Department-furnished materials shall be made available to the Contractor at the location specified.

All costs of handling, transportation from the specified location to the site of work, storage, and installing Department-furnished materials shall be included in the unit price bid for the contract item in which such Department-furnished material is used.

After any Department-furnished material has been delivered to the location specified, the Contractor shall be responsible for any demurrage, damage, loss, or other deficiencies that may occur during the Contractor's handling, storage, or use of such Owner-furnished material. The Department will deduct from any monies due or to become due the Contractor any cost incurred by the Department in making good such loss due to the Contractor's handling, storage, or use of Department -furnished materials.

END OF SECTION 60

Section 70 Legal Regulations and Responsibility to Public

70-01 Laws to be observed. The Contractor shall keep fully informed of all federal and state laws, all local laws, ordinances, and regulations and all orders and decrees of bodies or tribunals having any jurisdiction or authority, which in any manner affect those engaged or employed on the work, or which in any way affect the conduct of the work. The Contractor shall at all times observe and comply with all such laws, ordinances, regulations, orders, and decrees; and shall protect and indemnify the Department and all their officers, agents, or servants against any claim or liability arising from or based on the violation of any such law, ordinance, regulation, order, or decree, whether by the Contractor or the Contractor’s employees.

70-02 Permits, licenses, and taxes. The Contractor shall procure all permits and licenses, pay all charges, fees, and taxes, and give all notices necessary and incidental to the due and lawful execution of the work.

70-03 Patented devices, materials, and processes. If the Contractor is required or desires to use any design, device, material, or process covered by letters of patent or copyright, the Contractor shall provide for such use by suitable legal agreement with the Patentee or Owner, guaranteeing the Department indemnity from and against all claims for infringement, and shall include the cost of such agreement in the price bid for the work. It shall be the duty of the Contractor, if so demanded by the Department to furnish said Department with a copy of the legal agreement with the patentee or owner, and if such copy is furnished when demanded, then the Department may, if it elects, withhold any and all payments to said Contractor until said legal agreement is furnished. If a suitable legal agreement with patentee or owner is not made as required herein. The Contractor and the surety shall indemnify and hold harmless the Department, any third party, or political subdivision from any and all claims for infringement by reason of the use of any such patented design, device, material or process, or any trademark or copyright, and shall indemnify the Department for any costs, expenses, and damages which it may be obliged to pay by reason of an infringement, at any time during the execution or after the completion of the work.

70-04 Restoration of surfaces disturbed by others. The Department reserves the right to authorize the construction, reconstruction, or maintenance of any public or private utility service, FAA or National Oceanic and Atmospheric Administration (NOAA) facility, or a utility service of another government agency at any time during the progress of the work. To the extent that such construction, reconstruction, or maintenance has been coordinated with the Owner, such authorized work (by others) must be shown on the plans and is indicated as follows:

University of Illinois – Willard Airport

Utility Service or Facility	Person to Contact	Contact Phone
Airfield Lighting Cables	U of I Tim Bannon	217-300-8225
FAA Control and Communications Cable	Rob Carter	217-355-4052
Sanitary Sewer	J.U.L.I.E.	800-892-0123
Electric Cables	J.U.L.I.E.	800-892-0123

Water	J.U.L.I.E.	800-892-0123
Telephone Cables	J.U.L.I.E.	800-892-0123
Gas Lines	J.U.L.I.E.	800-892-0123
All Utilities	U of I Operations and Maintenance	217-333-0340

Except as listed above, the Contractor shall not permit any individual, firm, or corporation to excavate or otherwise disturb such utility services or facilities located within the limits of the work without the written permission of the RPR.

Should the Department of public or private utility service, FAA, or NOAA facility, or a utility service of another government agency be authorized to construct, reconstruct, or maintain such utility service or facility during the progress of the work, the Contractor shall cooperate with such Owners by arranging and performing the work in this contract to facilitate such construction, reconstruction or maintenance by others whether or not such work by others is listed above. When ordered as extra work by the Engineer, the Contractor shall make all necessary repairs to the work which are due to such authorized work by others, unless otherwise provided for in the contract, plans, or specifications. It is understood and agreed that the Contractor shall not be entitled to make any claim for damages due to such authorized work by others or for any delay to the work resulting from such authorized work.

70-05 Federal Participation. The United States Government has agreed to reimburse the Department for some portion of the contract costs. The contract work is subject to the inspection and approval of duly authorized representatives of the FAA Administrator. No requirement of this contract shall be construed as making the United States a party to the contract nor will any such requirement interfere, in any way, with the rights of either party to the contract.

70-06 Sanitary, health, and safety provisions. The Contractor’s worksite and facilities shall comply with applicable federal, state, and local requirements for health, safety and sanitary provisions.

70-07 Public convenience and safety. The Contractor shall control their operations and those of their subcontractors and all suppliers, to assure the least inconvenience to the traveling public. Under all circumstances, safety shall be the most important consideration.

The Contractor shall maintain the free and unobstructed movement of aircraft and vehicular traffic with respect to their own operations and those of their own subcontractors and all suppliers in accordance with Section 40, paragraph 40-05, *Maintenance of Traffic*, and shall limit such operations for the convenience and safety of the traveling public as specified in Section 80, paragraph 80-04, *Limitation of Operations*.

The Contractor shall remove or control debris and rubbish resulting from its work operations at frequent intervals, and upon the order of the RPR. If the RPR determines the existence of Contractor debris in the work site represents a hazard to airport operations and the Contractor is unable to respond in a prompt and reasonable manner, the RPR reserves the right to assign the task of debris removal to a third party and recover the resulting costs as a liquidated damage against the Contractor.

70-08 Construction Safety and Phasing Plan (CSPP). The Contractor shall complete the work in accordance with the approved Construction Safety and Phasing Plan (CSPP) developed in accordance with AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP is on sheet(s) 2-4 inclusive of the project plans.

70-09 Use of explosives. The use of explosives is not permitted on this project.

70-10 Protection and restoration of property and landscape. The Contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property markers until the Engineer/RPR has witnessed or otherwise referenced their location and shall not move them until directed.

The Contractor shall be responsible for all damage or injury to property of any character, during the execution of the work, resulting from any act, omission, neglect, or misconduct in manner or method of executing the work, or at any time due to defective work or materials, and said responsibility shall not be released until the project has been completed and accepted.

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 non-execution thereof by the Contractor, the Contractor shall restore, at their 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 the Contractor shall make good such damage or injury in an acceptable manner.

70-11 Responsibility for damage claims. The Contractor shall indemnify and hold harmless the Engineer, the Department, and the engineering firm their officers, agents, and employees from all suits, actions, or claims, of any character, brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of said Contractor; or because of any claims or amounts recovered from any infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the “Workmen’s Compensation Act,” or any other law, ordinance, order, or decree. Money due the Contractor under and by virtue of their own contract considered necessary by the Department for such purpose may be retained for the use of the Department or, in case no money is due, their own surety may be held until such suits, actions, or claims for injuries or damages shall have been settled and suitable evidence to that effect furnished to the Department, except that money due the Contractor will not be withheld when the Contractor produces satisfactory evidence that he or she is adequately protected by public liability and property damage insurance.

The Contractor, prior to execution of the contract, shall file with the department copies of completed certificates of insurance, satisfactory to the Department, to afford protection against all claims for damages to public or private property, and injuries to persons, arising out of and during the progress of the work to its completion, as defined by Section 89-12. The policy of insurance shall include the Owner and the participating agencies as an additional insured or provide separate coverage with an Owner’ Protection Policy. The minimum amounts of insurance shall be as follows, except no restrictions or occurrence limits will be permitted.

Bodily Injury	Property Damage Liability	
	Each Occurance	Aggregate
\$2,000,000	\$1,000,000	\$2,000,000

All such insurance must include an endorsement whereby the insurer agrees to notify the Department at least 30 days prior to nonrenewal, reduction or cancellation. The Contractor shall cease operations on the project if the insurance is cancelled or reduced below the required minimum amount of coverage. All costs for insurance as specified herein will not be paid for separately, but shall be considered incidental to the contract.

70-12 Third party beneficiary clause. It is specifically agreed between the parties executing the contract that it is not intended by any of the provisions of any part of the contract to create for the public or any member thereof, a third-party beneficiary or to authorize anyone not a party to the contract to maintain a suit for personal injuries or property damage pursuant to the terms or provisions of the contract.

70-13 Opening sections of the work to traffic. If it is necessary for the Contractor to complete portions of the contract work for the beneficial occupancy of the Department prior to completion of the entire contract, such “phasing” of the work must be specified below and indicated on the approved Construction Safety and Phasing Plan (CSPP) and the project plans. When so specified, the Contractor shall complete such portions of the work on or before the date specified or as otherwise specified. Refer to the Construction Safety Phasing Plan sheets for more information.

Upon completion of any portion of work listed above, such portion shall be accepted by the Department in accordance with Section 50, paragraph 50-14, *Partial Acceptance*.

No portion of the work may be opened by the Contractor until directed by the Engineer in writing. Should it become necessary to open a portion of the work to traffic on a temporary or intermittent basis, such openings shall be made when, in the opinion of the RPR, such portion of the work is in an acceptable condition to support the intended traffic. Temporary or intermittent openings are considered to be inherent in the work and shall not constitute either acceptance of the portion of the work so opened or a waiver of any provision of the contract. Any damage to the portion of the work so opened that is not attributable to traffic which is permitted by the Engineer shall be repaired by the Contractor at their expense.

The Contractor shall make their own estimate of the inherent difficulties involved in completing the work under the conditions herein described and shall not claim any added compensation by reason of delay or increased cost due to opening a portion of the contract work.

The Contractor must conform to safety standards contained AC 150/5370-2 and the approved CSPP.

Contractor shall refer to the plans, specifications, and the approved CSPP to identify barricade requirements, temporary and/or permanent markings, airfield lighting, guidance signs and other safety requirements prior to opening up sections of work to traffic.

70-14 Contractor’s responsibility for work. Until the Engineer’s final written acceptance of the entire completed work, excepting only those portions of the work accepted in accordance with Section 50, paragraph 50-14, *Partial Acceptance*, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part due to the action of the elements or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof except damage to the work due to unforeseeable causes beyond the control of and without the fault or negligence of the Contractor, including but not restricted to acts of God such as earthquake, tidal wave, tornado, hurricane or other cataclysmic phenomenon of nature, or acts of the public enemy or of government authorities.

If the work is suspended for any cause whatever, the Contractor shall be responsible for the work and shall take such precautions necessary to prevent damage to the work. The Contractor shall provide for normal drainage and shall erect necessary temporary structures, signs, or other facilities at their own expense. During such period of suspension of work, the Contractor shall properly and continuously maintain in an acceptable growing condition all living material in newly established planting, seeding, and sodding furnished under the contract, and shall take adequate precautions to protect new tree growth and other important vegetative growth against injury.

70-15 Contractor’s responsibility for utility service and facilities of others. As provided in paragraph 70-04, *Restoration of Surfaces Disturbed by Others*, the Contractor shall cooperate with the owner of any public or private utility service, FAA or NOAA, or a utility service of another government agency that

may be authorized by the Department to construct, reconstruct or maintain such utility services or facilities during the progress of the work. In addition, the Contractor shall control their operations to prevent the unscheduled interruption of such utility services and facilities.

To the extent that such public or private utility services, FAA, or NOAA facilities, or utility services of another governmental agency are known to exist within the limits of the contract work, the approximate locations have been indicated on the plans and/or in the contract documents.

University of Illinois – Willard Airport

Utility Service or Facility	Person to Contact	Contact Phone
Airfield Lighting Cables	U of I Tim Bannon	217-369-0099
FAA Control and Communications Cable	Rob Carter	217-355-4052
Sanitary Sewer	J.U.L.I.E.	800-892-0123
Electric Cables	J.U.L.I.E.	800-892-0123
Water	J.U.L.I.E.	800-892-0123
Telephone Cables	J.U.L.I.E.	800-892-0123
Gas Lines	J.U.L.I.E.	800-892-0123
All Utilities	U of I Operations and Maintenance	217-333-0340

It is understood and agreed that the Department 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 plans or encountered in the work. Any inaccuracy or omission in such information shall not relieve the Contractor of the responsibility to protect such existing features from damage or unscheduled interruption of service.

It is further understood and agreed that the Contractor shall, upon execution of the contract, notify the Owner of all utility services or other facilities of their plan of operations. Such notification shall be in writing addressed to “The Person to Contact” as provided in this paragraph and paragraph 70-04, *Restoration of Surfaces Disturbed By Others*. A copy of each notification shall be given to the Engineer/RPR.

In addition to the general written notification provided, it shall be the responsibility of the Contractor to keep such individual utility Owners advised of changes in their plan of operations that would affect such utility Owners.

Prior to beginning the work in the general vicinity of an existing utility service or facility, the Contractor shall again notify each such utility Owner of their plan of operation. If, in the Contractor’s opinion, the Department’s assistance is needed to locate the utility service or facility or the presence of a representative of the utility Owner is desirable to observe the work, such advice should be included in the

notification. Such notification shall be given by the most expeditious means to reach the utility owner's "Person to Contact" no later than two normal business days prior to the Contractor's commencement of operations in such general vicinity. The Contractor shall furnish a written summary of the notification to the Engineer/RPR.

The Contractor's failure to give the two days' notice shall be cause for the Department to suspend the Contractor's operations in the general vicinity of a utility service or facility.

Where the outside limits of an underground utility service have been located and staked on the ground, the Contractor shall be required to use hand excavation methods within 3 feet (1 m) of such outside limits at such points as may be required to ensure protection from damage due to the Contractor's operations.

Should the Contractor damage or interrupt the operation of a utility service or facility by accident or otherwise, the Contractor shall immediately notify the proper authority and the Engineer/RPR and shall take all reasonable measures to prevent further damage or interruption of service. The Contractor, in such events, shall cooperate with the utility service or facility owner, the Engineer and the RPR continuously until such damage has been repaired and service restored to the satisfaction of the utility or facility owner.

The Contractor shall bear all costs of damage and restoration of service to any utility service or facility due to their operations whether due to negligence or accident. The Department reserves the right to deduct such costs from any monies due or which may become due the Contractor, or their own surety.

70-15.1 FAA facilities and cable runs. The Contractor is hereby advised that the construction limits of the project include existing facilities and buried cable runs that are owned, operated and maintained by the FAA. The Contractor, during the execution of the project work, shall comply with the following:

a. The Contractor shall permit FAA maintenance personnel the right of access to the project work site for purposes of inspecting and maintaining all existing FAA owned facilities.

b. The Contractor shall provide notice to the FAA Air Traffic Organization (ATO)/Technical Operations/System Support Center (SSC) Point-of-Contact through the airport operator a minimum of seven (7) calendar days prior to commencement of construction activities in order to permit sufficient time to locate and mark existing buried cables and to schedule any required facility outages.

c. If execution of the project work requires a facility outage, the Contractor shall contact the FAA Point-of-Contact a minimum of 72 hours prior to the time of the required outage.

d. Any damage to FAA cables, access roads, or FAA facilities during construction caused by the Contractor's equipment or personnel whether by negligence or accident will require the Contractor to repair or replace the damaged cables, access road, or FAA facilities to FAA requirements. The Contractor shall not bear the cost to repair damage to underground facilities or utilities improperly located by the FAA.

e. If the project work requires the cutting or splicing of FAA owned cables, the FAA Point-of-Contact shall be contacted a minimum of 72 hours prior to the time the cable work commences. The FAA reserves the right to have a FAA representative on site to observe the splicing of the cables as a condition of acceptance. All cable splices are to be accomplished in accordance with FAA specifications and require approval by the FAA Point-of-Contact as a condition of acceptance by the Department. The Contractor is hereby advised that FAA restricts the location of where splices may be installed. If a cable splice is required in a location that is not permitted by FAA, the Contractor shall furnish and install a sufficient length of new cable that eliminates the need for any splice.

70-16 Furnishing rights-of-way. The Department will be responsible for furnishing all rights-of-way upon which the work is to be constructed in advance of the Contractor's operations.

70-17 Personal liability of public officials. In carrying out any of the contract provisions or in exercising any power or authority granted by this contract, there shall be no liability upon the Engineer, RPR, their

authorized representatives, or any officials of the Department either personally or as an official of the Department. It is understood that in such matters they act solely as agents and representatives of the Department.

70-18 No waiver of legal rights. Upon completion of the work, the Department will expeditiously make final inspection and notify the Contractor of final acceptance. Such final acceptance, however, shall not preclude or stop the Department from correcting any measurement, estimate, or certificate made before or after completion of the work, nor shall the Owner be precluded or stopped from recovering from the Contractor or their surety, or both, such overpayment as may be sustained, or by failure on the part of the Contractor to fulfill their obligations under the contract. A waiver on the part of the Department of any breach of any part of the contract shall not be held to be a waiver of any other or subsequent breach.

The Contractor, without prejudice to the terms of the contract, shall be liable to the Department for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Department's rights under any warranty or guaranty.

70-19 Environmental protection. The Contractor shall comply with all federal, state, and local laws and regulations controlling pollution of the environment. The Contractor shall take necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuels, oils, asphalts, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

70-20 Archaeological and historical findings. Unless otherwise specified in this subsection, the Contractor is advised that the site of the work is not within any property, district, or site, and does not contain any building, structure, or object listed in the current National Register of Historic Places published by the United States Department of Interior.

Should the Contractor encounter, during their operations, any building, part of a building, structure, or object that is incongruous with its surroundings, the Contractor shall immediately cease operations in that location and notify the RPR. The RPR will immediately investigate the Contractor's finding and the Department will direct the Contractor to either resume operations or to suspend operations as directed.

Should the Department order suspension of the Contractor's operations in order to protect an archaeological or historical finding, or order the Contractor to perform extra work, such shall be covered by an appropriate contract change order or supplemental agreement as provided in Section 40, paragraph 40-04, *Extra Work*, and Section 90, paragraph 90-05, *Payment for Extra Work*. If appropriate, the contract change order or supplemental agreement shall include an extension of contract time in accordance with Section 80, paragraph 80-07, *Determination and Extension of Contract Time*.

70-21 Contractor's public liability and property damage liability insurance. The Contractor, with respect to the work that they perform, will be required to carry regular Contractors: Public Liability Insurance, including automobile coverage, in limits of not less than \$500,000 for all damages arising out of bodily injuries to or death of one person and subject to that limit for each person, a total amount of \$1,000,000 for all damages arising out of bodily injuries to or death of two or more persons in any one accident and regular Contractors' Property Damage Liability Insurance, including automobile coverage, in limits of not less than \$500,000 for all damages arising out of injury to or destruction of property in any one accident and, subject to that limit per accident, a total (or aggregate) limit of \$1,000,000 for all damages arising out of injury to or destruction of property during the policy period.

The Contractor shall furnish a certified copy of the policy to the Department. The policy shall provide that in the event the insurance should be changed or cancelled, such change or cancellation

shall not be effective until 30 days after the Department has received notice of such change or cancellation from the insurance company.

70-22 Security During Construction. The Contractor will be responsible for maintaining airport security by maintaining the airport perimeter fence line at all times during the course of the work. All work shall be approved by the TSA and the Airport Operations Office. The Contractor shall maintain the existing airport perimeter fence line during the course of the work according to the following method:

The Contractor shall supply a 24-hour emergency contact that is capable of providing emergency fence repair.

Fines can be levied against the Contractor by the Transportation Security Administration (TSA) for negligence if the airport security is compromised and the airport perimeter fence line is not maintained as specified above. Fines can also be levied against the contractor for failure to cooperate with the airport management as required to maintain airport security

The Contractor shall maintain security on the Airport as specified or as directed by the Airport including adhering to all provisions of federal security regulations and all security requirements in the Airport Security Program and airport policies.

The project area lies entirely within the airport's security fence. Access to this area is only by airport issued access cards. No access point may be left unsecured and unattended at any time. During hauling operations and those requiring the access gate to remain open a security guard must be posted to maintain the security of the airport perimeter. The security guard must obtain an airport issued ID as specified below. The security guard must verify each vehicle and persons in the vehicle are authorized entry to the airport by use of authorized access lists and stop lists provided by the contractor and the airport. The security guard shall be required to carry a cell phone at all times while guarding an opening. The Contractor's Superintendent, Foremen, Security Guards, Flagmen, and any other employee directed by

Airport Management, must display a current photo I.D. badge, issued by the Airport. To obtain the photo I.D. badge for any of the Contractor's employees, the following is required:

- a. The Contractor will be responsible for certifying that all employees needing access and requesting an access ID are currently employed and require access by providing authorized signature forms and authorized subcontractor and employee lists directly to the Airport Security Coordinator.
- b. Each ID applicant must submit to a fingerprint based FBI Criminal History Records Check and successfully pass with no disqualifying crimes or the applicant will be prohibited from working in the secured area of the airport. A fingerprint fee will apply for each applicant
- c. The employee must complete an Airport Safety and Security Training Session before issue of their ID.
- d. The contractor will be responsible for all fees and costs associated with finger printing, issue of cards, and required security training for each applicant.

All ID applicants must complete their fingerprint checks and training before reporting for work. Due to the nature of the CHRC process and training requirements the contractor is urged to have employees report to the Operations Office as soon as practical.

The Contractor shall submit a list of subcontractors a minimum of 10 days prior to the preconstruction meeting. Subcontractors shall have the same badging requirements as the prime contractor.

In addition, the Airport Security Coordinator will require that all Security Guards undergo additional training necessary to meet the Airport's security needs.

The Contractor is responsible for payment of Transportation Security Administration fines and penalties resulting from security infractions perpetrated by, caused by, or permitted by his personnel or work forces of his subcontractors or suppliers.

The Contractor shall be responsible for security during construction as follows:

- a. Possess a copy of the Airport's project security plan.
- b. Visibly delineate his construction zone by placing a line of barricades around the entire work zone during each phase of the contract.
- c. Comply with the Airport's security plan associated with the construction project and ensure that construction personnel are familiar with security procedures and regulations on the Airport.
- d. Provide a 24 hour point of contact that will coordinate an immediate response to correct any construction-related activity that may adversely affect the operational safety of the Airport.
- e. Restrict movement of construction vehicles to construction areas with flagging and barricading, erecting temporary fencing, or providing escorts, as appropriate or as shown in plans.
- f. Ensure that no construction employees, employees of subcontractors or suppliers, or other persons enter any part of the aircraft operations area from construction site unless authorized.
- g. The Airport Manager may require that all Gate Security Guards undergo additional training necessary to meet the Airport's security needs.

- h. The Contractor shall be required to maintain security on the Airport as specified or as directed by the Airport.
- i. The Airport has a program in which the Contractor has the ability to have personnel approved to acquire uncontrolled access to the Air Operations area (AOA) for purposes of this contractor. Those person(s) having uncontrolled access must successfully complete a Criminal History Records Check (CHRC), security training, and provide proper documentation as required by the Airport Security Coordinator. Person(s) with uncontrolled access privileges must successfully complete the necessary security training in order that they can escort additional workers limited to having only controlled access privileges.
- j. All workers are to remain in their immediate work area(s) at all times.
- k. Contractor will provide 24 hours contact phone numbers to the Airport Security Coordinator (ASC) prior to the start of any work.
- l. Only those person(s) with the approved security training and badges may have an unescorted physical presence inside the fenced areas and airport operations area (AOA).
- m. Any person identified as being on a TSA/FAA security watch list will be immediately reported to the controlling agencies and is prohibited from working on airport property. Noticed will be given to the Contractor if such action is necessary.
- n. Airport security badges have a non-refundable \$50.00 processing fee per applicant badge and an additional refundable, \$300.00 deposit per badge.
- o. The Contractor will be required to post a Project Security Deposit, which shall be a cashier's check in the amount of \$3000.00. If there are any security fines or penalties imposed upon the Contractor, the fine will be paid from this check with any balance returned to the Contractor at the end of the project.
- p. Review the requirements in AC 150/5370-2 (current edition) and comply with items listed as contractor's responsibility.
- q. Implement a SPCD as required in AC 150/5370-2 (current edition) and ensure that construction personnel are familiar with operational safety procedures and regulations on the Airport.
- r. Provide a safety officer/construction inspector(s) trained in airport safety to maintain the SPCD and to monitor all construction activities.
- s. Be the subject of daily vehicle inspections for every vehicle that he wishes to bring inside the AOA fence.

It is strongly suggested that a contractor training coordinator be appointed by the Contractor to interact between the Contractor and the Airport Security Coordinator (ASC). This contractor training coordinator will then be assigned/trained contractor security training duties and responsibilities necessary to the project. The Airport Security Coordinator will hold two security training classes. The first is for the contractor security coordinator and second is for that training session, the contractor security coordinator

will be responsible to train all other company personnel necessary to the success of the project. Training dates and times will be mutually agreeable to the Contractor and the ASC.

All costs relating to the Contractor's security shall be the responsibility of the Contractor.

70-23 Worker's compensation insurance. Prior to the approval of the contract by the Department, the contractor shall furnish to the Department certificates of insurance covering Worker's Compensation, or such satisfactory evidence that this liability is otherwise taken care of according to Section 4(a) of the "Workers Compensation Act of the State of Illinois" as amended.

Such insurance, or other means of protection as herein provided, shall be kept in force until all work to be performed under the terms of the contract has been completed and accepted in accordance to the specifications, and it is hereby understood and agreed that the maintenance of such insurance or other protection, until acceptance of the work by the Department, is a part of the contract. Failure to maintain such insurance, cancellation by the industrial commission of its approval of such other means of protection as might have been elected, or any other act which results in lack of protection under said "Worker's Compensation Act" may be considered as breach of the contract.

70-24 Contractor's protective public liability and property damage insurance. At the time of filing their contract and bonds, the Contractor shall notify the Department, in writing, as to whether or not they propose to sublet any of the work under the terms of their contract. The Contractor, with respect to the operations performed for them by subcontractors, will be required to carry Contractors' Protective Public Liability and Property Damage Liability Insurance, including automobile coverage, in the same limits as prescribed in the paragraph 70-21 titled CONTRACTORS' PUBLIC LIABILITY AND PROPERTY DAMAGE LIABILITY INSURANCE of this section, and shall furnish copies of the policies of such insurance and certificates as above required. If no part of the work is to be sublet, this article will not apply.

Insurance coverage as required above shall be kept in force until all work to be performed under the terms of the contract has been accepted by the Department and it is clearly understood that the upkeep of these insurance policies until acceptance of the work by the Department is a part of the contract. The Contractor shall include the cost of all such insurance in their unit bid price and no extra compensation will be granted to them, nor will any deduction be made by the Department due to extra work and/or decreased quantities of work and/or elimination of items.

Such insurance or other means of protection as herein provided shall be kept in force until all work to be performed under the terms of the contract has been completed and accepted in accordance with the specifications and it is hereby understood and agreed that the maintenance of such insurance or other protection, until acceptance of the work by the Department, is a part of the contract. Failure to maintain such insurance, cancellation by the Industrial Commission of its approval of such other means of protection as might have been elected, or any other act which results in lack of protection under the said "Worker's Compensation Act" may be considered as a breach of the contract.

END OF SECTION 70

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Section 80 Execution and Progress

80-01 Subletting of contract. The Engineer will not recognize any subcontractor on the work. The Contractor shall at all times when work is in progress be represented either in person, by a qualified superintendent, or by other designated, qualified representative who is duly authorized to receive and execute orders of the Engineer. The Contractor shall not subcontract, sell, transfer, assign, or otherwise dispose of the contract or contracts or any portion thereof, or of their right, title, or interest therein, without written consent of the Engineer.

Notwithstanding consent to subcontract approved by the Engineer, the Contractor shall perform, with their organization, an amount of work equal to at least 51 percent of the total contract cost, and with materials purchased or produced by the Contractor. Items designated in the contract as “specialty items” may be performed by subcontract and the cost of any such specialty items so performed by subcontract may be deducted from the total cost before computing the amount of work required to be performed by the Contractor with his/her own organization. “Specialty Items” will be those items so designated on the Summary of Quantities included in the plans.

No subcontracts, or assignments of payments due or to become due, shall in any case release the Contractor or surety of liability under the contract and bonds. All transactions of the Engineer shall be with the Contractor. The Contractor shall have a representative on the job at all times when either contract or subcontract work is being performed.

All requests to subcontract shall contain a certification that the subcontract agreement exists in writing, that the subcontract incorporates by reference the terms and conditions of the contract, and that the subcontract incorporates fully therein the required Federal and State Equal Employment Opportunity provisions and labor Compliance provisions, including the contract wage requirements. The Contractor shall permit Department of Federal representative to examine the subcontract agreements upon notice.

The Engineer may order the Contractor to remove a subcontractor who does not perform satisfactory work or does not possess the integrity, experience, ability, and equipment the work requires in accordance with the terms and conditions of the contract. The Contractor shall comply at once and shall not employ the subcontractor for any further work under the contract.

All subcontractors shall be registered with the Department as a condition for approval to perform work on the contract.

Should the Contractor elect to assign their contract, said assignment shall be concurred in by the surety, shall be presented for the consideration and approval of the Engineer, and shall be consummated only on the written approval of the Engineer.

Prior to the issuance of the NTP, the Contractor shall submit to the Engineer all subcontract information on form AER 260, “Request for Approval of Subcontractor”.

80-02 Notice to proceed (NTP). The Department's notice to proceed will state the date on which contract time commences. The Contractor is expected to commence project operations within 10 days of the NTP date. The Contractor shall notify the RPR at least 48 hours in advance of the time contract operations begins. The Contractor shall not commence any actual operations prior to the date on which the notice to proceed is issued by the Department.

80-03 Execution and progress. Unless otherwise specified, the Contractor shall submit their coordinated construction schedule showing all work activities within the number of calendar days specified in the

contract for the Engineer's review prior to the issuance of the NTP. The Contractor's progress schedule, once accepted by the Engineer, will represent the Contractor's baseline plan to accomplish the project in accordance with the terms and conditions of the Contract. The Engineer will compare actual Contractor progress against the baseline schedule to determine that status of the Contractor's performance. The Contractor shall provide sufficient materials, equipment, and labor to guarantee the completion of the project in accordance with the plans and specifications within the time set forth in the proposal.

If the Contractor falls significantly behind the submitted schedule, the Contractor shall, upon the RPR's request, submit a revised schedule for completion of the work within the contract time and modify their operations to provide such additional materials, equipment, and labor necessary to meet the revised schedule. Should the execution of the work be discontinued for any reason, the Contractor shall notify the RPR at least 24 hours in advance of resuming operations.

The Contractor shall not commence any actual construction prior to the date on which the NTP is issued by the Department.

The project schedule shall be prepared as a network diagram in Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), or other format, or as otherwise specified. It shall include information on the sequence of work activities, milestone dates, and activity duration. The schedule shall show all work items identified in the project proposal for each work area and shall include the project start date and end date.

The Contractor shall maintain the work schedule and provide an update and analysis of the progress schedule on a twice monthly basis, or as otherwise specified in the contract. Submission of the work schedule shall not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

80-04 Limitation of operations. The Contractor shall control their operations and the operations of their subcontractors and all suppliers to provide for the free and unobstructed movement of aircraft in the air operations areas (AOA) of the airport.

When the work requires the Contractor to conduct their operations within an AOA of the airport, the work shall be coordinated with airport operations (through the RPR) at least 48 hours prior to commencement of such work. The Contractor shall not close an AOA until so authorized by the RPR and until the necessary temporary marking, signage and associated lighting is in place as provided in Section 70, paragraph 70-08, *Construction Safety and Phasing Plan (CSPP)*.

When the contract work requires the Contractor to work within an AOA of the airport on an intermittent basis (intermittent opening and closing of the AOA), the Contractor shall maintain constant communications as specified; immediately obey all instructions to vacate the AOA; and immediately obey all instructions to resume work in such AOA. Failure to maintain the specified communications or to obey instructions shall be cause for suspension of the Contractor's operations in the AOA until satisfactory conditions are provided. The areas of the AOA identified in the Construction Safety Phasing Plan (CSPP) and as listed below, cannot be closed to operating aircraft to permit the Contractor's operations on a continuous basis and will therefore be closed to aircraft operations intermittently as follows:

Refer to the Construction Safety Phasing Plan for detailed information.

The Contractor shall be required to conform to safety standards contained in AC 150/5370-2, Operational Safety on Airports During Construction and the approved CSPP.

80-04.1 Operational safety on airport during construction. All Contractors' operations shall be conducted in accordance with the approved project Construction Safety and Phasing Plan (CSPP) and the Safety Plan Compliance Document (SPCD) and the provisions set forth within the current version of AC 150/5370-2, Operational Safety on Airports During Construction. The CSPP included within the contract

documents conveys minimum requirements for operational safety on the airport during construction activities. The Contractor shall prepare and submit a SPCD that details how it proposes to comply with the requirements presented within the CSPP.

The Contractor shall implement all necessary safety plan measures prior to commencement of any work activity. The Contractor shall conduct routine checks to assure compliance with the safety plan measures.

The Contractor is responsible to the Department for the conduct of all subcontractors it employs on the project. The Contractor shall assure that all subcontractors are made aware of the requirements of the CSPP and SPCD and that they implement and maintain all necessary measures.

No deviation or modifications may be made to the approved CSPP and SPCD unless approved in writing by the Department. The necessary coordination actions to review Contractor proposed modifications to an approved CSPP or approved SPCD can require a significant amount of time.

80-05 Character of workers, methods, and equipment. The Contractor shall, at all times, employ sufficient labor and equipment for prosecuting the work to full completion in the manner and time required by the contract, plans, and specifications.

All workers shall have sufficient skill and experience to perform properly the work assigned to them. Workers engaged in special work or skilled work shall have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person employed by the Contractor or by any subcontractor who violates any operational regulations or operational safety requirements and, in the opinion of the RPR, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the RPR, be removed immediately by the Contractor or subcontractor employing such person, and shall not be employed again in any portion of the work without approval of the RPR.

Should the Contractor fail to remove such person or persons, or fail to furnish suitable and sufficient personnel for the proper execution of the work, the RPR may suspend the work by written notice until compliance with such orders.

All equipment that is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the work shall not cause injury to previously completed work, adjacent property, or existing airport facilities due to its use.

When the methods and equipment to be used by the Contractor in accomplishing the work are not prescribed in the contract, the Contractor is free to use any methods or equipment that will accomplish the work in conformity with the requirements of the contract, plans, and specifications.

When the contract specifies the use of certain methods and equipment, such methods and equipment shall be used unless otherwise authorized by the RPR. If the Contractor desires to use a method or type of equipment other than specified in the contract, the Contractor may request authority from the RPR to do so. The request shall be in writing and shall include a full description of the methods and equipment proposed and of the reasons for desiring to make the change. If approval is given, it will be on the condition that the Contractor will be fully responsible for producing work in conformity with contract requirements. If, after trial use of the substituted methods or equipment, the RPR determines that the work produced does not meet contract requirements, the Contractor shall discontinue the use of the substitute method or equipment and shall complete the remaining work with the specified methods and equipment. The Contractor shall remove any deficient work and replace it with work of specified quality, or take such other corrective action as the RPR may direct. No change will be made in basis of payment for the contract items involved nor in contract time as a result of authorizing a change in methods or equipment under this paragraph.

80-06 Temporary suspension of the work. The Engineer shall have the authority to suspend the work wholly, or in part, for such period or periods the Engineer may deem necessary, due to unsuitable weather, or other conditions considered unfavorable for the execution of the work, or for such time necessary due to the failure on the part of the Contractor to carry out orders given or perform any or all provisions of the contract.

In the event that the Contractor is ordered by the Engineer, in writing, to suspend work for some unforeseen cause not otherwise provided for in the contract and over which the Contractor has no control, the Contractor may be reimbursed for actual money expended on the work during the period of shutdown. No allowance will be made for anticipated profits. The period of shutdown shall be computed from the effective date of the written order to suspend work to the effective date of the written order to resume the work. Claims for such compensation shall be filed with the RPR within the time period stated in the Engineer's order to resume work. The Contractor shall submit with their own claim information substantiating the amount shown on the claim. The RPR will forward the Contractor's claim to the Department for consideration in accordance with local laws or ordinances. No provision of this article shall be construed as entitling the Contractor to compensation for delays due to inclement weather or for suspension made at the request of the Engineer, any other delay provided for in the contract, plans, or specifications.

If it becomes necessary to suspend work for an indefinite period, the Contractor shall store all materials in such manner that they will not become an obstruction nor become damaged in any way. The Contractor shall take every precaution to prevent damage or deterioration of the work performed and provide for normal drainage of the work. The Contractor shall erect temporary structures where necessary to provide for traffic on, to, or from the airport.

80-07 Determination and extension of contract time. The number of calendar days shall be stated in the proposal and contract and shall be known as the Contract Time.

If the contract time requires extension for reasons beyond the Contractor's control, it shall be adjusted as follows:

80-07.1

Contract time based on calendar days. Contract Time based on calendar days shall consist of the number of calendar days stated in the contract counting from the effective date of the Notice to Proceed and including all Saturdays, Sundays, holidays, and non-work days. All calendar days elapsing between the effective dates of the Owner's orders to suspend and resume all work, due to causes not the fault of the Contractor, shall be excluded.

At the time of final payment, the contract time shall be increased in the same proportion as the cost of the actually completed quantities bears to the cost of the originally estimated quantities in the proposal. Such increase in the contract time shall not consider either cost of work or the extension of contract time that has been covered by a change order or supplemental agreement. Charges against the contract time will cease as of the date of final acceptance.

80-08 Failure to complete on time. Should the Contractor fail to complete the work within the final contract time, the Contractor shall be liable to the Department in the amount shown in the current schedule of deductions as provided in the contract documents, not as a penalty but as liquidated damages, for each day of overrun in the final contract time.

Schedule	Liquidated Damages Cost	Allowed Construction Time
1	\$750.00	See Proposal Form

Permitting the contractor to continue and finish the work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, will in no way operate as a waiver on the part of the Department or any of its rights under the contract.

80-09 Default and termination of contract. The Contractor shall be considered in default of their contract and such default will be considered as cause for the Department to terminate the contract for any of the following reasons, if the Contractor:

- a. Fails to begin the work under the contract within the time specified in the Notice to Proceed, or
- b. Fails to perform the work or fails to provide sufficient workers, equipment and/or materials to assure completion of work in accordance with the terms of the contract, or
- c. Performs the work unsuitably or neglects or refuses to remove materials or to perform anew such work as may be rejected as unacceptable and unsuitable, or
- d. Discontinues the execution of the work, or
- e. Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
- f. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or
- g. Allows any final judgment to stand against the Contractor unsatisfied for a period of 10 days, or
- h. Makes an assignment for the benefit of creditors, or
- i. For any other cause whatsoever, fails to carry on the work in an acceptable manner.

Should the Department consider the Contractor in default of the contract for any reason above, the Department shall immediately give written notice to the Contractor and the Contractor’s surety as to the reasons for considering the Contractor in default and the Department’s intentions to terminate the contract.

If the Contractor or surety, within a period of 10 days after such notice, does not proceed in accordance therewith, then the Department will, upon written notification from the RPR of the facts of such delay, neglect, or default and the Contractor’s failure to comply with such notice, have full power and authority without violating the contract, to take the execution of the work out of the hands of the Contractor. The Department may appropriate or use any or all materials and equipment that have been mobilized for use in the work and are acceptable and may enter into an agreement for the completion of said contract according to the terms and provisions thereof, or use such other methods as in the opinion of the RPR will be required for the completion of said contract in an acceptable manner.

All costs and charges incurred by the Department, together with the cost of completing the work under contract, will be deducted from any monies due or which may become due the Contractor. If such expense exceeds the sum which would have been payable under the contract, then the Contractor and the surety shall be liable and shall pay to the Department the amount of such excess.

80-10 Termination for national emergencies. The Department shall terminate the contract or portion thereof by written notice when the Contractor is prevented from proceeding with the construction contract as a direct result of an Executive Order of the President with respect to the execution of war or in the interest of national defense.

When the contract, or any portion thereof, is terminated before completion of all items of work in the contract, payment will be made for the actual number of units or items of work completed at the contract

price or as mutually agreed for items of work partially completed or not started. No claims or loss of anticipated profits shall be considered.

Reimbursement for organization of the work, and other overhead expenses, (when not otherwise included in the contract) and moving equipment and materials to and from the job will be considered, the intent being that an equitable settlement will be made with the Contractor.

Acceptable materials, obtained or ordered by the Contractor for the work and that are not incorporated in the work shall, at the option of the Contractor, be purchased from the Contractor at actual cost as shown by receipted bills and actual cost records at such points of delivery as may be designated by the RPR.

Termination of the contract or a portion thereof shall neither relieve the Contractor of their responsibilities for the completed work nor shall it relieve their surety of its obligation for and concerning any just claim arising out of the work performed.

80-11 Work area, storage area and sequence of operations. The Contractor shall obtain approval from the RPR prior to beginning any work in all areas of the airport. No operating runway, taxiway, or air operations area (AOA) shall be crossed, entered, or obstructed while it is operational. The Contractor shall plan and coordinate work in accordance with the approved CSPP and SPCD.

80-12 Termination of the contractor's responsibility. Whenever the improvement called for by the contract shall have been completely performed on the part of the Contractor and all parts of the work have been approved by the Engineer and accepted by the participating agencies according to the contract, and the final estimate paid, the Contractor's obligations shall then be considered fulfilled, except as set forth in their bond and in Section 70, paragraphs 70-11 and 70-18 titled RESPONSIBILITY FOR DAMAGE CLAIMS and NO WAIVER OF LEGAL RIGHTS respectively.

Termination of the contract or a portion thereof shall neither relieve the Contractor of their responsibilities for the completed work nor shall it relieve their surety of its obligation for and concerning any just claim arising out of the work performed.

END OF SECTION 80

Section 90 Measurement and Payment

90-01 Measurement of quantities. All work completed under the contract will be measured by the RPR, or their authorized representatives, using United States Customary Units of Measurement.

The method of measurement and computations to be used in determination of quantities of material furnished and of work performed under the contract will be those methods generally recognized as conforming to good engineering practice.

Unless otherwise specified, longitudinal measurements for area computations will be made horizontally, and no deductions will be made for individual fixtures (or leave-outs) having an area of 9 square feet (0.8 square meters) or less. Unless otherwise specified, transverse measurements for area computations will be the neat dimensions shown on the plans or ordered in writing by the RPR.

Unless otherwise specified, all contract items which are measured by the linear foot such as electrical ducts, conduits, pipe culverts, underdrains, and similar items shall be measured parallel to the base or foundation upon which such items are placed.

The term “lump sum” when used as an item of payment will mean complete payment for the work described in the contract. When a complete structure or structural unit (in effect, “lump sum” work) is specified as the unit of measurement, the unit will be construed to include all necessary fittings and accessories.

When requested by the Contractor and approved by the RPR in writing, material specified to be measured by the cubic yard (cubic meter) may be weighed, and such weights will be converted to cubic yards (cubic meters) for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the RPR and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.

Measurement and Payment Terms

Term	Description
Excavation and Embankment Volume	In computing volumes of excavation, the average end area method will be used unless otherwise specified.
Measurement and Proportion by Weight	The term “ton” will mean the short ton consisting of 2,000 pounds (907 kg) avoirdupois. All materials that are measured or proportioned by weights shall be weighed on accurate, independently certified scales by competent, qualified personnel at locations designated by the RPR. If material is shipped by rail, the car weight may be accepted provided that only the actual weight of material is paid for. However, car weights will not be acceptable for material to be passed through mixing plants. Trucks used to haul material being paid for by weight shall be weighed empty daily at such times as the RPR directs, and each truck shall bear a plainly legible identification mark.
Measurement by Volume	Materials to be measured by volume in the hauling vehicle shall be hauled in approved vehicles and measured therein at the point of delivery. Vehicles for this purpose may be of any size or type acceptable for the materials hauled, provided that the body is of such shape that the actual contents may be readily and accurately determined. All vehicles

Term	Description
	shall be loaded to at least their water level capacity, and all loads shall be leveled when the vehicles arrive at the point of delivery.
Asphalt Material	Asphalt materials will be measured by the gallon (liter) or ton (kg). When measured by volume, such volumes will be measured at 60°F (16°C) or will be corrected to the volume at 60°F (16°C) using ASTM D1250 for asphalts. Net certified scale weights or weights based on certified volumes in the case of rail shipments will be used as a basis of measurement, subject to correction when asphalt material has been lost from the car or the distributor, wasted, or otherwise not incorporated in the work. When asphalt materials are shipped by truck or transport, net certified weights by volume, subject to correction for loss or foaming, will be used for computing quantities.
Cement	Cement will be measured by the ton (kg) or hundredweight (km).
Structure	Structures will be measured according to neat lines shown on the plans or as altered to fit field conditions.
Timber	Timber will be measured by the thousand feet board measure (MFBM) actually incorporated in the structure. Measurement will be based on nominal widths and thicknesses and the extreme length of each piece.
Plates and Sheets	The thickness of plates and galvanized sheet used in the manufacture of corrugated metal pipe, metal plate pipe culverts and arches, and metal cribbing will be specified and measured in decimal fraction of inch.
Miscellaneous Items	When standard manufactured items are specified such as fence, wire, plates, rolled shapes, pipe conduit, etc., and these items are identified by gauge, unit weight, section dimensions, etc., such identification will be considered to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.
Scales	<p>Scales must be tested for accuracy and serviced before use. Scales for weighing materials which are required to be proportioned or measured and paid for by weight shall be furnished, erected, and maintained by the Contractor, or be certified permanently installed commercial scales. Platform scales shall be installed and maintained with the platform level and rigid bulkheads at each end.</p> <p>Scales shall be accurate within 0.5% of the correct weight throughout the range of use. The Contractor shall have the scales checked under the observation of the RPR before beginning work and at such other times as requested. The intervals shall be uniform in spacing throughout the graduated or marked length of the beam or dial and shall not exceed 0.1% of the nominal rated capacity of the scale, but not less than one pound (454 grams). The use of spring balances will not be permitted.</p> <p>In the event inspection reveals the scales have been “overweighing” (indicating more than correct weight) they will be immediately adjusted. All materials received subsequent to the last previous correct weighting-accuracy test will be reduced by the percentage of error in excess of 0.5%.</p> <p>In the event inspection reveals the scales have been under-weighing (indicating less than correct weight), they shall be immediately adjusted. No additional payment to the Contractor will be allowed for materials previously weighed and recorded.</p> <p>Beams, dials, platforms, and other scale equipment shall be so arranged that the operator and the RPR can safely and conveniently view them.</p>

Term	Description
	<p>Scale installations shall have available ten standard 50-pound (2.3 km) weights for testing the weighing equipment or suitable weights and devices for other approved equipment.</p> <p>All costs in connection with furnishing, installing, certifying, testing, and maintaining scales; for furnishing check weights and scale house; and for all other items specified in this subsection, for the weighing of materials for proportioning or payment, shall be included in the unit contract prices for the various items of the project.</p>
Rental Equipment	<p>Rental of equipment will be measured by time in hours of actual working time and necessary traveling time of the equipment within the limits of the work. Special equipment ordered in connection with extra work will be measured as agreed in the change order or supplemental agreement authorizing such work as provided in paragraph 90-05 <i>Payment for Extra Work</i>.</p>
Pay Quantities	<p>When the estimated quantities for a specific portion of the work are designated as the pay quantities in the contract, they shall be the final quantities for which payment for such specific portion of the work will be made, unless the dimensions of said portions of the work shown on the plans are revised by the RPR. If revised dimensions result in an increase or decrease in the quantities of such work, the final quantities for payment will be revised in the amount represented by the authorized changes in the dimensions.</p>

90-02 Scope of payment. The Contractor shall receive and accept compensation provided for in the contract as full payment for furnishing all materials, for performing all work under the contract in a complete and acceptable manner, and for all risk, loss, damage, or expense of whatever character arising out of the nature of the work or the execution thereof, subject to the provisions of Section 70, paragraph 70-18, *No Waiver of Legal Rights*.

When the “basis of payment” subsection of a technical specification requires that the contract price (price bid) include compensation for certain work or material essential to the item, this same work or material will not also be measured for payment under any other contract item which may appear elsewhere in the contract, plans, or specifications.

90-03 Compensation for altered quantities. When the accepted quantities of work vary from the quantities in the proposal, the Contractor shall accept as payment in full, so far as contract items are concerned, payment at the original contract price for the accepted quantities of work actually completed and accepted. No allowance, except as provided for in Section 40, paragraph 40-02, *Alteration of Work and Quantities*, will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor which results directly from such alterations or indirectly from their own unbalanced allocation of overhead and profit among the contract items, or from any other cause.

90-04 Payment for omitted items. As specified in Section 40, paragraph 40-03, Deleted Items, the RPR shall have the right to delete from the work (order nonperformance) any contract item, except major contract items, in the best interest of the Department.

Should the RPR delete or order nonperformance of a contract item or portion of such item from the work, the Contractor shall accept payment in full at the contract prices for any work actually completed and acceptable prior to the RPR’s order to omit or non-perform such contract item.

Acceptable materials ordered by the Contractor or delivered on the work prior to the date of the RPR’s order will be paid for at the actual cost to the Contractor and shall thereupon become the property of the Department.

In addition to the reimbursement hereinbefore provided, the Contractor shall be reimbursed for all actual costs incurred for the purpose of performing the deleted contract item prior to the date of the RPR's order. Such additional costs incurred by the Contractor must be directly related to the deleted contract item and shall be supported by certified statements by the Contractor as to the nature the amount of such costs.

90-05 Payment for extra work. Extra work, performed in accordance with Section 40, paragraph 40-04, *Extra Work*, will be paid for at the contract prices or agreed prices specified in the change order or supplemental agreement authorizing the extra work.

Extra work will be paid for at either the contract price, a lump sum price or agreed unit prices, or on a force account basis.

- a. **Lump sum price or agreed unit price.** When extra work is to be paid for at either a lump sum price or agreed unit prices, the lump sum or unit prices shall be agreed upon by the Contractor and Engineer.
- b. **Force account basis.** When extra work is to be paid for by force account, the basis for the force account shall be as follows:

(1) **Labor.** For all labor and foremen in direct charge of the specific operations, the Contractor shall receive the actual normal rate of wage paid for each and every hour that said labor and foremen are actually engaged in such work.

The Contractor shall receive the actual costs paid to, or in behalf of, workers by reason of subsistence and travel allowances, health and welfare benefits, pension fund benefits or other benefits, when such employment contract generally applicable to the classes of labor employed on the work.

An amount equal to 35% of the sum of the above items will also be paid the Contractor.

(2) **Bond, insurance and tax.** For property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions and social security taxes on the force account work the Contractor shall receive the actual cost, to which 10% will be added. The Contractor shall furnish satisfactory evidence of the rate or rates paid for such bond, insurance and tax.

(3) **Materials.** For materials accepted by the Engineer and used, the Contractor shall receive the actual cost of such materials delivered on the work, including transportation charges paid by the Contractor (exclusive of machinery rentals as hereinafter set forth), to which cost, 15% will be added.

(4) **Equipment.** Equipment used for extra work shall be authorized by the Engineer. The equipment shall be specifically described, be of suitable size and capacity for the work to be performed, and be in good operating condition. For such equipment, the Contractor will be paid as follows:

- (a) **Contractor Owned Equipment.** Contractor owned equipment will be paid for by the hour using the applicable FHWA hourly rate from the "Equipment Watch Rental Rate Blue Book" (Blue Book) in effect when the force account work begins. The FHWA hourly rate is calculated as follows.

$$\text{FHWA hourly rate} = (\text{monthly rate}/176) \times (\text{model year adj.}) \times (\text{Illinois adj.}) + \text{EOC}$$

Where: EOC = Estimated Operating Costs per hour (from the Blue Book)

The time allowed will be the actual time the equipment is operating on the extra work. For the time required to move the equipment to and from the site of the extra work and any authorized idle (standby) time, payment will be made at the follow hourly rate:

0.5 x (FHWA hourly rate – EOC)

All time allowed shall fall within the working hours authorized for the extra work. The rates above include the cost of fuel, oil, lubrication, supplies, small tools, necessary attachments, repairs, overhaul and maintenance of any kind, depreciation, storage, overhead, profits, insurance, and all incidentals. The rates do not include labor.

The Contractor shall submit to the Engineer sufficient information for each piece of equipment and its attachments to enable the Engineer to determine the proper equipment category. If a rate is not established in the Blue Book for a particular piece of equipment, the Engineer will establish a rate for that piece of equipment that is consistent with its cost and use in the industry.

- (b) **Rented Equipment.** Whenever it is necessary for the Contractor to rent equipment to perform extra work, the rental and transportation costs of the equipment plus 5% for overhead will be paid. In no case shall the rental rates exceed those established distributors or equipment rental agencies.

All prices shall be agreed to in writing before the equipment is used.

- (5) **Miscellaneous.** No additional allowance will be made for general superintendence, the use of small tools, or other costs for which no specific allowance is herein provided.

- (6) **Statements.** No payment will be made for work performed on a force account basis until the Contractor has furnished the Engineer with itemized statements of the cost of such force account work. Statements shall be accompanied and supported by invoices for all materials used and transportation charges. However, if materials used on the force account work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from their stock, that the quantity claimed was actually used, and that the price and transportation claimed represent the actual cost to the Contractor.

- (a) Name, classification, date, daily hours, total hours, rate, and extension for laborer and foreman. Payrolls shall be submitted to substantiate actual wages paid if so requested by the Engineer.
- (b) Designation, dates, daily hours, total hours, rental rates, and extension for each unit of machinery and equipment.
- (c) Quantities of materials, prices and extensions.
- (d) Transportation of materials.
- (e) Cost of property damage, liability and workmen's compensation insurance premiums, unemployment insurance contributions, and social security tax.

- (7) **Work Performed by an Approved Subcontractor.** When extra work is performed by an approved subcontractor, the Contractor shall receive, as administrative costs, an amount equal to 5% of the total approved costs of such work with the minimum payment being \$100.

- (8) All statements of the cost of force account work shall be furnished to the Engineer no later than 60 days after receipt of form AER 635, "Extra Work Daily Report". If the statement is not received within the specified time frame, all demands for payment for the extra work are waived and the Department is released from any and all such demands. It is the responsibility of the Contractor to ensure that all statements are received within the specified time regardless of the manner or method of delivery.

90-06 Partial payments. Partial payments will be made to the Contractor at least once each month as the work progresses. Said payments will be based upon estimates, prepared by the RPR, of the value of the work performed and materials complete and in place, in accordance with the contract, plans, and specifications. Such partial payments may also include the delivered actual cost of those materials stockpiled and stored in accordance with paragraph 90-07, *Payment for Materials on Hand*. No partial payment will be made when the amount due to the Contractor since the last estimate amounts to less than five hundred dollars.

Retainage for each CPP to the Contractor shall be calculated as follows:

- a. For the first 50% of the total contract value, an amount of 10% of the value of the completed work shall be retained from the Contractor until after completion of the entire final contract and to the satisfaction of the Department.
- b. After more than 50% of the total contract value is completed, the Department may, at its discretion, certify the remaining partial payments be made to the Contractor without further retainage, provided that satisfactory progress is being made, and provided that the total retained amount is not less than 5% of the total adjusted contract value.
- c. At the discretion of the Department and with the consent of the surety, a semi-final Construction Progress Payment may be made when the principal contract payment items have been satisfactorily completed. In no event shall the amount retained from the Contractor after making the semi-final payment be less than 1% of the adjusted contract value, nor less than five hundred dollars.
- d. Should the Contractor exercise their option, as provided in the subsection 90-08 titled TRUST AGREEMENT OPTION of this section, no such percent retainage shall be deducted.

Regardless of retainage withheld, the Contractor is required to pay all subcontractors in full for satisfactory performance of their contracts no later than 30 days after the Contractor has received a partial payment. The Department must ensure prompt and full payment of retainage from the prime Contractor to the subcontractor within 30 days after the subcontractor's work is satisfactorily completed. A subcontractor's work is satisfactorily completed when all the tasks called for in the subcontract have been accomplished and documented as required by the Department. When the Department has made an incremental acceptance of a portion of a prime contract, the work of a subcontractor covered by that acceptance is deemed to be satisfactorily completed.

If, upon delivery of any of the materials, the Contractor fails to supply documentation meeting the requirements of the current Illinois Department of Transportation, Bureau of Airport Engineering Manual for Documentation of Airport Materials, the Department shall not include payment for that material on a Contractor Progress Payment Report until such statements have been furnished. Copies of the latest revision of the Bureau of Airport Engineering Manual for Documentation of Airport Materials may be obtained by contacting the Department. Copies are also available on the internet at the Illinois Department of Transportation's website.

It is understood and agreed that the Contractor shall not be entitled to demand or receive partial payment based on quantities of work in excess of those provided in the proposal or covered by approved change orders or supplemental agreements, except when such excess quantities have been determined by the Engineer to be a part of the final quantity for the item of work in question.

No partial payment shall bind the Department to the acceptance of any materials or work in place as to quality or quantity. All partial payments are subject to correction at the time of final payment as provided in paragraph 90-09, *Acceptance and Final Payment*.

The Contractor shall deliver to the Department a complete release of all claims for labor and material arising out of this contract before the final payment is made. If any subcontractor or supplier fails to furnish such a release in full, the Contractor may furnish a bond or other collateral satisfactory to the Department to indemnify the Department against any potential lien or other such claim. The bond or collateral shall include all costs, expenses, and attorney fees the Department may be compelled to pay in discharging any such lien or claim.

90-07 Payment for materials on hand. Partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the contract, plans, and specifications and are delivered to acceptable sites on the airport property or at other sites in the vicinity that are acceptable to the Owner. Such delivered costs of stored or stockpiled materials may be included in the next partial payment after the following conditions are met:

- a. The material has been stored or stockpiled in a manner acceptable to the Engineer/RPR at or on an approved site.
- b. The Contractor has furnished the Engineer/RPR with acceptable evidence of the quantity and quality of such stored or stockpiled materials.
- c. The Contractor has furnished the Engineer/RPR with satisfactory evidence that the material and transportation costs have been paid.
- d. The Contractor has furnished the Department legal title (free of liens or encumbrances of any kind) to the material stored or stockpiled.
- e. The Contractor has furnished the Department evidence that the material stored or stockpiled is insured against loss by damage to or disappearance of such materials at any time prior to use in the work.

It is understood and agreed that the transfer of title and the Owner's payment for such stored or stockpiled materials shall in no way relieve the Contractor of their responsibility for furnishing and placing such materials in accordance with the requirements of the contract, plans, and specifications.

In no case will the amount of partial payments for materials on hand exceed the contract price for such materials or the contract price for the contract item in which the material is intended to be used.

No partial payment will be made for stored or stockpiled living or perishable plant materials.

The Contractor shall bear all costs associated with the partial payment of stored or stockpiled materials in accordance with the provisions of this paragraph.

90-08 Trust agreement option. When the awarding authority is the State of Illinois and the request of a Contractor the amounts to be paid to the Contractor, including the amounts to be retained from the Contractor as set forth in subsection 90-06 titled PARTIAL PAYMENTS of this section, may be deposited under the Department's Trust Agreement with an Illinois financial institution of the Contractor's choice. The Contractor shall receive any interest thereon. The Trust Agreement contains, as a minimum, the following provisions:

- a. The terms and conditions for depositing the retainage, holding the retainage in trust and the final disbursement of the retainage;
- b. The return or repayment of retainage upon demand made by the Department;
- c. The types of investments the financial institution may make with the retainage;
- d. The terms and conditions of the return or repayment of retainage in case of default of the Contractor;
- e. The Department's right to withhold progress payments on account of lien claims, liquidated damages, or as otherwise provided by the contract.

- f. The Contractor's responsibilities for obtaining the written consent of the financial institution, and any costs or service fees for administering the Trust Agreement shall be borne by the Contractor;
- g. The termination of the Trust Agreement upon completion of the contract.

At the Contractor's option, if an Department withholds retainage in accordance with the methods described in paragraph 90-06 *Partial Payments*, the Contractor may request that the Department deposit the retainage into an escrow account. The Department's deposit of retainage into an escrow account is subject to the following conditions:

a. The Contractor shall bear all expenses of establishing and maintaining an escrow account and escrow agreement acceptable to the Department.

b. The Contractor shall deposit to and maintain in such escrow only those securities or bank certificates of deposit as are acceptable to the Department and having a value not less than the retainage that would otherwise be withheld from partial payment.

c. The Contractor shall enter into an escrow agreement satisfactory to the Department.

d. The Contractor shall obtain the written consent of the surety to such agreement.

90-09 Acceptance and final payment. When the contract work has been accepted in accordance with the requirements of Section 50, paragraph 50-15, *Final Acceptance*, the RPR will prepare the final estimate of the items of work actually performed. The Contractor shall approve the RPR's final estimate or advise the RPR of the Contractor's objections to the final estimate which are based on disputes in measurements or computations of the final quantities to be paid under the contract as amended by change order or supplemental agreement. The Contractor and the RPR shall resolve all disputes (if any) in the measurement and computation of final quantities to be paid within 30 calendar days of the Contractor's receipt of the RPR's final estimate. If, after such 30-day period, a dispute still exists, the Contractor may approve the RPR's estimate under protest of the quantities in dispute, and such disputed quantities shall be considered by the Owner as a claim in accordance with Section 50, paragraph 50-16, *Claims for Adjustment and Disputes*.

After the Contractor has approved, or approved under protest, the RPR's final estimate, and after the RPR's receipt of the project closeout documentation required in paragraph 90-11, *Contractor Final Project Documentation*, final payment will be processed based on the entire sum, or the undisputed sum in case of approval under protest, determined to be due the Contractor less all previous payments and all amounts to be deducted under the provisions of the contract. All prior partial estimates and payments shall be subject to correction in the final estimate and payment.

If the Contractor has filed a claim for additional compensation under the provisions of Section 50, paragraph 50-16, *Claims for Adjustments and Disputes*, or under the provisions of this paragraph, such claims will be considered by the Department in accordance with local laws or ordinances. Upon final adjudication of such claims, any additional payment determined to be due the Contractor will be paid pursuant to a supplemental final estimate.

90-10 Construction warranty.

a. In addition to any other warranties in this contract, the Contractor warrants that work performed under this contract conforms to the contract requirements and is free of any defect in equipment, material, workmanship, or design furnished, or performed by the Contractor or any subcontractor or supplier at any tier.

b. This warranty shall continue for a period of one year from the date of final acceptance of the work, except as noted. If the Department takes possession of any part of the work before final acceptance, this

warranty shall continue for a period of one year from the date the Department takes possession. However, this will not relieve the Contractor from corrective items required by the final acceptance of the project work. Light Emitting Diode emitting diode (LED) light fixtures with the exception of obstruction lighting, must be warranted by the manufacturer for a minimum of four (4) years after date of installation inclusive of all electronics.

c. The Contractor shall remedy at the Contractor's expense any failure to conform, or any defect. In addition, the Contractor shall remedy at the Contractor's expense any damage to Owner real or personal property, when that damage is the result of the Contractor's failure to conform to contract requirements; or any defect of equipment, material, workmanship, or design furnished by the Contractor.

d. The Contractor shall restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced will run for one year from the date of repair or replacement.

e. The Department will notify the Contractor, in writing, within seven (7) days after the discovery of any failure, defect, or damage.

f. If the Contractor fails to remedy any failure, defect, or damage within 14 days after receipt of notice, the Owner shall have the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.

g. With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor shall: (1) Obtain all warranties that would be given in normal commercial practice; (2) Require all warranties to be executed, in writing, for the benefit of the Department, as directed by the Department, and (3) Enforce all warranties for the benefit of the Department.

h. This warranty shall not limit the Department's rights with respect to latent defects, gross mistakes, or fraud.

90-11 Contractor Final Project Documentation. Approval of final payment to the Contractor is contingent upon completion and submittal of the items required by the Department. The final payment will not be approved until the RPR approves the Contractor's final submittal. The Contractor shall:

a. Provide two (2) copies of all manufacturers warranties specified for materials, equipment, and installations.

b. Provide weekly payroll records (not previously received) from the general Contractor and all subcontractors.

c. Complete final cleanup in accordance with Section 40, paragraph 40-08, *Final Cleanup*.

d. Complete all punch list items identified during the Final Inspection.

e. Provide complete release of all claims for labor and material arising out of the Contract.

f. Provide a certified statement signed by the subcontractors, indicating actual amounts paid to the Disadvantaged Business Enterprise (DBE) subcontractors and/or suppliers associated with the project.

g. When applicable per state requirements, return copies of sales tax completion forms.

h. Manufacturer's certifications for all items incorporated in the work.

i. All required record drawings, as-built drawings or as-constructed drawings.

j. Project Operation and Maintenance (O&M) Manual(s).

k. Security for Construction Warranty.

l. Equipment commissioning documentation submitted, if required.

- m. Submit all EEO Reports on form AER 1956 to the RPR.
- n. Submit all weekly certified payrolls to the RPR.
- o. Submit Good Faith Effort Waiver Request if the Contractor was unable to meet minority and female goal presented on IDOT form BC 1256 prior to construction.
- p. Submit DBE Final Documentation on form AER 1958 to the RPR
- q. Submit a list of total payments to subcontractors for each federal fiscal year in which the project is active.
- r. Submit a DBE Payment Agreement on form SBE 2115 to the RPR after the Contractor pays DBE subcontractors.
- s. Return Airport Security badges previously held by the Contractor and all subcontractors to the Airport.

90-12 Increased quantities. Payment will not be made for quantities in excess of the maximum payment percentages found in the current Illinois Department of Transportation, Bureau of Airport Engineering *Airport Construction Documentation Manual*.

END OF SECTION 90

Part 2 – General Construction Items

Item C-100 Contractor Quality Control Program (CQCP)

100-1 General. Quality is more than test results. Quality is the combination of proper materials, testing, workmanship, equipment, inspection, and documentation of the project. Establishing and maintaining a culture of quality is key to achieving a quality project. The Contractor shall establish, provide, and maintain an effective Contractor Quality Control Program (CQCP) that details the methods and procedures that will be taken to assure that all materials and completed construction required by this contract conform to contract plans, technical specifications and other requirements, whether manufactured by the Contractor, or procured from subcontractors or vendors. Although guidelines are established and certain minimum requirements are specified here and elsewhere in the contract technical specifications, the Contractor shall assume full responsibility for accomplishing the stated purpose.

The Contractor shall establish a CQCP that will:

- a. Provide qualified personnel to develop and implement the CQCP.
- b. Provide for the production of acceptable quality materials.
- c. Provide sufficient information to assure that the specification requirements can be met.
- d. Document the CQCP process.

The Contractor shall not begin any construction or production of materials to be incorporated into the completed work until the CQCP has been reviewed and approved by the Resident Project Representative (RPR). No partial payment will be made for materials subject to specific quality control (QC) requirements until the CQCP has been reviewed and approved.

The QC requirements contained in this section and elsewhere in the contract technical specifications are in addition to and separate from the quality assurance (QA) testing requirements. QA testing requirements are the responsibility of the RPR or Contractor as specified in the specifications.

A Quality Control (QC)/Quality Assurance (QA) workshop with the Engineer, Resident Project Representative (RPR), Contractor, subcontractors, testing laboratories, and Owner's representative must be held prior to start of construction. The QC/QA workshop will be facilitated by the Contractor. The Contractor shall coordinate with the Airport and the RPR on time and location of the QC/QA workshop. Items to be addressed, at a minimum, will include:

- a. Review of the CQCP including submittals, QC Testing, Action & Suspension Limits for Production, Corrective Action Plans, Distribution of QC reports, and Control Charts.
- b. Discussion of the QA program.
- c. Discussion of the QC and QA Organization and authority including coordination and information exchange between QC and QA.
- d. Establish regular meetings to discuss control of materials, methods and testing.
- e. Establishment of the overall QC culture.

100-2 Description of program.

a. General description. The Contractor shall establish a CQCP to perform QC inspection and testing of all items of work required by the technical specifications, including those performed by subcontractors.

The CQCP shall ensure conformance to applicable specifications and plans with respect to materials, off-site fabrication, workmanship, construction, finish, and functional performance. The CQCP shall be effective for control of all construction work performed under this Contract and shall specifically include surveillance and tests required by the technical specifications, in addition to other requirements of this section and any other activities deemed necessary by the Contractor to establish an effective level of QC.

b. Contractor Quality Control Program (CQCP). The Contractor shall describe the CQCP in a written document that shall be reviewed and approved by the RPR prior to the start of any production, construction, or off-site fabrication. The written CQCP shall be submitted to the RPR for review and approval at least 10 calendar days before the CQCP Workshop. The Contractor's CQCP and QC testing laboratory must be approved in writing by the RPR prior to the Notice to Proceed (NTP).

The CQCP shall be organized to address, as a minimum, the following:

1. QC organization and resumes of key staff
2. Project progress schedule
3. Submittals schedule
4. Inspection requirements
5. QC testing plan
6. Documentation of QC activities and distribution of QC reports
7. Requirements for corrective action when QC and/or QA acceptance criteria are not met
8. Material quality and construction means and methods. Address all elements applicable to the project that affect the quality of the pavement structure including subgrade, subbase, base, and surface course. Some elements that must be addressed include, but is not limited to mix design, aggregate grading, stockpile management, mixing and transporting, placing and finishing, quality control testing and inspection, smoothness, laydown plan, equipment, and temperature management plan.

The Contractor must add any additional elements to the CQCP that is necessary to adequately control all production and/or construction processes required by this contract.

100-3 CQCP organization. The CQCP shall be implemented by the establishment of a QC organization. An organizational chart shall be developed to show all QC personnel, their authority, and how these personnel integrate with other management/production and construction functions and personnel.

The organizational chart shall identify all QC staff by name and function, and shall indicate the total staff required to implement all elements of the CQCP, including inspection and testing for each item of work. If necessary, different technicians can be used for specific inspection and testing functions for different items of work. If an outside organization or independent testing laboratory is used for implementation of all or part of the CQCP, the personnel assigned shall be subject to the qualification requirements of paragraphs 100-03a and 100-03b. The organizational chart shall indicate which personnel are Contractor employees and which are provided by an outside organization.

The QC organization shall, as a minimum, consist of the following personnel:

a. Program Administrator. The Contractor Quality Control Program Administrator (CQCPA) must be a full-time on-site employee of the Contractor, or a consultant engaged by the Contractor. The CQCPA must have a minimum of five (5) years of experience in QC pavement construction with prior QC experience on a project of comparable size and scope as the contract.

Included in the five (5) years of paving/QC experience, the CQCPA must meet at least one of the following requirements:

- (1) Professional Engineer with one (1) year of airport paving experience.
- (2) Engineer-in-training with two (2) years of airport paving experience.
- (3) National Institute for Certification in Engineering Technologies (NICET) Civil Engineering Technology Level IV with three (3) years of airport paving experience.
- (4) An individual with four (4) years of airport paving experience, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.

The CQCPA must have full authority to institute any and all actions necessary for the successful implementation of the CQCP to ensure compliance with the contract plans and technical specifications. The CQCPA authority must include the ability to immediately stop production until materials and/or processes are in compliance with contract specifications. The CQCPA must report directly to a principal officer of the construction firm. The CQCPA may supervise the Quality Control Program on more than one project provided that person can be at the job site within two (2) hours after being notified of a problem.

b. QC technicians. A sufficient number of QC technicians necessary to adequately implement the CQCP must be provided. These personnel must be either Engineers, engineering technicians, or experienced craftsman with qualifications in the appropriate field equivalent to NICET Level II in Civil Engineering Technology or higher, and shall have a minimum of two (2) years of experience in their area of expertise.

The QC technicians must report directly to the CQCPA and shall perform the following functions:

- (1) Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by paragraph 100-6.
- (2) Performance of all QC tests as required by the technical specifications and paragraph 100-8.
- (3) Performance of tests for the RPR when required by the technical specifications.

Certification at an equivalent level of qualification and experience by a state or nationally recognized organization will be acceptable in lieu of NICET certification.

c. Staffing levels. The Contractor shall provide sufficient qualified QC personnel to monitor each work activity at all times. Where material is being produced in a plant for incorporation into the work, separate plant and field technicians shall be provided at each plant and field placement location. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The CQCP shall state where different technicians will be required for different work elements.

100-4 Project progress schedule. Critical QC activities must be shown on the project schedule as required by Section 80, paragraph 80-03, *Execution and Progress*.

100-5 Submittals schedule. The Contractor shall submit a detailed listing of all submittals (for example, mix designs, material certifications) and shop drawings required by the technical specifications. The listing can be developed in a spreadsheet format and shall include as a minimum:

- a. Specification item number
- b. Item description
- c. Description of submittal
- d. Specification paragraph requiring submittal
- e. Scheduled date of submittal

100-6 Inspection requirements. QC inspection functions shall be organized to provide inspections for all definable features of work, as detailed below. All inspections shall be documented by the Contractor as specified by paragraph 100-9.

Inspections shall be performed as needed to ensure continuing compliance with contract requirements until completion of the particular feature of work. Inspections shall include the following minimum requirements:

a. During plant operation for material production, QC test results and periodic inspections shall be used to ensure the quality of aggregates and other mix components, and to adjust and control mix proportioning to meet the approved mix design and other requirements of the technical specifications. All equipment used in proportioning and mixing shall be inspected to ensure its proper operating condition. The CQCP shall detail how these and other QC functions will be accomplished and used.

b. During field operations, QC test results and periodic inspections shall be used to ensure the quality of all materials and workmanship. All equipment used in placing, finishing, and compacting shall be inspected to ensure its proper operating condition and to ensure that all such operations are in conformance to the technical specifications and are within the plan dimensions, lines, grades, and tolerances specified. The CQCP shall document how these and other QC functions will be accomplished and used.

100-7 Contractor QC testing facility.

a. For projects that include Item P-401, Item P-403, and Item P-404, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM D3666, *Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials*:

- 8.1.3 Equipment Calibration and Checks;
- 8.1.9 Equipment Calibration, Standardization, and Check Records;
- 8.1.12 Test Methods and Procedures

b. For projects that include P-501, the Contractor shall ensure facilities, including all necessary equipment, materials, and current reference standards, are provided that meet requirements in the following paragraphs of ASTM C1077, *Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation*:

- 7 Test Methods and Procedures
- 8 Facilities, Equipment, and Supplemental Procedures

100-8 QC testing plan. As a part of the overall CQCP, the Contractor shall implement a QC testing plan, as required by the technical specifications. The testing plan shall include the minimum tests and test frequencies required by each technical specification Item, as well as any additional QC tests that the Contractor deems necessary to adequately control production and/or construction processes.

The QC testing plan can be developed in a spreadsheet fashion and shall, as a minimum, include the following:

- a.** Specification item number (e.g., P-401)
- b.** Item description (e.g., Hot Mix Asphalt Pavements)
- c.** Test type (e.g., gradation, grade, asphalt content)
- d.** Test standard (e.g., ASTM or American Association of State Highway and Transportation Officials (AASHTO) test number, as applicable)

e. Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated)

f. Responsibility (e.g., plant technician)

g. Control requirements (e.g., target, permissible deviations)

The QC testing plan shall contain a statistically-based procedure of random sampling for acquiring test samples in accordance with ASTM D3665. The RPR shall be provided the opportunity to witness QC sampling and testing.

All QC test results shall be documented by the Contractor as required by paragraph 100-9.

100-9 Documentation. The Contractor shall maintain current QC records of all inspections and tests performed. These records shall include factual evidence that the required QC inspections or tests have been performed, including type and number of inspections or tests involved; results of inspections or tests; nature of defects, deviations, causes for rejection, etc.; proposed remedial action; and corrective actions taken.

These records must cover both conforming and defective or deficient features, and must include a statement that all supplies and materials incorporated in the work are in full compliance with the terms of the contract. Legible copies of these records shall be furnished to the RPR daily. The records shall cover all work placed subsequent to the previously furnished records and shall be verified and signed by the CQCPA.

Contractor QC records required for the contract shall include, but are not necessarily limited to, the following records:

a. Daily inspection reports. Each Contractor QC technician shall maintain a daily log of all inspections performed for both Contractor and subcontractor operations. These technician's daily reports shall provide factual evidence that continuous QC inspections have been performed and shall, as a minimum, include the following:

- (1) Technical specification item number and description
- (2) Compliance with approved submittals
- (3) Proper storage of materials and equipment
- (4) Proper operation of all equipment
- (5) Adherence to plans and technical specifications
- (6) Summary of any necessary corrective actions
- (7) Safety inspection.
- (8) Photographs and/or video

The daily inspection reports shall identify all QC inspections and QC tests conducted, results of inspections, location and nature of defects found, causes for rejection, and remedial or corrective actions taken or proposed.

The daily inspection reports shall be signed by the responsible QC technician and the CQCPA. The RPR shall be provided at least one copy of each daily inspection report on the work day following the day of record. When QC inspection and test results are recorded and transmitted electronically, the results must be archived.

b. Daily test reports. The Contractor shall be responsible for establishing a system that will record all QC test results. Daily test reports shall document the following information:

- (1) Technical specification item number and description
- (2) Test designation

- (3) Location
- (4) Date of test
- (5) Control requirements
- (6) Test results
- (7) Causes for rejection
- (8) Recommended remedial actions
- (9) Retests

Test results from each day's work period shall be submitted to the RPR prior to the start of the next day's work period. When required by the technical specifications, the Contractor shall maintain statistical QC charts. When QC daily test results are recorded and transmitted electronically, the results must be archived.

100-10 Corrective action requirements. The CQCP shall indicate the appropriate action to be taken when a process is deemed, or believed, to be out of control (out of tolerance) and detail what action will be taken to bring the process into control. The requirements for corrective action shall include both general requirements for operation of the CQCP as a whole, and for individual items of work contained in the technical specifications.

The CQCP shall detail how the results of QC inspections and tests will be used for determining the need for corrective action and shall contain clear rules to gauge when a process is out of control and the type of correction to be taken to regain process control.

When applicable or required by the technical specifications, the Contractor shall establish and use statistical QC charts for individual QC tests. The requirements for corrective action shall be linked to the control charts.

100-11 Inspection and/or observations by the RPR. All items of material and equipment are subject to inspection and/or observation by the RPR at the point of production, manufacture or shipment to determine if the Contractor, producer, manufacturer or shipper maintains an adequate QC system in conformance with the requirements detailed here and the applicable technical specifications and plans. In addition, all items of materials, equipment and work in place shall be subject to inspection and/or observation by the RPR at the site for the same purpose.

Inspection and/or observations by the RPR does not relieve the Contractor of performing QC inspections of either on-site or off-site Contractor's or subcontractor's work.

100-12 Noncompliance.

a. The Resident Project Representative (RPR) will provide written notice to the Contractor of any noncompliance with their CQCP. After receipt of such notice, the Contractor must take corrective action.

b. When QC activities do not comply with either the CQCP or the contract provisions or when the Contractor fails to properly operate and maintain an effective CQCP, and no effective corrective actions have been taken after notification of non-compliance, the RPR will recommend the Owner take the following actions:

- (1) Order the Contractor to replace ineffective or unqualified QC personnel or subcontractors and/or
- (2) Order the Contractor to stop operations until appropriate corrective actions are taken.

METHOD OF MEASUREMENT

100-13 Basis of measurement and payment. Contractor Quality Control Program (CQCP) is for the personnel, tests, facilities and documentation required to implement the CQCP. The CQCP will be paid as a lump sum with the following schedule of partial payments:

- a. With first pay request, 25% with approval of CQCP and completion of the Quality Control (QC)/Quality Assurance (QA) workshop.
- b. When 25% or more of the original contract is earned, an additional 25%.
- c. When 50% or more of the original contract is earned, an additional 20%.
- d. When 75% or more of the original contract is earned, an additional 20%.
- e. After final inspection and acceptance of project, the final 10%.

BASIS OF PAYMENT

100-14 Payment will be made under:

Item AW401010 Contractor Quality Control Program (CQCP) - per lump sum

REFERENCES

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

National Institute for Certification in Engineering Technologies (NICET)

ASTM International (ASTM)

ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

END OF ITEM C-100

Item C-102 Temporary Air and Water Pollution, Soil Erosion, and Siltation Control

DESCRIPTION

102-1. This item shall consist of temporary control measures as shown on the plans or as ordered by the Resident Project Representative (RPR) during the life of a contract to control pollution of air and water, soil erosion, and siltation through the use of silt fences, berms, dikes, dams, sediment basins, fiber mats, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

Temporary erosion control shall be in accordance with the approved erosion control plan; the approved Construction Safety and Phasing Plan (CSPP) and AC 150/5370-2, *Operational Safety on Airports During Construction*. The temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

Temporary control may include work outside the construction limits such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites.

Temporary control measures shall be designed, installed and maintained to minimize the creation of wildlife attractants that have the potential to attract hazardous wildlife on or near public-use airports.

MATERIALS

102-2.1 Grass. Grass that will not compete with the grasses sown later for permanent cover per Item T-901 shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover. Selected grass species shall not create a wildlife attractant.

102-2.2 Mulches. Mulches may be hay, straw, fiber mats, netting, bark, wood chips, or other suitable material reasonably clean and free of noxious weeds and deleterious materials per Item T-908. Mulches shall not create a wildlife attractant.

102-2.3 Fertilizer. Fertilizer shall be a standard commercial grade and shall conform to all federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

102-2.4 Slope drains. Slope drains may be constructed of pipe, fiber mats, rubble, concrete, asphalt, or other materials that will adequately control erosion.

102-2.5 Silt fence. Silt fence shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life. Silt fence shall meet the requirements of ASTM D6461.

102-2.6 Other. All other materials shall meet commercial grade standards and shall be approved by the RPR before being incorporated into the project.

CONSTRUCTION REQUIREMENTS

102-3.1 General. In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

The RPR shall be responsible for assuring compliance to the extent that construction practices, construction operations, and construction work are involved.

102-3.2 Schedule. Prior to the start of construction, the Contractor shall submit schedules in accordance with the approved Construction Safety and Phasing Plan (CSPP) and the plans for accomplishment of temporary and permanent erosion control work for clearing and grubbing; grading; construction; paving; and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the RPR.

102-3.3 Construction details. The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the plans and approved CSPP. Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

Where erosion may be a problem, schedule and perform clearing and grubbing operations so that grading operations and permanent erosion control features can follow immediately if project conditions permit. Temporary erosion control measures are required if permanent measures cannot immediately follow grading operations. The RPR shall limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current with the accepted schedule. If seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified as directed by the RPR.

The Contractor shall provide immediate permanent or temporary pollution control measures to minimize contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment as directed by the RPR. If temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or directed by the RPR, the work shall be performed by the Contractor and the cost shall be incidental to this item.

The RPR may increase or decrease the area of erodible earth material that can be exposed at any time based on an analysis of project conditions.

The erosion control features installed by the Contractor shall be maintained by the Contractor during the construction period.

Provide temporary structures whenever construction equipment must cross watercourses at frequent intervals. Pollutants such as fuels, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, and other harmful materials shall not be discharged into any waterways, impoundments or into natural or manmade channels.

102-3.4 Installation, maintenance and removal of silt fence. Silt fences shall extend a minimum of 16 inches (41 cm) and a maximum of 34 inches (86 cm) above the ground surface. Posts shall be set no more than 10 feet (3 m) on center. Filter fabric shall be cut from a continuous roll to the length required minimizing joints where possible. When joints are necessary, the fabric shall be spliced at a support post with a minimum 12-inch (300-mm) overlap and securely sealed. A trench shall be excavated approximately 4 inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the silt fence. The trench shall be backfilled and the soil compacted over the silt fence fabric. The Contractor shall

remove and dispose of silt that accumulates during construction and prior to establishment of permanent erosion control. The fence shall be maintained in good working condition until permanent erosion control is established. Silt fence shall be removed upon approval of the RPR.

METHOD OF MEASUREMENT

102-4.1 Temporary erosion and pollution control work required will be performed as scheduled or directed by the RPR. Completed and accepted work will be incidental to the temporary erosion control pay item. Typical work may include

- a. Temporary seeding and mulching.
- b. Temporary slope drains.
- c. Temporary benches, dikes, dams, and sediment basins.
- d. All fertilizing.
- e. Installation and removal of silt fence.
- f. Maintenance of all installed temporary erosion control measures.

102-4.2 Inlet protections shall be measure by each installed and removed upon establishment of or turf or at the direction of the RPR.

102-4.3 Control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured and paid for directly but shall be considered as a subsidiary obligation of the Contractor.

BASIS OF PAYMENT

102-5.1 Accepted quantities of temporary water pollution, soil erosion, and siltation control work ordered by the RPR and measured as provided in paragraph 102-4.1 will be paid for under:

Item AW156500	Temporary Erosion Control - per lump sum
Item AW156520	Inlet Protection - per linear each

REFERENCES

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

Advisory Circulars (AC)

AC 150/5200-33	<i>Hazardous Wildlife Attractants on or Near Airports</i>
AC 150/5370-2	<i>Operational Safety on Airports During Construction</i>

ASTM International (ASTM)

ASTM D6461	<i>Standard Specification for Silt Fence Materials</i>
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United States Department of Agriculture (USDA)

FAA/USDA Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM C-102

Item C-105 Mobilization

105-1 Description. This item of work shall consist of, but is not limited to, work and operations necessary for the movement of personnel, equipment, material and supplies to and from the project site for work on the project except as provided in the contract as separate pay items. This item of work also included the Engineer’s Field Office.

105-2 Mobilization limit. Mobilization shall be limited to 8 percent of the total project cost.

105-3 Posted notices. Prior to commencement of construction activities, the Contractor must post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the prime Contractor and by all employees of subcontractors engaged by the prime Contractor: Equal Employment Opportunity (EEO) Poster “Equal Employment Opportunity is the Law” in accordance with the Office of Federal Contract Compliance Programs Executive Order 11246, as amended; Davis Bacon Wage Poster (WH 1321) - DOL “Notice to All Employees” Poster; and Applicable Davis-Bacon Wage Rate Determination. These notices must remain posted until final acceptance of the work by the Owner.

105-4 Engineer/RPR field office. This item shall consist of furnishing and maintaining in good condition for the exclusive use of the RPR, a weatherproof building hereinafter described at locations approved by the Airport and RPR. The building shall be independent of any building used by the Contractor and all keys to the building shall be turned over to the RPR. The building shall remain on the work site until released by Substantial Completion.

Field offices shall have a minimum ceiling height of seven feet and a minimum floor space of 240 square feet. The office shall be provided with sufficient natural and artificial light and air conditioning. Doors and windows shall be equipped with locks approved by the RESIDENT ENGINEER.

Suitable on-site sanitary facilities meeting Federal, State, and local health department requirements shall be provided, maintained clean and in good working condition, and shall be stocked with lavatory and sanitary supplies at all times.

The building will include all utility costs and shall be released to the Contractor in good condition at the end of the project. In addition, the following equipment and furniture meeting the approval of the RESIDENT ENGINEER shall be furnished:

- A. Two desks and two non-folding chairs with upholstered seats and backs.
- B. One free standing four drawer legal size file cabinets with lock and an Underwriters“ Laboratories insulated file device 350 degrees one hour rating.
- C. One dry process copy, print, & scan machine (including maintenance and operating supplies) capable of both collating and reproducing prints up to a ledger size (11” x 17”) and capable of copying and scanning in color.
- D. One refrigerator with a minimum size of 8 cubic feet with a freezer unit.
- E. One electric desk tape calculator and adding machine with tape or one tape printing calculator
- F. One mobile wireless network with a cost-free connection to the internet to be used in the RPR field office and one the construction site for use by the RPR. Possible solutions

include wireless network cards installed in the RPR’s computer or wireless phones capable of supplying access to the internet via a mobile connection. The network shall be available to the RESIDENT ENGINEER until Substantial Completion.

METHOD OF MEASUREMENT

105-5 Basis of measurement and payment. Based upon the contract lump sum price for “Mobilization” partial payments will be allowed as follows:

- a. With first pay request, 25%.
- b. When 25% or more of the original contract is earned, an additional 25%.
- c. When 50% or more of the original contract is earned, an additional 40%.
- d. After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90, paragraph 90-11, *Contractor Final Project Documentation*, the final 10%.

105-5 Engineers Field Office. Payment for providing the field office fully equipped as specified shall be made at the contract lump sum price.

The building will include all utility costs and shall be released to the Contractor in good condition at the end of the project.

The cellular telephone and associated charges will be included in the contract unit price per lump sum for engineer’s field office. This price shall include all utility costs and shall reflect the salvage value of the building or buildings, equipment, and furniture which remain the property of the contractor after release by the engineer.

BASIS OF PAYMENT

105-6 Payment will be made under:

- | | |
|----------------------|---|
| Item AW150510 | ENGINEERS FIELD OFFICE, per lump sum |
| Item AW150520 | MOBILIZATION, per lump sum |

REFERENCES

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

Office of Federal Contract Compliance Programs (OFCCP)

Executive Order 11246, as amended

EEOC-P/E-1 – Equal Employment Opportunity is the Law Poster

United States Department of Labor, Wage and Hour Division (WHD)

WH 1321 – Employee Rights under the Davis-Bacon Act Poster

Item C-110 Method of Estimating Percentage of Material Within Specification Limits (PWL)

110-1 General. When the specifications provide for acceptance of material based on the method of estimating percentage of material within specification limits (PWL), the PWL will be determined in accordance with this section. All test results for a lot will be analyzed statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average (\bar{X}) and sample standard deviation (S_n) of the specified number (n) of sublots for the lot and the specification tolerance limits, L for lower and U for upper, for the particular acceptance parameter. From these values, the respective Quality index, Q_L for Lower Quality Index and/or Q_U for Upper Quality Index, is computed and the PWL for the lot for the specified n is determined from Table 1. All specification limits specified in the technical sections shall be absolute values. Test results used in the calculations shall be to the significant figure given in the test procedure.

There is some degree of uncertainty (risk) in the measurement for acceptance because only a small fraction of production material (the population) is sampled and tested. This uncertainty exists because all portions of the production material have the same probability to be randomly sampled. The Contractor's risk is the probability that material produced at the acceptable quality level is rejected or subjected to a pay adjustment. The Owner's risk is the probability that material produced at the rejectable quality level is accepted.

It is the intent of this section to inform the Contractor that, in order to consistently offset the Contractor's risk for material evaluated, production quality (using population average and population standard deviation) must be maintained at the acceptable quality specified or higher. In all cases, it is the responsibility of the Contractor to produce at quality levels that will meet the specified acceptance criteria when sampled and tested at the frequencies specified.

110-2 Method for computing PWL. The computational sequence for computing PWL is as follows:

- a. Divide the lot into n sublots in accordance with the acceptance requirements of the specification.
- b. Locate the random sampling position within the subplot in accordance with the requirements of the specification.
- c. Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.
- d. Find the sample average (\bar{X}) for all subplot test values within the lot by using the following formula:

$$\bar{X} = (x_1 + x_2 + x_3 + \dots + x_n) / n$$

Where: \bar{X} = Sample average of all subplot test values within a lot

x_1, x_2, \dots, x_n = Individual subplot test values

n = Number of subplot test values

- e. Find the sample standard deviation (S_n) by use of the following formula:

$$S_n = [(d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2)/(n-1)]^{1/2}$$

Where: S_n = Sample standard deviation of the number of subplot test values in the set

d_1, d_2, \dots, d_n = Deviations of the individual subplot test values x_1, x_2, \dots from the average value X

that is: $d_1 = (x_1 - X), d_2 = (x_2 - X) \dots d_n = (x_n - X)$

n = Number of subplot test values

f. For single sided specification limits (i.e., L only), compute the Lower Quality Index Q_L by use of the following formula:

$$Q_L = (X - L) / S_n$$

Where: L = specification lower tolerance limit

Estimate the percentage of material within limits (PWL) by entering Table 1 with Q_L , using the column appropriate to the total number (n) of measurements. If the value of Q_L falls between values shown on the table, use the next higher value of PWL.

g. For double-sided specification limits (i.e., L and U), compute the Quality Indexes Q_L and Q_U by use of the following formulas:

$$Q_L = (X - L) / S_n$$

and

$$Q_U = (U - X) / S_n$$

Where: L and U = specification lower and upper tolerance limits

Estimate the percentage of material between the lower (L) and upper (U) tolerance limits (PWL) by entering Table 1 separately with Q_L and Q_U , using the column appropriate to the total number (n) of measurements, and determining the percent of material above P_L and percent of material below P_U for each tolerance limit. If the values of Q_L fall between values shown on the table, use the next higher value of P_L or P_U . Determine the PWL by use of the following formula:

$$PWL = (P_U + P_L) - 100$$

Where: P_L = percent within lower specification limit

P_U = percent within upper specification limit

EXAMPLE OF PWL CALCULATION

Project: Example Project

Test Item: Item P-401, Lot A.

A. PWL Determination for Mat Density.

1. Density of four random cores taken from Lot A.

A-1 = 96.60

A-2 = 97.55

A-3 = 99.30

A-4 = 98.35

$n = 4$

2. Calculate average density for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$
$$X = (96.60 + 97.55 + 99.30 + 98.35) / 4$$
$$X = 97.95\% \text{ density}$$

3. Calculate the standard deviation for the lot.

$$S_n = [((96.60 - 97.95)^2 + (97.55 - 97.95)^2 + (99.30 - 97.95)^2 + (98.35 - 97.95)^2) / (4 - 1)]^{1/2}$$
$$S_n = [(1.82 + 0.16 + 1.82 + 0.16) / 3]^{1/2}$$
$$S_n = 1.15$$

4. Calculate the Lower Quality Index Q_L for the lot. ($L=96.3$)

$$Q_L = (X - L) / S_n$$
$$Q_L = (97.95 - 96.30) / 1.15$$
$$Q_L = 1.4348$$

5. Determine PWL by entering Table 1 with $Q_L = 1.44$ and $n = 4$.

$$PWL = 98$$

B. PWL Determination for Air Voids.

1. Air Voids of four random samples taken from Lot A.

$$A-1 = 5.00$$
$$A-2 = 3.74$$
$$A-3 = 2.30$$
$$A-4 = 3.25$$

2. Calculate the average air voids for the lot.

$$X = (x_1 + x_2 + x_3 + \dots + x_n) / n$$
$$X = (5.00 + 3.74 + 2.30 + 3.25) / 4$$
$$X = 3.57\%$$

3. Calculate the standard deviation S_n for the lot.

$$S_n = [((3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2) / (4 - 1)]^{1/2}$$
$$S_n = [(2.04 + 0.03 + 1.62 + 0.10) / 3]^{1/2}$$
$$S_n = 1.12$$

4. Calculate the Lower Quality Index Q_L for the lot. ($L = 2.0$)

$$Q_L = (X - L) / S_n$$
$$Q_L = (3.57 - 2.00) / 1.12$$
$$Q_L = 1.3992$$

5. Determine P_L by entering Table 1 with $Q_L = 1.41$ and $n = 4$.

$$P_L = 97$$

6. Calculate the Upper Quality Index Q_U for the lot. ($U = 5.0$)

$$Q_U = (U - X) / S_n$$
$$Q_U = (5.00 - 3.57) / 1.12$$

$$Q_U = 1.2702$$

7. Determine P_U by entering Table 1 with $Q_U = 1.29$ and $n = 4$.

$$P_U = 93$$

8. Calculate Air Voids PWL

$$PWL = (P_L + P_U) - 100$$

$$PWL = (97 + 93) - 100 = 90$$

EXAMPLE OF OUTLIER CALCULATION (REFERENCE ASTM E178)

Project: Example Project

Test Item: Item P-401, Lot A.

A. Outlier Determination for Mat Density.

1. Density of four random cores taken from Lot A arranged in descending order.

$$A-3 = 99.30$$

$$A-4 = 98.35$$

$$A-2 = 97.55$$

$$A-1 = 96.60$$

2. From ASTM E178, Table 1, for $n=4$ an upper 5% significance level, the critical value for test criterion = 1.463.

3. Use average density, standard deviation, and test criterion value to evaluate density measurements.

a. For measurements greater than the average:

If (measurement - average)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-3, check if $(99.30 - 97.95) / 1.15$ is greater than 1.463.

Since 1.174 is less than 1.463, the value is not an outlier.

b. For measurements less than the average:

If (average - measurement)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-1, check if $(97.95 - 96.60) / 1.15$ is greater than 1.463.

Since 1.135 is less than 1.463, the value is not an outlier.

Note: In this example, a measurement would be considered an outlier if the density were:

$$\text{Greater than } (97.95 + 1.463 \times 1.15) = 99.63\%$$

OR

$$\text{less than } (97.95 - 1.463 \times 1.15) = 96.27\%.$$

Table 1. Table for Estimating Percent of Lot Within Limits (PWL)

Percent Within Limits (P_L and P_U)	Positive Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630

Percent Within Limits (P _L and P _U)	Positive Values of Q (Q _L and Q _U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4717	1.4829	1.4914
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653
87	1.0597	1.1100	1.1173	1.1192	1.1199	1.1204	1.1208	1.1212
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990
83	0.9939	0.9900	0.9785	0.9715	0.9671	0.9643	0.9624	0.9610
82	0.9749	0.9600	0.9452	0.9367	0.9315	0.9281	0.9258	0.9241
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.5982
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686
70	0.6787	0.6000	0.5719	0.5582	0.5504	0.5454	0.5419	0.5394
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537
66	0.5563	0.4800	0.4545	0.4424	0.4355	0.4310	0.4280	0.4257
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4030	0.4001	0.3980
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566
55	0.1806	0.1500	0.1406	0.1363	0.1338	0.1322	0.1312	0.1304
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1049	0.1042
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0793	0.0786	0.0781
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264	0.0262	0.0260
50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Percent Within Limits (P _L and P _U)	Negative Values of Q (Q _L and Q _U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042

Percent Within Limits (P _L and P _U)	Negative Values of Q (Q _L and Q _U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
45	-0.1806	-0.1500	-0.1406	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304
44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1588	-0.1575	-0.1566
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.3161
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477	-0.3451	-0.3432
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4030	-0.4001	-0.3980
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4355	-0.4310	-0.4280	-0.4257
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105
30	-0.6787	-0.6000	-0.5719	-0.5582	-0.5504	-0.5454	-0.5419	-0.5394
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245	-0.8214	-0.8192
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9315	-0.9281	-0.9258	-0.9241
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9671	-0.9643	-0.9624	-0.9610
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789
13	-1.0597	-1.1100	-1.1173	-1.1192	-1.1199	-1.1204	-1.1208	-1.1212
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075	-1.2098	-1.2115
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4717	-1.4829	-1.4914
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127	-1.6313	-1.6454
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993	-1.7235	-1.7420
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053	-1.8379	-1.8630
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

REFERENCES

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

ASTM International (ASTM)

ASTM E178

Standard Practice for Dealing with Outlying Observations

Part 3 – Sitework

Item P-101 Preparation/Removal of Existing Pavements

DESCRIPTION

101-1 This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable plans.

This item shall also consist of the milling of existing pavement, the removal of concrete pavement from the work site to be crushed,

This item shall consist of construction of a site at the location designated on the plans for the PCC crusher to be located and to crush the broken concrete into particle size that can be reprocessed into the required material gradations.

EQUIPMENT AND MATERIALS

101-2 All equipment and materials shall be specified here and in the following paragraphs or approved by the Resident Project Representative (RPR). The equipment shall not cause damage to the pavement to remain in place.

CONSTRUCTION

101-3.1 Removal of existing pavement.

The Contractor's removal operation shall be controlled to not damage adjacent pavement structure, and base material, cables, utility ducts, pipelines, or drainage structures which are to remain under the pavement.

a. Concrete pavement removal. Full depth saw cuts shall be made perpendicular to the slab surface. The Contractor shall saw through the full depth of the slab including any dowels at the joint, removing the pavement and installing new dowels as shown on the plans and per the specifications. Where the perimeter of the removal limits is not located on the joint and there are no dowels present, the perimeter shall be saw cut the full depth of the pavement. The pavement inside the saw cut shall be removed by methods which will not cause distress in the pavement which is to remain in place. Material to be reused in the pavement structure construction shall be crushed to a gradation of Item P-154. Concrete slabs that are damaged by under breaking shall be repaired or removed and replaced as directed by the RPR.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Spall and underbreak repair shall be in accordance with the plans. Any underlying material that is to remain in place, shall be recompacted and/or replaced as shown on the plans. Adjacent areas damaged during repair shall be repaired or replaced at the Contractor's expense.

b. Asphalt pavement removal. Asphalt pavement to be removed shall be cut to the full depth of the asphalt pavement around the perimeter of the area to be removed. If the material is to be incorporated into embankment, it shall be meet the following gradation of Item P-154

c. Repair or removal of Base, Subbase, and/or Subgrade. All failed material including surface, base course, subbase course, and subgrade shall be removed and repaired as shown on the plans or as directed by the RPR. Materials and methods of construction shall comply with the applicable sections of these specifications. Any damage caused by Contractor's removal process shall be repaired at the Contractor's expense.

101-3.2 Preparation of joints and cracks prior to overlay/surface treatment. Remove all vegetation and debris from cracks to a minimum depth of 1 inch (25 mm). If extensive vegetation exists, treat the specific area with a concentrated solution of a water-based herbicide approved by the RPR. Fill all cracks greater than 1/4 inch (6 mm) wide) with a crack sealant per ASTM D6690. The crack sealant, preparation, and application shall be compatible with the surface treatment/overlay to be used. To minimize contamination of the asphalt with the crack sealant, underfill the crack sealant a minimum of 1/8 inch (3 mm), not to exceed 1/4 inch (6 mm). Any excess joint or crack sealer shall be removed from the pavement surface.

101-3.3 Removal of Foreign Substances/contaminates prior to overlay. Removal of foreign substances/contaminates from existing pavement that will affect the bond of the new treatment shall consist of removal of rubber, fuel spills, oil, crack sealer, at least 90% of paint, and other foreign substances from the surface of the pavement. Areas that require removal are designated on the plans and as directed by the RPR in the field during construction.

Cold milling may be used. Removal methods used shall not cause major damage to the pavement, or to any structure or utility within or adjacent to the work area. Major damage is defined as changing the properties of the pavement, removal of asphalt causing the aggregate to ravel, or removing pavement over 1/8 inch (3 mm) deep. If it is deemed by the RPR that damage to the existing pavement is caused by operational error, such as permitting the application method to dwell in one location for too long, the Contractor shall repair the damaged area without compensation and as directed by the RPR.

Removal of foreign substances shall not proceed until approved by the RPR. Water used for high-pressure water equipment shall be provided by the Contractor at the Contractor's expense. No material shall be deposited on the pavement shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans.

101-3.4 Concrete spall or failed asphaltic concrete pavement repair.

a. Repair of concrete spalls in areas to be overlaid with asphalt. The Contractor shall repair all spalled concrete as shown on the plans or as directed by the RPR. The perimeter of the repair shall be saw cut a minimum of 2 inches (50 mm) outside the affected area and 2 inches (50 mm) deep. The deteriorated material shall be removed to a depth where the existing material is firm or cannot be easily removed with a geologist pick. The removed area shall be filled with asphalt mixture with aggregate sized appropriately for the depth of the patch. The material shall be compacted with equipment approved by the RPR until the material is dense and no movement or marks are visible. The material shall not be placed in lifts over 4 inches (100 mm) in depth. This method of repair applies only to pavement to be overlaid.

b. Asphalt pavement repair. The Contractor shall repair all spalled concrete as shown on the plans or as directed by the RPR. The failed areas shall be removed as specified in paragraph 101-3.1b. All failed material including surface, base course, subbase course, and subgrade shall be removed. Materials and methods of construction shall comply with the applicable sections of these specifications.

101-3.5 Cold milling. Milling shall be performed with a power-operated milling machine or grinder, capable of producing a uniform finished surface. The milling machine or grinder shall operate without tearing or gouging the underlying surface. The milling machine or grinder shall be equipped with grade and slope controls, and a positive means of dust control. All millings shall be removed and disposed off Airport property or disposed of with the crushed concrete base. If the Contractor mills or grinds deeper or

wider than the plans specify, the Contractor shall replace the material removed with new material at the Contractor's Expense.

a. Patching. The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement and it shall have a positive method of controlling the depth of cut. The RPR shall layout the area to be milled with a straightedge in increments of 1-foot (30 cm) widths. The area to be milled shall cover only the failed area. Any excessive area that is milled because the Contractor doesn't have the appropriate milling machine, or areas that are damaged because of his negligence, shall be repaired by the Contractor at the Contractor's Expense.

b. Profiling, grade correction, or surface correction. The milling machine shall have a minimum width of 7 feet (2 m) and it shall be equipped with electronic grade control devices that will cut the surface to the grade specified. The tolerances shall be maintained within +0 inch and -1/4 inch (+0 mm and -6mm) of the specified grade. The machine must cut vertical edges and have a positive method of dust control. The machine must have the ability to remove the millings or cuttings from the pavement and load them into a truck. All millings shall be removed and disposed of in areas designated on the plans.

c. Clean-up. The Contractor shall sweep the milled surface daily and immediately after the milling until all residual materials are removed from the pavement surface. Prior to paving, the Contractor shall wet down the milled pavement and thoroughly sweep and/or blow the surface to remove loose residual material. Waste materials shall be collected and removed from the pavement surface and adjacent areas by sweeping or vacuuming. Waste materials shall be removed and disposed off Airport property.

101-3.6. Preparation of asphalt pavement surfaces prior to surface treatment. Existing asphalt pavements to be treated with a surface treatment shall be prepared as follows:

a. Patch asphalt pavement surfaces that have been softened by petroleum derivatives or have failed due to any other cause. Remove damaged pavement to the full depth of the damage and replace with new asphalt pavement similar to that of the existing pavement in accordance with paragraph 101-3.4b.

b. Repair joints and cracks in accordance with paragraph 101-3.2.

c. Remove oil or grease that has not penetrated the asphalt pavement by scrubbing with a detergent and washing thoroughly with clean water. After cleaning, treat these areas with an oil spot primer.

d. Clean pavement surface immediately prior to placing the surface treatment so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film.

101-3.7 Maintenance. The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the RPR. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor's expense.

101-3.8 Preparation of Joints in Rigid Pavement prior to resealing. Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the joint and does not damage the joint.

101-3.8.1 Removal of Existing Joint Sealant. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch (2 mm) from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry.

101-3.8.2 Cleaning prior to sealing. Immediately before sealing, joints shall be cleaned by removing any remaining laitance and other foreign material. Allow sufficient time to dry out joints prior to sealing. Joint surfaces will be surface-dry prior to installation of sealant.

101-3.8.3 Joint sealant. Joint material and installation will be in accordance with Item P-605.

101-3.9 Preparation of Cracks in Flexible Pavement prior to sealing. Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the cracks and does not damage the pavement.

101-3.9.1 Preparation of Crack. Widen crack with random crack saw by removing a minimum of 1/16 inch (2 mm) from each side of crack. Immediately before sealing, cracks will be blown out with a hot air lance combined with oil and water-free compressed air.

101-3.9.2 Removal of Existing Crack Sealant. Existing sealants will be removed by random crack saw. Following sawing any remaining debris will be removed by use of a hot lance combined with oil and water-free compressed air.

101-3.9.3 Crack Sealant. Crack sealant material and installation will be in accordance with Item P-605.

101-3.9.4 Removal of Pipe and other Buried Structures.

a. Removal of Existing Pipe Material. Remove the types of pipe as indicated on the plans. The pipe material shall be legally disposed of off-site in a timely manner following removal. Trenches shall be backfilled with material equal to or better in quality than adjacent embankment. Trenches under paved areas must be compacted to 95% of ASTM D1557.

b. Removal of Inlets/Manholes. Where indicated on the plans or as directed by the RPR, inlets and/or manholes shall be removed and legally disposed of off-site in a timely fashion after removal. Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. When under paved areas must be compacted to 95% of ASTM D1557, when outside of paved areas must be compacted to 95% of ASTM D698.

101-3.10 PCC Crushing. The Contractor shall construct a work area that will support the weight of a mobile or portable recycling plant and be sized no greater than 200' x 350' as shown in the plans. The work area shall be capable of storing broken concrete and processed concrete stockpiles. Contractor will be required to construct a surface that will allow the processed material to remain free of organic material during the handling of the material.

The Contractor shall provide sufficient means to limit the dust created by the crushing process. This may be accomplished by wetting the material being crushed or by use of a dust suppression machine or by other means approved by the RPR. Dust control measures shall be implemented when the winds blow towards active airfield pavement or as directed by the RPR.

The crushing activities shall include the handling of the broken concrete delivered from the removal site to the crushing site, the initial crushing of the broken concrete and the stockpiling of material to be processed into final gradation.

Steel and other unsuitable materials shall be set aside to be hauled off the construction site.

EQUIPMENT

101-4.1 PCC Crushing Equipment. The equipment required to crush the concrete shall be a mobile or portable type crushing plant. The plants shall be Jaw, Impact or Cone Crusher type or other crusher approved by the RPR. The plant shall be sized to meet the production needs of material needed to

construct the perimeter road. Multiple plants may be needed if the production is not able to meet the material demand.

The equipment provided shall provide sufficient means to limit the dust created by the crushing process. This may be accomplished by wetting the material being crushed or by use of a dust suppression machine or by other means approved by the RPR. Dust control measures shall be implemented when the winds blow towards active airfield pavement or as directed by the RPR.

The equipment provided shall have means to separate structural steel from the crushed concrete. Steel and other unsuitable materials shall be set aside to be hauled off the construction site.

METHOD OF MEASUREMENT

101-5.1 Pavement removal. The unit of measurement for pavement removal shall be the number of square yards (square meters) removed by the Contractor. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. No direct measurement or payment shall be made for saw cutting. Saw cutting shall be incidental to pavement removal. Dowel bar installation shall be incidental to pavement removal.

101-5.2 Cold milling. The unit of measure for cold milling shall be 3 inches of milling per square yard (square meter). The location and average depth of the cold milling shall be as shown on the plans. If the initial cut does not correct the condition, the Contractor shall re-mill the area and will be paid for the total depth of milling.

101-5.3 Removal of Pipe and other Buried Structures. The unit of measurement for removal of pipe shall be measured per linear foot and inlet structure removal will be made at the contract unit price for each completed and accepted item. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

101-5.3 Removal of Pipe and other Buried Structures. The unit of measurement for removal of pipe and other buried structures will be made at the contract unit price for each completed and accepted item. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

101-5.5 PCC Crushing. The quantity to be paid for shall be the number of in place cubic yards of broken PCC CRUSHED by the processing operation.

BASIS OF PAYMENT

101-6.1 Payment. Payment shall be made at contract unit price for the unit of measurement as specified above. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

101-6.2 Crushed Concrete. The accepted quantities of CRUSHED CONCTETE will be paid for at the contract unit price per cubic yard which price and payment shall be full compensation for furnishing all materials, crushing site construction/maintenance/removal, equipment, labor, material handling, dust control, and all other incidental items necessary to complete the work to the satisfaction of the Engineer.

Payment will be made under:

AW401650	Bituminous Pavement Milling – per square yard
AW501905	Remove Pavement – per square yard

AW501941	PCC Crushing – per cubic yard
AW701900	Remove Pipe – per linear foot
AW751900	Remove Inlet – per each

REFERENCES

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

Advisory Circulars (AC)

AC 150/5380-6 Guidelines and Procedures for Maintenance of Airport Pavements.

ASTM International (ASTM)

ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

Item P-152 Excavation, Subgrade, and Embankment

DESCRIPTION

152-1.1 This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

152-1.2 Classification. All material excavated shall be classified as defined below:

a. Unclassified excavation. Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature.

CONSTRUCTION METHODS

152-2.1 General. Before beginning excavation, grading, and embankment operations in any area, the area shall be cleared or cleared and grubbed in accordance with Item P-151.

The suitability of material to be placed in embankments shall be subject to approval by the RPR. All unsuitable material shall be disposed of in waste areas as shown on the plans. All waste areas shall be graded to allow positive drainage of the area and adjacent areas. The surface elevation of waste areas shall be specified on the plans or approved by the RPR.

When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued and the RPR notified per Section 70, paragraph 70-20. At the direction of the RPR, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Areas outside the limits of the pavement areas where the top layer of soil has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4 inches (100 mm), to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor shall notify the RPR, who shall arrange for their removal if necessary. The Contractor, at their own expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor's operations during the period of the contract.

152-2.2 Excavation. No excavation shall be started until the work has been staked out by the Contractor and the RPR has obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface. The Contractor and RPR shall agree that the original ground lines shown on the original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the RPR. All suitable excavated material shall be used in

the formation of embankment, subgrade, or other purposes as shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

The grade shall be maintained so that the surface is well drained at all times.

When the volume of the excavation exceeds that required to construct the embankments to the grades as indicated on the plans, the excess shall be used to grade the areas of ultimate development or disposed as directed by the RPR. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from borrow areas.

a. Selective grading. When selective grading is indicated on the plans, the more suitable material designated by the RPR shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas until it can be placed. The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved.

b. Undercutting. Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the RPR. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed off the airport. The cost is incidental to this item. This excavated material shall be paid for at the contract unit price per cubic yard for unclassified excavation. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities. The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans.

c. Over-break. Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the RPR. All over-break shall be graded or removed by the Contractor and disposed of as directed by the RPR. The RPR shall determine if the displacement of such material was unavoidable and their own decision shall be final. Payment will not be made for the removal and disposal of over-break that the RPR determines as avoidable. Unavoidable over-break will be classified as “Unclassified Excavation.”

d. Removal of utilities. The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by the Contractor as indicated on the plans. All existing foundations shall be excavated at least 2 feet (60 cm) below the top of subgrade or as indicated on the plans, and the material disposed of as directed by the RPR. All foundations thus excavated shall be backfilled with suitable material and compacted as specified for embankment or as shown on the plans.

152-2.3 Borrow excavation. Borrow areas are not required.

152-2.4 Drainage excavation. Drainage excavation shall consist of excavating drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. The work shall be performed in sequence with the other construction. Ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the RPR. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted.

152-2.5 Preparation of cut areas or areas where existing pavement has been removed. In those areas on which a subbase or base course is to be placed, the top 12 inches (300 mm) of subgrade shall be compacted to not less than 100 % of maximum density for non-cohesive soils, and [95%] of maximum density for cohesive soils as determined by ASTM D1557. As used in this specification, "non-

cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

152-2.6 Preparation of embankment area. All sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm) and shall then be compacted per paragraph 152-2.10.

Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches (300 mm) and compacted as specified for the adjacent fill.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the quantity of excavation removed will be paid for under the respective items of work.

152-2.7 Control Strip. The first half-day of construction of subgrade and/or embankment shall be considered as a control strip for the Contractor to demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the RPR.

152-2.8 Formation of embankments. The material shall be constructed in lifts as established in the control strip, but not less than 6 inches (150 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

The lifts shall be placed, to produce a soil structure as shown on the typical cross-section or as directed by the RPR. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained due to rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each lift shall be within $\pm 2\%$ of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The Contractor will take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with ASTM D 1557. A new Proctor shall be developed for each soil type based on visual classification.

Density tests will be taken by the contractor for every 3,000 square yards of compacted embankment for each lift which is required to be compacted, or other appropriate frequencies as determined by the RPR.

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until the embankment is compacted to not less than 100% of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D1557. Under all areas to be paved, the embankments shall be compacted to a depth of 12 inches and to a density of not less than 95 percent of the maximum density as determined by ASTM D1557. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches (100 mm) which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with Contractor's laboratory shall perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance. If the specified density is not attained, the area represented by the test or as designated by the RPR shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

Compaction areas shall be kept separate, and no lift shall be covered by another lift until the proper density is obtained.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment as each lift is placed. Lift placement shall begin in the deepest portion of the embankment fill. As placement progresses, the lifts shall be constructed approximately parallel to the finished pavement grade line.

When rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be incorporated into the outer portion of the embankment and the subgrade material shall be incorporated under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4 inches (100 mm) in their greatest dimensions will not be allowed in the top 12 inches (300 mm) of the subgrade. Rockfill shall be brought up in lifts as specified or as directed by the RPR and the finer material shall be used to fill the voids forming a dense, compact mass. Rock, cement concrete pavement, asphalt pavement, and other embankment material shall not be disposed of except at places and in the manner designated on the plans or by the RPR.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in lifts of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in lifts not exceeding 2 feet (60 cm) in thickness. Each lift shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The lift shall not be constructed above an elevation 4 feet (1.2 m) below the finished subgrade.

There will be no separate measurement of payment for compacted embankment. All costs incidental to placing in lifts, compacting, discing, watering, mixing, sloping, and other operations necessary for construction of embankments will be included in the contract price for excavation, borrow, or other items.

152-2.9 Proof rolling. Not Used

152-2.10 Compaction requirements. The subgrade under areas to be paved shall be compacted to a depth of 12 inches (300 mm) and to a density of not less than 100 percent of the maximum dry density as determined by ASTM D1557. The subgrade in areas outside the limits of the pavement areas shall be compacted to a depth of 12 inches (300 mm) and to a density of not less than 95 percent of the maximum density as determined by ASTM D1557.

The material to be compacted shall be within $\pm 2\%$ of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils). When the material has greater than 30 percent retained on the $\frac{3}{4}$ inch (19.0 mm) sieve, follow the methods in ASTM D1557. Tests for moisture content and compaction will be taken at a minimum of 1000 S.Y. of subgrade. All quality assurance testing shall be done by the Contractor's laboratory in the presence of the RPR, and density test results shall be furnished upon completion to the RPR for acceptance determination.

The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

If the specified density is not attained, the entire lot shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the RPR and the finished subgrade shall be maintained.

152-2.11 Finishing and protection of subgrade. Finishing and protection of the subgrade is incidental to this item. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low areas, holes or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been accepted by the RPR.

152-2.12 Haul. All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be made for any work or materials associated with providing, maintaining and removing haul roads or routes.

152-2.13 Surface Tolerances. In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75

mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

- a. **Smoothness.** The finished surface shall not vary more than +/- ½ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.
- b. **Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/- 0.05 feet (15 mm) of the specified grade.

On safety areas, turfed areas and other designated areas within the grading limits where no subbase or base is to be placed, grade shall not vary more than 0.10 feet (30 mm) from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

152-2.14 Topsoil. When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located as shown on the plans and the approved CSPP, and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the RPR, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further re-handling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

METHOD OF MEASUREMENT

152-3.1 Measurement for payment specified by the cubic yard (cubic meter) shall be computed by the average end areas of design cross sections for computation of neat line design quantities. The end area is that bound by the original ground line established by field cross-sections and the final theoretical pay line established by cross-sections shown on the plans, subject to verification by the RPR.

152-3.1 The quantity of unclassified excavation to be paid for shall be the number of cubic yards (cubic meters) measured in its original position. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

BASIS OF PAYMENT

152-4.1 Unclassified excavation payment shall be made at the contract unit price per cubic yard (cubic meter). This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

AW152410

Unclassified Excavation – per cubic yard

REFERENCES

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

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T-180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ASTM International (ASTM)

ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))

ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2700 kN-m/m³))

ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Advisory Circulars (AC)

AC 150/5370-2 Operational Safety on Airports During Construction Software

Software

FAARFIELD – FAA Rigid and Flexible Iterative Elastic Layered Design

U.S. Department of Transportation

FAA RD-76-66 Design and Construction of Airport Pavements on Expansive Soils

END OF ITEM P-152

Item P-153 Controlled Low-Strength Material (CLSM)

DESCRIPTION

153-1.1 This item shall consist of furnishing, transporting, and placing a controlled low-strength material (CLSM) as flowable backfill in trenches or at other locations shown on the plans or as directed by the Resident Project Representative (RPR).

MATERIALS

153-2.1 Materials.

- a. Cement.** Cement shall conform to the requirements of ASTM C150 Type I or ASTM C595 Type IL or IP.
- b. Fly ash.** Fly ash shall conform to ASTM C618, Class C or F.
- c. Fine aggregate (sand).** Fine aggregate shall conform to the requirements of ASTM C33 except for aggregate gradation. Any aggregate gradation which produces the specified performance characteristics of the CLSM and meets the following requirements, will be accepted.

Sieve Size	Percent Passing by weight
3/4 inch (19.0 mm)	100
No. 200 (75 µm)	0 - 12

d. Water. Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

MIX DESIGN

153-3.1 Proportions. The Contractor shall submit, to the RPR, a mix design including the proportions and source of aggregate, fly ash, cement, water, and approved admixtures. No CLSM mixture shall be produced for payment until the RPR has given written approval of the proportions. The proportions shall be prepared by a laboratory and shall remain in effect for the duration of the project. The proportions shall establish a single percentage or weight for aggregate, fly ash, cement, water, and any admixtures proposed. Laboratory costs are incidental to this item.

a. Compressive strength. CLSM shall be designed to achieve a 28-day compressive strength of 100 to 200 psi (690 to 1379 kPa) when tested in accordance with ASTM D4832, with no significant strength gain after 28 days.

b. Consistency. Design CLSM to achieve a consistency that will produce an approximate 8-inch (200 mm) diameter circular-type spread without segregation. CLSM consistency shall be determined per ASTM D6103.

CONSTRUCTION METHODS

153-4.1 Placement.

a. Placement. CLSM may be placed by any reasonable means from the mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed so structures or pipes are not displaced from their final position and intrusion of CLSM into unwanted areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as directed by the RPR. Each placement of CLSM shall be as continuous an operation as possible. If CLSM is placed in more than one lift, the base lift shall be free of surface water and loose foreign material prior to placement of the next lift.

b. Contractor Quality Control. The Contractor shall collect all batch tickets to verify the CLSM delivered to the project conforms to the mix design. The Contractor shall verify daily that the CLSM is consistent with 153-3.1a and 153-3.1b. Adjustments shall be made as necessary to the proportions and materials as needed. The Contractor shall provide all batch tickets to the RPR.

c. Limitations of placement. CLSM shall not be placed on frozen ground. Mixing and placing may begin when the air or ground temperature is at least 35°F (2°C) and rising. Mixing and placement shall stop when the air temperature is 40°F (4°C) and falling or when the anticipated air or ground temperature will be 35°F (2°C) or less in the 24-hour period following proposed placement. At the time of placement, CLSM shall have a temperature of at least 40°F (4°C).

153-4.2 Curing and protection

a. Curing. The air in contact with the CLSM shall be maintained at temperatures above freezing for a minimum of 72 hours. If the CLSM is subjected to temperatures below 32°F (0°C), the material may be rejected by the RPR if damage to the material is observed.

b. Protection. The CLSM shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi (105 kPa) is obtained. The Contractor shall be responsible for providing evidence to the RPR that the material has reached the desired strength. Acceptable evidence shall be based upon compressive tests made in accordance with paragraph 153-3.1a.

153-4.3 Quality Assurance (QA) Acceptance. CLSM QA acceptance shall be based upon batch tickets provided by the Contractor to the RPR to confirm that the delivered material conforms to the mix design.

METHOD OF MEASUREMENT

153-5.1 Measurement.

No separate measurement for payment shall be made for controlled low strength material (CLSM). CLSM shall be considered necessary and incidental to the work of this Contract.

BASIS OF PAYMENT

153-6.1 Payment.

No payment will be made separately or directly for controlled low strength material (CLSM). CLSM shall be considered necessary and incidental to the work of this Contract.

REFERENCES

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

ASTM International (ASTM)

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low-Strength Material (CLSM) Test Cylinders
ASTM D6103	Flow Consistency of Controlled Low Strength Material (CLSM)

END OF ITEM P-153

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Item P-154 Subbase Course

DESCRIPTION

154-1.1 This item shall consist of a subbase course composed of granular materials constructed on a prepared subgrade or underlying course in accordance with these specifications, and in conformity with the dimensions and typical cross-section shown on the plans.

This material shall be the processed recycled asphalt and concrete material recycled from existing pavement within the project limits.

MATERIALS

154-2.1 Materials. The subbase material shall consist of hard durable particles or fragments of granular aggregates, recycled asphalt pavement (RAP), and/or recycled concrete pavement (RCO). The material may be obtained from gravel pits, stockpiles, or may be produced from a crushing and screening plant with proper blending. The materials from these sources shall meet the requirements for gradation, quality, and consistency. The material shall be free from vegetative matter, excessive amounts of clay, and other objectionable substances; uniformly blended; and be capable of being compacted into a dense, stable subbase.

The subbase material shall exhibit a California Bearing Ratio (CBR) value of at least 20 when tested in accordance with ASTM D1883. The subbase material shall meet the gradation specified in the table below.

Subbase Gradation Requirements

Sieve designation	Percentage by weight passing sieves	Contractor's Final Gradation	Job Control Grading Band Tolerances ¹ (Percent)
	Recycled pavement (RAP or RCO)		
3 inch (75 mm)			0
1 1/2 inch (37.5 mm)	100		0
3/4 inch (19.0 mm)	70-100		±10
No. 10 (2.00 mm)	20-100		±10
No. 40 (425 µm)	5-60		±5
No. 200 (75 µm)	[0-10]		±5

¹The "Job Control Grading Band Tolerances" shall be applied to "Contractor's Final Gradation" to establish the job control grading band.

The portion of the material passing the No. 40 (425 µm) sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than six (6) when tested in accordance with ASTM D4318.

154-2.2 Sampling and testing.

a. Aggregate base materials. Samples shall be taken by the Contractor per ASTM D75 for initial aggregate subbase requirements and gradation. Material shall meet the requirements in paragraphs 154-2.1. The Contractor shall submit to the Resident Project Representative (RPR) certified test results showing that the aggregate meets the Material requirements of this section. Tests shall be representative of the material to be used for the project.

b. Gradation requirements. The Contractor shall take at least one aggregate subbase sample per day in the presence of the RPR to check the final gradation. Samples shall be taken from the in-place, un-compacted material at sampling locations determined by the RPR on a random basis per ASTM D3665. Sampling shall be per ASTM D75 and tested per ASTM C136 and ASTM C117. Results shall be furnished to the RPR by the Contractor each day during construction. Material shall meet the requirements in paragraph 154-2.1.

154-2.3 Separation Geotextile. Not used.

CONSTRUCTION METHODS

154-3.1 General. The subbase course shall be placed where designated on the plans or as directed by the RPR. The material shall be shaped and thoroughly compacted within the tolerances specified.

Granular subbases which, due to grain sizes or shapes, are not sufficiently stable to support the construction equipment without movement, shall be mechanically modified to the depth necessary to provide stability as directed by the RPR. The mechanical modification shall include the addition of a fine-

grained medium to bind the particles of the subbase material sufficiently to furnish a bearing strength, so the course will not deform under construction equipment traffic.

154-3.2 Preparing underlying course. Prior to constructing the subbase course, clean the underlying course or subgrade of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances in accordance with Item P-152. Correct ruts, soft yielding spots in the underlying courses, and subgrade areas having inadequate compaction and/or deviations of the surface from the specified requirements, by loosening and removing soft or unsatisfactory material, adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, the surface shall be stabilized prior to placement of the overlying course by mixing the overlying course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the overlying course is placed. The underlying course shall be checked and accepted by the RPR before placing and spreading operations are started.

To protect the subgrade and to ensure proper drainage, spreading of the subbase shall begin along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope.

154-3.3 Control Strip. The first half-day of subbase construction shall be considered as a control strip for the Contractor to demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the RPR.

154-3.4 Placement. The material shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the RPR, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted. The material shall not be placed when the underlying course is soft or yielding.

The material shall meet gradation and moisture requirements prior to compaction. Material may be free-draining and the minimum moisture content shall be established for placement and compaction of the material.

The material shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

154-3.5 Compaction. The subbase material shall be compacted, adjusting moisture as necessary, to be within $\pm 2\%$ of optimum moisture. The field density of the compacted material shall be at least 100% of

the maximum density as specified in paragraph 154-3.9a. If the specified density is not attained, the area of the lift represented by the test shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

154-3.6 Weather limitation. Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on subbase course shall not be conducted when the subgrade is wet or frozen or the subbase material contains frozen material.

154-3.7 Maintenance. No base or surface course shall be placed on the subbase until the subbase has been accepted by the RPR. The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, the Contractor shall verify that materials still meet all specification requirements before placement of additional material. Equipment may be routed over completed sections of subbase course, provided the equipment does not damage the subbase course and the equipment is routed over the full width of the completed subbase course. Any damage to the subbase course from routing equipment over the subbase course shall be repaired by the Contractor at their expense.

154-3.8 Surface tolerance. In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

a. Smoothness. The finished surface shall not vary more than +/- ½ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

b. Grade. The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/- 0.05 feet (15 mm) of the specified grade.

154-3.9 Acceptance sampling and testing. The aggregate base course shall be accepted for density and thickness on an area basis. Two test shall be made for density and thickness for each 1200 square yards (1000 square meters). Sampling locations will be determined on a random basis per ASTM D3665.

a. Density. The Contractor's laboratory shall perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance.

Each area shall be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens compacted and tested per ASTM D1557. The in-place field density shall be determined per ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the area represented by the failed test shall be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

When the material has greater than 30 percent retained on the ¾ inch (19.0 mm) sieve, use methods in ASTM D1557 and the procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles.

b. Thickness. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the RPR for

each area. Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

METHOD OF MEASUREMENT

154-4.1 Subbase course shall be measured by the number of square yards (square meters) of subbase course material placed and compacted to specified density and plan thickness requirements in the completed course. The quantity of subbase course material shall be measured in final position based upon survey of the completed work computed from elevations to the nearest 0.01 foot (3 mm). On individual depth measurements, thicknesses more than 1/2 inch (12 mm) in excess of that shown on the plans shall be considered as the specified thickness plus 1/2 inch (12 mm) in computing the yardage for payment. Subbase materials shall not be included in any other excavation quantities.

BASIS OF PAYMENT

154-5.1 Payment shall be made at the contract unit price per square yard (square meter) for subbase course. This price shall be full compensation for furnishing all materials; for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

AW154518 Crushed Concrete Subbase 18” – per square yard

REFERENCES

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

ASTM International (ASTM)

ASTM C117	Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kN-m/m ³))
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

ASTM D4759	Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
American Association of State Highway and Transportation Officials (AASHTO)	
M 288	Geotextile Specification for Highway Applications

END OF ITEM P-154

Item P-209 Crushed Aggregate Base Course

DESCRIPTION

209-1.1 This item consists of a base course composed of crushed aggregate base constructed on a prepared course in accordance with these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

This item specifically is for the crushed aggregate base course to be placed as part of the pavement structure shown in the plan typical sections.

MATERIALS

209-2.1 Crushed aggregate base. Crushed aggregate shall consist of clean, sound, durable particles of crushed stone, crushed gravel, or crushed slag and shall be free from coatings of clay, silt, organic material, clay lumps or balls or other deleterious materials or coatings. The method used to produce the crushed gravel shall result in the fractured particles in the finished product as consistent and uniform as practicable. Fine aggregate portion, defined as the portion passing the No. 4 (4.75 mm) sieve shall consist of fines from the coarse aggregate crushing operation. The fine aggregate shall be produced by crushing stone, gravel, or slag that meet the coarse aggregate requirements for wear and soundness. Aggregate base material requirements are listed in the following table.

Crushed Aggregate Base Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate		
Resistance to Degradation	Loss: 45% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Percentage of Fractured Particles	Minimum 90% by weight of particles with at least two fractured faces and 100% with at least one fractured face ¹	ASTM D5821
Flat Particles, Elongated Particles, or Flat and Elongated Particles	10% maximum, by weight, of flat, elongated, or flat and elongated particles ²	ASTM D4791
Bulk density of slag	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Fine Aggregate		
Liquid limit	Less than or equal to 25	ASTM D4318
Plasticity Index	Not more than five (5)	ASTM D4318

¹ The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

² A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

209-2.2 Gradation requirements. The gradation of the aggregate base material shall meet the requirements of the gradation given in the following table when tested per ASTM C117 and ASTM C136. The gradation shall be well graded from coarse to fine and shall not vary from the lower limit on one sieve to the high limit on an adjacent sieve or vice versa.

Gradation of Aggregate Base

Sieve Size	Design Range Percentage by Weight passing	Contractor’s Final Gradation	Job Control Grading Band Tolerances ¹ (Percent)
2 inch (50 mm)	100		0
1-1/2 inch (37.5 mm)	95-100		±5
1 inch (25.0 mm)	70-95		±8
3/4 inch (19.0 mm)	55-85		±8
No. 4 (4.75 mm)	30-60		±8
No. 40 ² (425 µm)	10-30		±5
No. 200 ² (75 µm)	0-10		±3

¹ The “Job Control Grading Band Tolerances for Contractor’s Final Gradation” in the table shall be applied to “Contractor’s Final Gradation” to establish a job control grading band. The full tolerance still applies if application of the tolerances results in a job control grading band outside the design range.

² The fraction of material passing the No 200 (75 µm) sieve shall not exceed two-thirds the fraction passing the No 40 (425 µm) sieve.

209-2.3 Sampling and Testing.

a. Aggregate base materials. The Contractor shall take samples of the aggregate base in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraph 209-2.1. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

b. Gradation requirements. The Contractor shall take at least two aggregate base samples per day in the presence of the Resident Project Representative (RPR) to check the final gradation. Sampling shall be per ASTM D75. Material shall meet the requirements in paragraph 209-2.2. The samples shall be taken from the in-place, un-compacted material at sampling points and intervals designated by the RPR.

209-2.4 Separation Geotextile. Separation geotextile shall be Class 2, 0.02 sec⁻¹ permittivity per ASTM D4491, Apparent opening size per ASTM D4751 with 0.60 mm maximum average roll value.

CONSTRUCTION METHODS

209-3.1 Control strip. The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of the specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor’s demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted or removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved by the RPR.

209-3.2 Preparing underlying subgrade and/or subbase. The underlying subgrade and/or subbase shall be checked and accepted by the RPR before base course placing and spreading operations begin. Re-proof rolling of the subgrade or proof rolling of the subbase in accordance with Item P-152, at the Contractor's expense, may be required by the RPR if the Contractor fails to ensure proper drainage or protect the subgrade and/or subbase. Any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, shall be corrected before the base course is placed. To ensure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

209-3.3 Production. The aggregate shall be uniformly blended and, when at a satisfactory moisture content per paragraph 209-3.5, the approved material may be transported directly to the placement.

209-3.4 Placement. The aggregate shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the RPR, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

The aggregate shall meet gradation and moisture requirements prior to compaction. The base course shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications at the Contractor's expense.

209-3.5 Compaction. Immediately after completion of the spreading operations, compact each layer of the base course, as specified, with approved compaction equipment. The number, type, and weight of rollers shall be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade.

The field density of each compacted lift of material shall be at least 95% of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. The laboratory specimens shall be compacted and tested in accordance with ASTM D1557. The moisture content of the material during placing operations shall be within ± 2 percentage points of the optimum moisture content as determined by ASTM D1557. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

209-3.6 Weather limitations. Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on base course shall not be conducted when the subgrade or subbase is wet or frozen or the base material contains frozen material.

209-3.7 Maintenance. The base course shall be maintained in a condition that will meet all specification requirements. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor shall verify that materials still meet all specification requirements. Equipment may be routed over completed sections of base course, provided that no damage results and the equipment is routed over the full width of the completed base course. Any damage

resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at the Contractor's expense.

209-3.8 Surface tolerances. After the course has been compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and recompacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense. The smoothness and accuracy requirements specified here apply only to the top layer when base course is constructed in more than one layer.

a. Smoothness. The finished surface shall not vary more than 3/8-inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

b. Grade. The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +0 and -1/2 inch (12 mm) of the specified grade.

209-3.9 Acceptance sampling and testing. Crushed aggregate base course shall be accepted for density and thickness on an area basis. Two tests shall be made for density and thickness for each 1200 square yds (1000 m²). Sampling locations will be determined on a random basis per ASTM D3665

a. Density. The Contractor's laboratory shall perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance.

Each area shall be accepted for density when the field density is at least 95% of the maximum density of laboratory specimens compacted and tested per ASTM 1557. The in-place field density shall be determined per ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the area represented by the failed test must be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

b. Thickness. Depth tests shall be made by test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the RPR for each area. Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

METHOD OF MEASUREMENT

209-4.1 The quantity of crushed aggregate base course will be determined by measurement of the number of square yards (square meters) of material actually constructed and accepted by the RPR as complying with the plans and specifications. Base materials shall not be included in any other excavation quantities.

BASIS OF PAYMENT

209-5.1 Payment shall be made at the contract unit price per square yard (square meter) for crushed aggregate base course. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

Payment will be made under:

Item AW209606 Crushed Agg. Base Course – 6” – per square yard

REFERENCES

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

ASTM International (ASTM)

ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75- μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2700 kN-m/m ³))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4643	Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4751	Standard Test Methods for Determining Apparent Opening Size of a Geotextile

ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D7928	Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
American Association of State Highway and Transportation Officials (AASHTO)	
M288	Standard Specification for Geosynthetic Specification for Highway Applications

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Part 6 – Flexible Pavements

Item P-401 Asphalt Mix Pavement

DESCRIPTION

401-1.1 This item shall consist of pavement courses composed of mineral aggregate and asphalt binder mixed in a central mixing plant and placed on a prepared base or stabilized course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

MATERIALS

401-2.1 Aggregate. Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand, and mineral filler, as required. The aggregates should have no known history of detrimental pavement staining due to ferrous sulfides, such as pyrite. Coarse aggregate is the material retained on the No. 4 (4.75 mm) sieve. Fine aggregate is the material passing the No. 4 (4.75 mm) sieve.

a. Coarse aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Coarse aggregate material requirements are given in the table below.

Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	0.3% maximum	ASTM C142
Percentage of Fractured Particles	For pavements designed for aircraft gross weights of 60,000 pounds (27200 kg) or more: Minimum 75% by weight of particles with at least two fractured faces and 85% with at least one fractured face ¹	ASTM D5821
	For pavements designed for aircraft gross weights less than 60,000 pounds (27200 kg): Minimum 50% by weight of particles with at least two fractured faces and 65% with at least one fractured face ¹	
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 ²	ASTM D4791
Bulk density of slag ³	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29.

¹ The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

² A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

³ Only required if slag is specified.

b. Fine aggregate. Fine aggregate shall consist of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel and shall be free from coatings of clay, silt, or other objectionable matter. Natural (non-manufactured) sand may be used to obtain the gradation of the fine aggregate blend or to improve the workability of the mix. Fine aggregate material requirements are listed in the table below.

Fine Aggregate Material Requirements

Material Test	Requirement	Standard
Liquid limit	25 maximum	ASTM D4318
Plasticity Index	4 maximum	ASTM D4318
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	0.3% maximum	ASTM C142
Sand equivalent	45 minimum	ASTM D2419
Natural Sand	0% to 15% maximum by weight of total aggregate	ASTM D1073

c. Sampling. ASTM D75 shall be used in sampling coarse and fine aggregate.

401-2.2 Mineral filler. Mineral filler (baghouse fines) may be added in addition to material naturally present in the aggregate. Mineral filler shall meet the requirements of ASTM D242.

Mineral Filler Requirements

Material Test	Requirement	Standard
Plasticity Index	4 maximum	ASTM D4318

401-2.3 Asphalt binder. Asphalt binder shall conform to ASTM D6373 Performance Grade (PG) 70-22.

Asphalt Binder PG Plus Test Requirements

Material Test	Requirement	Standard
Elastic Recovery	75% minimum	ASTM D6084

401-2.4 Anti-stripping agent. Any anti-stripping agent or additive (anti-strip) shall be heat stable and shall not change the asphalt binder grade beyond specifications. Anti-strip shall be an approved material of the Department of Transportation of the State in which the project is located.

COMPOSITION

401-3.1 Composition of mixture(s). The asphalt mix shall be composed of a mixture of aggregates, filler and anti-strip agent if required, and asphalt binder. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

401-3.2 Job mix formula (JMF) laboratory. The laboratory used to develop the JMF shall possess a current certificate of accreditation, listing D3666 from a national accrediting authority and all test methods required for developing the JMF; and be listed on the accrediting authority’s website. A copy of

the laboratory's current accreditation and accredited test methods shall be submitted to the Resident Project Representative (RPR) prior to start of construction.

401-3.3 Job mix formula (JMF). No asphalt mixture shall be placed until an acceptable mix design has been submitted to the RPR for review and accepted in writing. The RPR's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

When the project requires asphalt mixtures of differing aggregate gradations and/or binders, a separate JMF shall be submitted for each mix. Add anti-stripping agent to meet tensile strength requirements.

The JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 401-3.2. The asphalt mixture shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Samples shall be prepared and compacted using the gyratory compactor in accordance with ASTM D6925.

Should a change in sources of materials be made, a new JMF must be submitted to the RPR for review and accepted in writing before the new material is used. After the initial production JMF has been approved by the RPR and a new or modified JMF is required for whatever reason, the subsequent cost of the new or modified JMF, including a new control strip when required by the RPR, will be borne by the Contractor.

The RPR may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

The JMF shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations. The JMF shall be developed within the same construction season using aggregates proposed for project use.

The JMF shall be dated, and stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

- Manufacturer's Certificate of Analysis (COA) for the asphalt binder used in the JMF in accordance with paragraph 401-2.3. Certificate of asphalt performance grade is with modifier already added, if used and must indicate compliance with ASTM D6373. For plant modified asphalt binder, certified test report indicating grade certification of modified asphalt binder.
- Manufacturer's Certificate of Analysis (COA) for the anti-stripping agent if used in the JMF in accordance with paragraph 401-2.4.
- Certified material test reports for the course and fine aggregate and mineral filler in accordance with paragraphs 401-2.1.
- Percent passing each sieve size for individual gradation of each aggregate cold feed and/or hot bin; percent by weight of each cold feed and/or hot bin used; and the total combined gradation in the JMF.
- Specific Gravity and absorption of each coarse and fine aggregate.
- Percent natural sand.
- Percent fractured faces.
- Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).
- Percent of asphalt.
- Number of blows or gyrations

- Laboratory mixing and compaction temperatures.
- Supplier-recommended field mixing and compaction temperatures.
- Plot of the combined gradation on a 0.45 power gradation curve.
- Graphical plots of air voids, voids in the mineral aggregate (VMA), and unit weight versus asphalt content. To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.
- Tensile Strength Ratio (TSR).
- Type and amount of Anti-strip agent when used.
- Asphalt Pavement Analyzer (APA) results.
- Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season shall not be accepted.
- Percentage and properties (asphalt content, asphalt binder properties, and aggregate properties) of reclaimed asphalt mix pavement (RAP) in accordance with paragraph 401-3.4.

Table 1. Asphalt Design Criteria

Test Property	Value	Test Method
Number of blows or gyrations	75	
Air voids (%)	3.5	ASTM D3203
Percent voids in mineral aggregate (VMA), minimum	See Table 2	ASTM D6995
Tensile Strength Ratio (TSR) ¹	not less than 80 at a saturation of 70-80%	ASTM D4867
Asphalt Pavement Analyzer (APA) ²	Less than 10 mm @ 4000 passes	AASHTO T340 at 250 psi hose pressure at 64°C test temperature

¹ Test specimens for TSR shall be compacted at 7 ± 1.0 % air voids. In areas subject to freeze-thaw, use freeze-thaw conditioning in lieu of moisture conditioning per ASTM D4867.

² AASHTO T340 at 100 psi hose pressure at 64°C test temperature may be used in the interim. If this method is used the required Value shall be less than 5 mm @ 8000 passes

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 2 when tested in accordance with ASTM C136 and ASTM C117.

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the sources of supply; be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

Table 2. Aggregate - Asphalt Pavements

Sieve Size	Percentage by Weight Passing Sieve	
	Gradation 1 (Base)	Gradation 2 (Surface)
1 inch (25.0 mm)	100	--
3/4 inch (19.0 mm)	90-100	100
1/2 inch (12.5 mm)	68-88	90-100
3/8 inch (9.5 mm)	60-82	72-88
No. 4 (4.75 mm)	45-67	53-73
No. 8 (2.36 mm)	32-54	38-60
No. 16 (1.18 mm)	22-44	26-48
No. 30 (600 µm)	15-35	18-38
No. 50 (300 µm)	9-25	11-27
No. 100 (150 µm)	6-18	6-18
No. 200 (75 µm)	3-6	3-6
Minimum Voids in Mineral Aggregate (VMA)¹	14.0	15.0
Asphalt Percent:		
Stone or gravel	4.5-7.0	5.0-7.5
Slag	5.0-7.5	6.5-9.5
Recommended Minimum Construction Lift Thickness	3 inch	2 inch

¹To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute MS-2 Mix Design Manual, 7th Edition.

Where locally-available aggregates cannot be economically blended to meet the grading requirements of the gradations shown, the gradations may be modified to fit the characteristics of such local aggregates with approval of the FAA. The modified gradation must produce a paving mixture that satisfies the mix design requirements.

401-3.4 Reclaimed asphalt pavement (RAP). Reclaimed asphalt shall consist of reclaimed asphalt pavement (RAP), coarse aggregate, fine aggregate, mineral filler, and asphalt. The RAP shall be of a consistent gradation and asphalt content and properties. When RAP is fed into the plant, the maximum RAP size shall not exceed one inch (25 mm). The reclaimed asphalt pavement mix shall be designed using procedures contained in the Asphalt Institute MS-2 Mix Design Manual, 7th Edition. The percentage of asphalt in the RAP shall be established for the mixture design according to ASTM D2172 using the appropriate dust correction procedure. The JMF shall meet the requirements of paragraph 401-3.3. RAP shall only be used for shoulder surface course mixes and for any intermediate courses. The amount of RAP shall be limited to 20 percent. In addition to the requirements of paragraph 401-3.3, the

JMF shall indicate the percent of reclaimed asphalt pavement and the percent and grade of new asphalt binder. For the PG graded asphalt binder selected in 401-2.3, adjust as follows:

- a. For 0-20% RAP, there is no change in virgin asphalt binder content.
- b. For >20 to 30% RAP, select asphalt binder one grade softer, i.e., PG 64-22 would soften to PG 58-28.

RAP containing Coal Tar shall not be used. Coal Tar surface treatments must be removed prior to recycling underlying asphalt material.

Recycled asphalt shingles (RAS) shall not be used.

RAP may be included in the composition of the Gradation 1 (Base) but shall not be used in the Gradation 2 (Surface).

401-3.5 Control Strip. Full production shall not begin until an acceptable control strip has been constructed and accepted in writing by the RPR. The Contractor shall prepare and place a quantity of asphalt according to the JMF. The underlying grade or pavement structure upon which the control strip is to be constructed shall be the same as the remainder of the course represented by the control strip.

The Contractor will not be allowed to place the control strip until the Contractor quality control program (CQCP), showing conformance with the requirements of paragraph 401-5.1, has been accepted, in writing, by the RPR.

The control strip will consist of at least 250 tons (227 metric tons) or 1/2 subplot, whichever is greater. The control strip shall be placed in two lanes of the same width and depth to be used in production with a longitudinal cold joint. The cold joint must be cut back in accordance with paragraph 401-4.14 using the same procedure that will be used during production. The cold joint for the control strip will be an exposed construction joint at least four (4) hours old or when the mat has cooled to less than 160°F (71°C). The equipment used in construction of the control strip shall be the same type, configuration and weight to be used on the project.

The control strip will be considered acceptable by the RPR if the gradation, asphalt content, and VMA are within the action limits specified in paragraph 401-5.5a; and Mat density, air voids, and joint density meet the requirements specified in paragraphs 401-6.2.

If the control strip is unacceptable, necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made and another control strip shall be placed. Unacceptable control strips shall be removed at the Contractor's expense.

Payment will only be made for an acceptable control strip in accordance with paragraph 401-8.1 using a lot pay factor equal to 100.

CONSTRUCTION METHODS

401-4.1 Weather limitations. The asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the RPR, if requested; however, all other requirements including compaction shall be met.

Table 4. Surface Temperature Limitations of Underlying Course

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 inches (7.5 cm) or greater	40 ¹	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

401-4.2 Asphalt plant. Plants used for the preparation of asphalt shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 including the following items.

a. Inspection of plant. The RPR, or RPR’s authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

b. Storage bins and surge bins. The asphalt mixture stored in storage and/or surge bins shall meet the same requirements as asphalt mixture loaded directly into trucks. Asphalt mixture shall not be stored in storage and/or surge bins for a period greater than twelve (12) hours. If the RPR determines there is an excessive heat loss, segregation, or oxidation of the asphalt mixture due to temporary storage, temporary storage shall not be allowed.

401-4.3 Aggregate stockpile management. Aggregate stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the asphalt batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used.

A continuous supply of materials shall be provided to the work to ensure continuous placement.

401-4.4 Hauling equipment. Trucks used for hauling asphalt shall have tight, clean, and smooth metal beds. To prevent the asphalt from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the RPR. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

401-4.4.1 Material transfer vehicle (MTV). Material transfer vehicles used to transfer the material from the hauling equipment to the paver, shall use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation.

401-4.5 Asphalt pavers. Asphalt pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of asphalt that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The asphalt paver shall be equipped with a control system capable of automatically maintaining the specified screed grade and elevation.

If the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued.

The paver shall be capable of paving to a minimum width specified in paragraph 401-4.12.

401-4.6 Rollers. The number, type, and weight of rollers shall be sufficient to compact the asphalt to the required density while it is still in a workable condition without crushing of the aggregate, depressions or other damage to the pavement surface. Rollers shall be in good condition, clean, and capable of operating at slow speeds to avoid displacement of the asphalt. All rollers shall be specifically designed and suitable for compacting asphalt concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used.

401-4.7 Density device. The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall supply a qualified technician during all paving operations to calibrate the gauge and obtain accurate density readings for all new asphalt. These densities shall be supplied to the RPR upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

401-4.8 Preparation of asphalt binder. The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. The temperature of unmodified asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 325°F (160°C) when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F (175°C) when added to the aggregate.

401-4.9 Preparation of mineral aggregate. The aggregate for the asphalt shall be heated and dried. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F (175°C) when the asphalt binder is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.

401-4.10 Preparation of Asphalt mixture. The aggregates and the asphalt binder shall be weighed or metered and mixed in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95% of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all asphalt upon discharge shall not exceed 0.5%.

401-4.11 Application of Prime and Tack Coat. Immediately before placing the asphalt mixture, the underlying course shall be cleaned of all dust and debris.

A prime coat in accordance with Item P-602 shall be applied to aggregate base prior to placing the asphalt mixture.

A tack coat shall be applied in accordance with Item P-603 to all vertical and horizontal asphalt and concrete surfaces prior to placement of the first and each subsequent lift of asphalt mixture.

401-4.12 Laydown plan, transporting, placing, and finishing. Prior to the placement of the asphalt, the Contractor shall prepare a laydown plan with the sequence of paving lanes and width to minimize the number of cold joints; the location of any temporary ramps; laydown temperature; and estimated time of completion for each portion of the work (milling, paving, rolling, cooling, etc.). The laydown plan and any modifications shall be approved by the RPR.

Deliveries shall be scheduled so that placing and compacting of asphalt is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to approximately ambient temperature. The Contractor, at their expense, shall be responsible for repair of any damage to the pavement caused by hauling operations.

Contractor shall survey each lift of asphalt surface course and certify to RPR that every lot of each lift meets the grade tolerances of paragraph 401-6.2d before the next lift can be placed.

Edges of existing asphalt pavement abutting the new work shall be saw cut and the cut off material and laitance removed. Apply a tack coat in accordance with P-603 before new asphalt material is placed against it.

The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Placement of the asphalt mix shall begin along the centerline of a crowned section or on the high side of areas with a one way slope unless shown otherwise on the laydown plan as accepted by the RPR. The asphalt mix shall be placed in consecutive adjacent lanes having a minimum width of 10 feet (m) except where edge lanes require less width to complete the area. Additional screed sections attached to widen the paver to meet the minimum lane width requirements must include additional auger sections to move the asphalt mixture uniformly along the screed extension.

The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least one foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m). On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the asphalt may be spread and luted by hand tools.

The RPR may at any time, reject any batch of asphalt, on the truck or placed in the mat, which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or overheated asphalt mixture. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the RPR, and if it can be demonstrated in the laboratory, in the presence of the RPR, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

Areas of segregation in the surface course, as determined by the RPR, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of the construction lift thickness as specified in paragraph 401-3.3, Table 2 for the approved mix design. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.

401-4.13 Compaction of asphalt mixture. After placing, the asphalt mixture shall be thoroughly and uniformly compacted by self-propelled rollers. The surface shall be compacted as soon as possible when the asphalt has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any surface defects and/or displacement occurring as a result of the roller, or from any other cause, shall be corrected at the Contractor's expense.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the asphalt to the roller, the wheels shall be equipped with a scraper and kept moistened with water as necessary.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power tampers.

Any asphalt that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

401-4.14 Joints. The formation of all joints shall be made to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid asphalt except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. In both methods, all contact surfaces shall be coated with an asphalt tack coat before placing any fresh asphalt against the joint.

Longitudinal joints which have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material and any laitance produced from cutting joints shall be removed from the project. Asphalt tack coat in accordance with P-603 shall be applied to the clean, dry joint prior to placing any additional fresh asphalt against the joint. The cost of this work shall be considered incidental to the cost of the asphalt.

401-4.15 Saw-cut grooving. Saw-cut grooves shall be provided as specified in Item P-621. Saw-cut grooving is not required.

401-4.16 Diamond grinding. Diamond grinding shall be completed prior to pavement grooving. Diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive.

Diamond grinding shall be performed with a machine designed specifically for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with a sufficient number of blades to create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Equipment or grinding procedures that cause ravels, aggregate fractures, spalls or disturbance to the pavement will not be permitted. Contractor shall demonstrate to the RPR that the grinding equipment will produce satisfactory results prior to making corrections to surfaces. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. The Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

401-4.17 Nighttime paving requirements. The Contractor shall provide adequate lighting during any nighttime construction. A lighting plan shall be submitted by the Contractor and approved by the RPR prior to the start of any nighttime work. All work shall be in accordance with the approved CSPP and lighting plan.

CONTRACTOR QUALITY CONTROL (CQC)

401-5.1 General. The Contractor shall develop a Contractor Quality Control Program (CQCP) in accordance with Item C-100. No partial payment will be made for materials without an approved CQCP.

401-5.2 Contractor quality control (QC) facilities. The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The RPR shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The RPR will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

401-5.3 Contractor QC testing. The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to these specifications and as set forth in the approved CQCP. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A QC Testing Plan shall be developed as part of the CQCP.

a. Asphalt content. A minimum of two tests shall be performed per day in accordance with ASTM D6307 or ASTM D2172 for determination of asphalt content. When using ASTM D6307, the correction factor shall be determined as part of the first test performed at the beginning of plant production; and as part of every tenth test performed thereafter. The asphalt content for the day will be determined by averaging the test results.

b. Gradation. Aggregate gradations shall be determined a minimum of twice per day from mechanical analysis of extracted aggregate in accordance with ASTM D5444, ASTM C136, and ASTM C117.

c. Moisture content of aggregate. The moisture content of aggregate used for production shall be determined a minimum of once per day in accordance with ASTM C566.

d. Moisture content of asphalt. The moisture content shall be determined once per day in accordance with AASHTO T329 or ASTM D1461.

e. Temperatures. Temperatures shall be checked, at least four times per day, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the asphalt at the plant, and the asphalt at the job site.

f. In-place density monitoring. The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.

g. Smoothness for Contractor Quality Control.

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) straightedge or a rolling inclinometer meeting the requirements of ASTM E2133. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer is used, the data may be evaluated using the FAA profile program, ProFAA, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

(1) Transverse measurements. Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the RPR. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

(2) Longitudinal measurements. Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 401-4.16 or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 401-6.1d(3). Areas that have been ground shall be sealed with a surface treatment in accordance with Item P-608. To avoid the surface treatment creating any conflict with runway or taxiway markings, it may be necessary to seal a larger area.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

h. Grade. Grade shall be evaluated daily to allow adjustments to paving operations when grade measurements do not meet specifications. As a minimum, grade shall be evaluated prior to and after the placement of the first lift and after placement of the surface lift.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically and 0.1 feet (30 mm) laterally. The documentation will be provided by the Contractor to the RPR by the end of the following working day.

Areas with humps or depressions that exceed grade or smoothness criteria and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. Grinding shall be in accordance with paragraph 401-4.16.

The Contractor shall repair low areas or areas that cannot be corrected by grinding by removal of deficient areas to the depth of the final course plus 1/2 inch and replacing with new material. Skin patching is not allowed.

401-5.4 Sampling. When directed by the RPR, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

401-5.5 Control charts. The Contractor shall maintain linear control charts for both individual measurements and range (i.e. difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each day will be calculated and monitored by the QC laboratory.

Control charts shall be posted in a location satisfactory to the RPR and kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor’s test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor’s projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the RPR may suspend production or acceptance of the material.

a. Individual measurements. Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation, asphalt content, and VMA. The control charts shall use the job mix formula target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

Control Chart Limits for Individual Measurements

Sieve	Action Limit	Suspension Limit
3/4 inch (19.0 mm)	±6%	±9%
1/2 inch (12.5 mm)	±6%	±9%
3/8 inch (9.5 mm)	±6%	±9%
No. 4 (4.75 mm)	±6%	±9%
No. 16 (1.18 mm)	±5%	±7.5%
No. 50 (300 µm)	±3%	±4.5%
No. 200 (75 µm)	±2%	±3%
Asphalt Content	±0.45%	±0.70%
Minimum VMA	-0.5%	-1.0%

b. Range. Control charts shall be established to control gradation process variability. The range shall be plotted as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of n = 2. Should the Contractor elect to perform more than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.

Control Chart Limits Based on Range

Sieve	Suspension Limit
1/2 inch (12.5 mm)	11%
3/8 inch (9.5 mm)	11%
No. 4 (4.75 mm)	11%
No. 16 (1.18 mm)	9%
No. 50 (300 µm)	6%
No. 200 (75 µm)	3.5%
Asphalt Content	0.8%

c. Corrective Action. The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain rules to gauge when a process is out of

control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

- (1) One point falls outside the Suspension Limit line for individual measurements or range; or
- (2) Two points in a row fall outside the Action Limit line for individual measurements.

401-5.6 QC reports. The Contractor shall maintain records and shall submit reports of QC activities daily, in accordance with Item C-100.

MATERIAL ACCEPTANCE

401-6.1 Acceptance sampling and testing. Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the RPR at no cost to the Contractor except that coring as required in this section shall be completed and paid for by the Contractor.

a. Quality assurance (QA) testing laboratory. The QA testing laboratory performing these acceptance tests will be accredited in accordance with ASTM D3666. The QA laboratory accreditation will be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing will be listed on the lab accreditation.

b. Lot size. A standard lot will be equal to one day's production divided into approximately equal sublots of between 400 to 600 tons. When only one or two sublots are produced in a day's production, the sublots will be combined with the production lot from the previous or next day.

Where more than one plant is simultaneously producing asphalt for the job, the lot sizes will apply separately for each plant.

c. Asphalt air voids. Plant-produced asphalt will be tested for air voids on a subplot basis.

(1) Sampling. Material from each subplot shall be sampled in accordance with ASTM D3665. Samples shall be taken from material deposited into trucks at the plant or at the job site in accordance with ASTM D979. The sample of asphalt may be put in a covered metal tin and placed in an oven for not less than 30 minutes nor more than 60 minutes to maintain the material at or above the compaction temperature as specified in the JMF.

(2) Testing. Air voids will be determined for each subplot in accordance with ASTM D3203 for a set of compacted specimens prepared in accordance with ASTM D6925.

d. In-place asphalt mat and joint density. Each subplot will be tested for in-place mat and joint density as a percentage of the theoretical maximum density (TMD).

(1) Sampling. The Contractor will cut minimum 5 inch (125 mm) diameter samples in accordance with ASTM D5361. The Contractor shall furnish all tools, labor, and materials for cleaning, and filling the cored pavement. Laitance produced by the coring operation shall be removed immediately after coring, and core holes shall be filled within one day after sampling in a manner acceptable to the RPR.

(2) Bond. Each lift of asphalt shall be bonded to the underlying layer. If cores reveal that the surface is not bonded, additional cores shall be taken as directed by the RPR to determine the extent of unbonded areas. Unbonded areas shall be removed by milling and replaced at no additional cost as directed by the RPR.

(3) Thickness. Thickness of each lift of surface course will be evaluated by the RPR for compliance to the requirements shown on the plans after any necessary corrections for grade. Measurements of thickness will be made using the cores extracted for each subplot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch (6 mm) less

than the thickness indicated for the lift. Average thickness of lift, or combined lifts, will not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or subplot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the RPR to circumscribe the deficient area.

(4) Mat density. One core shall be taken from each subplot. Core locations will be determined by the RPR in accordance with ASTM D3665. Cores for mat density shall not be taken closer than one foot (30 cm) from a transverse or longitudinal joint. The bulk specific gravity of each cored sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each subplot sample by the TMD for that subplot.

(5) Joint density. One core centered over the longitudinal joint shall be taken for each subplot that has a longitudinal joint. Core locations will be determined by the RPR in accordance with ASTM D3665. The bulk specific gravity of each core sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each joint density sample by the average TMD for the lot. The TMD used to determine the joint density at joints formed between lots will be the lower of the average TMD values from the adjacent lots.

401-6.2 Acceptance criteria.

a. General. Acceptance will be based on the implementation of the Contractor Quality Control Program (CQCP) and the following characteristics of the asphalt and completed pavements: air voids, mat density, joint density, grade and Profilograph roughness.

b. Air Voids and Mat density. Acceptance of each lot of plant produced material for mat density and air voids will be based on the percentage of material within specification limits (PWL). If the PWL of the lot equals or exceeds 90%, the lot will be acceptable. Acceptance and payment will be determined in accordance with paragraph 401-8.1.

c. Joint density. Acceptance of each lot of plant produced asphalt for joint density will be based on the PWL. If the PWL of the lot is equal to or exceeds 90%, the lot will be considered acceptable. If the PWL is less than 90%, the Contractor shall evaluate the reason and act accordingly. If the PWL is less than 80%, the Contractor shall cease operations and until the reason for poor compaction has been determined. If the PWL is less than 71%, the pay factor for the lot used to complete the joint will be reduced by five (5) percentage points. This lot pay factor reduction will be incorporated and evaluated in accordance with paragraph 401-8.1.

d. Grade. The final finished surface of the pavement shall be surveyed to verify that the grade elevations and cross-sections shown on the plans do not deviate more than 1/2 inch (12 mm) vertically or 0.1 feet (30 mm) laterally.

Cross-sections of the pavement shall be taken at a minimum 50-foot (15-m) longitudinal spacing and at all longitudinal grade breaks. Minimum cross-section grade points shall include grade at centerline, \pm 10 feet of centerline, and edge of taxiway pavement.

The survey and documentation shall be stamped and signed by a licensed surveyor. Payment for sublots that do not meet grade for over 25% of the subplot shall not be more than 95%.

e. Profilograph roughness for QA Acceptance. The final profilograph shall be the full length of the project to facilitate testing of roughness between lots. The Contractor, in the presence of the RPR shall perform a profilograph roughness test on the completed project with a profilograph meeting the requirements of ASTM E1274 or a Class I inertial profiler meeting ASTM E950. Data and results shall be provided within 48 hrs of profilograph roughness tests.

The pavement shall have an average profile index less than 15 inches per mile per 1/10 mile. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate

“must grind” bumps and the Profile Index for the pavement using a 0.2-inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved, trained operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). Profilograph shall be performed one foot right and left of project centerline and 15 feet (4.5 m) right and left of project centerline. Any areas that indicate “must grind” shall be corrected with diamond grinding per paragraph 401-4.16 or by removing and replacing full depth of surface course, as directed by the RPR. Where corrections are necessary, a second profilograph run shall be performed to verify that the corrections produced an average profile index of 15 inches per mile per 1/10 mile or less.

401-6.3 Percentage of material within specification limits (PWL). The PWL will be determined in accordance with procedures specified in Item C-110. The specification tolerance limits (L) for lower and (U) for upper are contained in Table 5.

Table 5. Acceptance Limits for Air Voids and Density

Test Property	Pavements Specification Tolerance Limits	
	L	U
Air Voids Total Mix (%)	2.0	5.0
Surface Course Mat Density (%)	92.8	-
Base Course Mat Density (%)	91.8	-
Joint density (%)	90.5	--

a. Outliers. All individual tests for mat density and air voids will be checked for outliers (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded, and the PWL will be determined using the remaining test values. The criteria in Table 5 is based on production processes which have a variability with the following standard deviations: Surface Course Mat Density (%), 1.20; Base Course Mat Density (%), 1.55; Joint Density (%), 1.8.

The Contractor should note that (1) 90 PWL is achieved when consistently producing a surface course with an average mat density of at least 94% with 1.20% or less variability, (2) 90 PWL is achieved when consistently producing a base course with an average mat density of at least 93.5% with 1.8% or less variability, and (3) 90 PWL is achieved when consistently producing joints with an average joint density of at least 91% with 1.8% or less variability.

401-6.4 Resampling pavement for mat density.

a. General. Resampling of a lot of pavement will only be allowed for mat density, and then, only if the Contractor requests same, in writing, within 48 hours after receiving the written test results from the RPR. A retest will consist of all the sampling and testing procedures contained in paragraphs 401-6.1d and 401-6.2b. Only one resampling per lot will be permitted.

(1) A redefined PWL will be calculated for the resampled lot. The number of tests used to calculate the redefined PWL will include the initial tests made for that lot plus the retests.

(2) The cost for resampling and retesting shall be borne by the Contractor.

b. Payment for resampled lots. The redefined PWL for a resampled lot will be used to calculate the payment for that lot in accordance with Table 6.

c. Outliers. Check for outliers in accordance with ASTM E178, at a significance level of 5%.

METHOD OF MEASUREMENT

401-7.1 Measurement. Asphalt shall be measured by the number of tons of asphalt used in the accepted work. Batch weights or truck scale weights will be used to determine the basis for the tonnage.

BASIS OF PAYMENT

401-8.1 Payment. Payment for a lot of asphalt meeting all acceptance criteria as specified in paragraph 401-6.2 shall be made based on results of tests for mat density and air voids. Payment for acceptable lots shall be adjusted according to paragraph 401-8.1c for mat density and air voids; and paragraph 401-6.2c for joint density, subject to the limitation that:

a. The total project payment for plant mix asphalt pavement shall not exceed 100% percent of the product of the contract unit price and the total number of tons (kg) of asphalt used in the accepted work.

b. The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

c. Basis of adjusted payment. The pay factor for each individual lot shall be calculated in accordance with Table 6. A pay factor shall be calculated for both mat density and air voids. The lot pay factor shall be the higher of the two values when calculations for both mat density and air voids are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either mat density or air voids is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both mat density and air voids are less than 100%. If PWL for joint density is less than 71% then the lot pay factor shall be reduced by 5% but be no higher than 95%.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 401-8.1a. Payment in excess of 100% for accepted lots of asphalt shall be used to offset payment for accepted lots of asphalt pavement that achieve a lot pay factor less than 100%.

Payment for sublots which do not meet grade in accordance with paragraph 401-6.2d after correction for over 25% of the subplot shall be reduced by 5%.

Table 6. Price adjustment schedule¹

Percentage of material within specification limits (PWL)	Lot pay factor (percent of contract unit price)
96 – 100	106
90 – 95	PWL + 10
75 – 89	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject ²

¹ Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment above 100% shall be subject to the total project payment limitation specified in paragraph 401-8.1a.

² The lot shall be removed and replaced. However, the RPR may decide to allow the rejected lot to remain. In that case, if the RPR and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50% of the contract unit price and the total project payment shall be reduced by the amount withheld for the rejected lot.

d. Profilograph Roughness. The Contractor will receive full payment when the profilograph average profile index is in accordance with paragraph 401-6.2e. When the final average profile index for

the entire length of pavement does not exceed 15 inches per mile per 1/10 mile, payment will be made at the contract unit price for the completed pavement.

401-8.1 Payment.

Payment will be made under:

Item AW401610	BITUMINOUS SURFACE COURSE - PER TON
Item AW401630	BITUMINOUS SURFACE TEST SECTION – PER EACH
Item AW403610	BITUMINOUS BASE COURSE - PER TON
Item AW403630	BITUMINOUS BASE COURSE TEST SECTION - PER EACH

REFERENCES

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

ASTM International (ASTM)

ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D242	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
ASTM D946	Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979	Standard Practice for Sampling Asphalt Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Asphalt Paving Mixtures
ASTM D1188	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples

ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from Asphalt Paving Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Asphalt Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489	Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D3381	Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4552	Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5361	Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6084	Standard Test Method for Elastic Recovery of Bituminous Materials by Durometer
ASTM D6307	Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder

ASTM D6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gytratory Compactor.
ASTM D6926	Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus
ASTM D6927	Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM D6995	Standard Test Method for Determining Field VMA based on the Maximum Specific Gravity of the Mix (Gmm)
ASTM E11	Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E950	Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
ASTM E2133	Standard Test Method for Using a Rolling Inclinator to Measure Longitudinal and Transverse Profiles of a Traveled Surface
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
AASHTO T329	Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
AASHTO T324	Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures
AASHTO T 340	Standard Method of Test for Determining the Rutting Susceptibility of Hot Mix Asphalt (APA) Using the Asphalt Pavement Analyzer (APA)
Asphalt Institute (AI)	
Asphalt Institute Handbook MS-26, Asphalt Binder	
Asphalt Institute MS-2 Mix Design Manual, 7th Edition	
AI State Binder Specification Database	
Federal Highway Administration (FHWA)	
Long Term Pavement Performance Binder Program	
Advisory Circulars (AC)	
AC 150/5320-6	Airport Pavement Design and Evaluation

FAA Orders

5300.1

Modifications to Agency Airport Design, Construction, and Equipment Standards

Software

FAARFIELD

END OF ITEM P-401

Part 9– Miscellaneous

Item P-602 Emulsified Asphalt Prime Coat

DESCRIPTION

602-1.1 This item shall consist of an application of emulsified asphalt material on the prepared base course in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

MATERIALS

602-2.1 Emulsified Asphalt material. The emulsified asphalt material shall be as specified in ASTM D3628 for use as a prime coat appropriate to local conditions. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the emulsified asphalt material. The COA shall be provided to and approved by the Resident Project Representative (RPR) before the emulsified asphalt material is applied. The furnishing of the COA for the emulsified asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

CONSTRUCTION METHODS

602-3.1 Weather limitations. The emulsified asphalt prime coat shall be applied only when the existing surface is dry; the atmospheric temperature is 50°F (10°C) or above, and the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the RPR.

602-3.2 Equipment. The equipment shall include a self-powered pressure asphalt material distributor and equipment for heating asphalt material.

Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 65.0 psi (4.5 kg/sq cm) of tire width to prevent rutting, shoving or otherwise damaging the base, surface or other layers in the pavement structure. Design and equip the distributor to spray the asphalt material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 1.0 gallons per square yard (0.23 to 4.5 L/square meter), with a pressure range of 25 to 75 psi (172.4 to 517.1 kPa) and with an allowable variation from the specified rate of not more than ±5%, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying asphalt material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the asphalt material during the heating process. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

A power broom and power blower suitable for cleaning the surfaces to which the asphalt coat is to be applied shall be provided.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the RPR.

602-3.3 Application of emulsified asphalt material. Immediately before applying the prime coat, the full width of the surface to be primed shall be swept with a power broom to remove all loose dirt and other objectionable material.

The asphalt emulsion material shall be uniformly applied with an asphalt distributor at the rate of 0.15 to 0.30 gallons per square yard (0.68 to 1.36 liters per square meter) depending on the base course surface texture. The type of asphalt material and application rate shall be approved by the RPR prior to application.

Following application of the emulsified asphalt material and prior to application of the succeeding layer of pavement, allow the asphalt coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread sand to effectively blot up and cure excess asphalt material. The Contractor shall remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Owner. Keep traffic off surfaces freshly treated with asphalt material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

602-3.4 Trial application rates. The Contractor shall apply a minimum of three lengths of at least 100 feet (30 m) for the full width of the distributor bar to evaluate the amount of emulsified asphalt material that can be satisfactorily applied with the equipment. Apply three different application rates of emulsified asphalt materials within the application range specified in paragraph 602-3.3. Other trial applications can be made using various amounts of material as directed by the RPR. The trial application is to demonstrate the equipment can uniformly apply the emulsified asphalt material within the rates specified and determine the application rate for the project.

602-3.5 Freight and waybills. The Contractor shall submit waybills and delivery tickets during the progress of the work. Before the final estimate is allowed, file with the RPR certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

METHOD OF MEASUREMENT

602-4.1 The emulsified asphalt material for prime coat shall be measured by the gallon (liter). Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D4311. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

BASIS OF PAYMENT

602-5.1 Payment shall be made at the contract unit price per gallon (liter) for emulsified asphalt prime coat. This price shall be full compensation for furnishing all materials and for all preparation, delivering,

and applying the materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

AW602510 **Bituminous Prime Coat - per gallon**

REFERENCES

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

ASTM International (ASTM)

ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

END OF ITEM P-602

Item P-603 Emulsified Asphalt Tack Coat

DESCRIPTION

603-1.1 This item shall consist of preparing and treating an asphalt or concrete surface with asphalt material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

MATERIALS

603-2.1 Asphalt materials. The asphalt material shall be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions. The emulsified asphalt shall not be diluted. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt material to the Resident Project Representative (RPR) before the asphalt material is applied for review and acceptance. The furnishing of COA for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

CONSTRUCTION METHODS

603-3.1 Weather limitations. The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the RPR.

603-3.2 Equipment. The Contractor shall provide equipment for heating and applying the emulsified asphalt material. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute).

The equipment will be tested under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application, spray-bar height and pressure and pump speed, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

The distributor truck shall be equipped to effectively heat and mix the material to the required temperature prior to application as required. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Do not overheat or over mix the material.

The distributor shall be equipped with a hand sprayer.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the RPR.

A power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied shall be provided.

603-3.3 Application of emulsified asphalt material. The emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the RPR prior to application.

Emulsified Asphalt

Surface Type	Residual Rate, gal/SY (L/square meter)	Emulsion Application Bar Rate, gal/SY (L/square meter)
New asphalt	0.02-0.05 (0.09-0.23)	0.03-0.07 (0.13-0.32)
Existing asphalt	0.04-0.07 (0.18-0.32)	0.06-0.11 (0.27-0.50)
Milled Surface	0.04-0.08 (0.18-0.36)	.06-0.12 (0.27-0.54)
Concrete	0.03-0.05 (0.13-0.23)	0.05-0.08 (0.23-0.36)

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the RPR. The Contractor shall protect the tack coat and maintain the surface until the next course has been placed. When the tack coat has been disturbed by the Contractor, tack coat shall be reapplied at the Contractor's expense.

603-3.4 Freight and waybills The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the RPR certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

METHOD OF MEASUREMENT

603-4.1 The emulsified asphalt material for tack coat shall be measured by the gallon (liter). Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D1250. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

BASIS OF PAYMENT

603.5-1 Payment shall be made at the contract unit price per gallon (liter) of emulsified asphalt material. This price shall be full compensation for furnishing all materials, for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

AW603510 Bituminous Tack Coat - per gallon

REFERENCES

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

ASTM International (ASTM)

ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

END ITEM P-603

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Item P-610 Concrete for Miscellaneous Structures

DESCRIPTION

610-1.1 This item shall consist of concrete and reinforcement, as shown on the plans, prepared and constructed in accordance with these specifications. This specification shall be used for all concrete other than airfield pavement which are cast-in-place.

MATERIALS

610-2.1 General. Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the Resident Project Representative (RPR) before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

a. Reactivity. Fine aggregate and coarse aggregates to be used in all concrete shall have been tested separately within six months of the project in accordance with ASTM C1260. Test results shall be submitted to the RPR. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion either or both test specimen is greater than 0.08% at 14 days, but less than 0.20%, a minimum of 25% of Type F fly ash, or between 40% and 55% of slag cement shall be used in the concrete mix.

If the expansion is greater than 0.20% the aggregates shall not be used, and test results for other aggregates must be submitted for evaluation.

610-2.2 Coarse aggregate. The coarse aggregate for concrete shall meet the requirements of ASTM C33 and the requirements of Table 4, Class Designation 5S; and the grading requirements shown below, as required for the project.

Coarse Aggregate Grading Requirements

Maximum Aggregate Size	ASTM C33, Table 3 Grading Requirements (Size No.)
1 1/2 inch (37.5 mm)	467 or 4 and 67
1 inch (25 mm)	57
3/4 inch (19 mm)	67
1/2 inch (12.5 mm)	7

610-2.2.1 Coarse Aggregate susceptibility to durability (D) cracking.

Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

Crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test requirements but must meet all other quality tests specified in Item P-501.

610-2.3 Fine aggregate. The fine aggregate for concrete shall meet all fine aggregate requirements of ASTM C33.

610-2.4 Cement. Cement shall conform to the requirements of ASTM C150 Type I or ASTM C595 Type IP or IL.

610-2.5 Cementitious materials.

a. Fly ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the RPR.

b. Slag cement (ground granulated blast furnace (GGBF)). Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

610-2.6 Water. Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

610-2.7 Admixtures. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the RPR may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the

requirements of the cited specifications. Subsequent tests may be made of samples taken by the RPR from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

a. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

b. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

c. Other chemical admixtures. The use of set retarding, and set-accelerating admixtures shall be approved by the RPR. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

610-2.8 Premolded joint material. Not used.

610-2.9 Joint filler. Not Used.

610-2.10 Steel reinforcement. Reinforcing shall consist of welded steel wire fabric conforming to the requirements of ASTM A1064 or ASTM A884.

610-2.11 Materials for curing concrete. Curing materials shall conform to ASTM C309, White-pigmented Liquid Membrane-Forming Compound, Type 2, Class B.

CONSTRUCTION METHODS

610-3.1 General. The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the RPR.

610-3.2 Concrete Mixture. The concrete shall develop a compressive strength of 4000 psi in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39. The concrete shall contain not less than 470 pounds of cementitious material per cubic yard (280 kg per cubic meter). The water cementitious ratio shall not exceed 0.45 by weight. The air content of the concrete shall be 5% +/- 1.2% as determined by ASTM C231 and shall have a slump of not more than 4 inches (100 mm) as determined by ASTM C143.

610-3.3 Mixing. Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94 or ASTM C685.

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without the RPRs approval. If approval is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material is not permitted.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

610-3.4 Forms. Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the RPR. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.

The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface.

610-3.5 Placing reinforcement. All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

610-3.6 Embedded items. Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

610-3.7 Concrete Consistency. The Contractor shall monitor the consistency of the concrete delivered to the project site; collect each batch ticket; check temperature; and perform slump tests on each truck at the project site in accordance with ASTM C143.

610-3.8 Placing concrete. All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the RPR. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

610-3.9 Vibration. Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

610-3.10 Joints. Joints shall be constructed as indicated on the plans.

610-3.11 Finishing. All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated.

610-3.12 Curing and protection. All concrete shall be properly cured in accordance with the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. The concrete shall be protected from damage until project acceptance.

610-3.13 Cold weather placing. When concrete is placed at temperatures below 40°F (4°C), follow the cold weather concreting recommendations found in ACI 306R, Cold Weather Concreting.

610-3.14 Hot weather placing. When concrete is placed in hot weather greater than 85°F (30 °C), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

QUALITY ASSURANCE (QA)

610-4.1 Quality Assurance sampling and testing. Concrete for each day's placement will be accepted on the basis of the compressive strength specified in paragraph 610-3.2. The RPR will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231; make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

610-4.2 Defective work. Any defective work that cannot be satisfactorily repaired as determined by the RPR, shall be removed and replaced at the Contractor's expense. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

METHOD OF MEASUREMENT

610-5.1 Concrete shall be considered incidental, and no separate measurement shall be made of concrete complete in place and accepted.

BASIS OF PAYMENT

610-6.1 Concrete shall be considered incidental, and no separate payment shall be made. This price shall be full compensation for furnishing all materials including reinforcement and embedded items and for all preparation, delivery, installation, and curing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

REFERENCES

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

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars

ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

<u>ASTM C1365</u>	<u>Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis</u>
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

American Concrete Institute (ACI)

ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308R	Guide to External Curing of Concrete
ACI 309R	Guide for Consolidation of Concrete

END OF ITEM P-610

Item P-620 Runway and Taxiway Marking

DESCRIPTION

620-1.1 This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the Resident Project Representative (RPR). The terms “paint” and “marking material” as well as “painting” and “application of markings” are interchangeable throughout this specification.

MATERIALS

620-2.0 PROOF OF BUY AMERICAN NOTICE: All tier contractors and subcontractors shall provide proof of Buy American compliance for all manufactured products in accordance with statutes established under Title 49 U.S.C. Section 50101. The AIP Buy American preference does not recognize US trade agreements such as NAFTA. If upon submittal, sufficient information to confirm compliance is not included, the submittal will be returned with no action.

620-2.1 Materials acceptance. The Contractor shall furnish manufacturer’s certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer’s surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the Resident Project Representative (RPR) prior to the initial application of markings. The reports can be used for material acceptance or the RPR may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the RPR upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the RPR.

620-2.2 Marking materials.

Table 1. Marking Materials

Paint		Glass Beads		
Type	Application Rate	Type I, Gradation A ¹ , Minimum	Type III, Minimum	Type IV, Gradation A ¹ , Minimum
Waterborne Type I or II	115 ft ² /gal	7.0 lb/gal	10 lb/gal	
Waterborne Type III	90 ft ² /gal	7.0 lb/gal	8.0 lb/gal	
Waterborne Type III	55 ft ² /gal		6.0 lb/gal	5.0 lb/gal
Temporary Marking Waterborne Type I or II	230 ft ² /gal	No beads	No beads	No beads

1. Glass bead application rate for Red and Pink paint shall be reduced by 2 lb/gal (0.24 kg/l) for Type I and Type IV beads.

a. Paint. Paint shall be waterborne in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595.

Table 2. Acceptable Paint Color

Paint Color	Fed Std. No 595 Color Number
White	37925
Red	31136
Yellow	33538 or 33655
Black	37038
Pink	1 part 31136 to 2 parts 37925
Green	34108

Waterborne. Paint shall meet the requirements of Federal Specification TT-P-1952F, Type I, Type II or Type III. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis. The acrylic resin used for Type III shall be 100% cross linking acrylic as evidenced by infrared peaks at wavelengths 1568, 1624, and 1672 cm-1 with intensities equal to those produced by an acrylic resin known to be 100% cross linking.

b. Reflective media. Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type I, Gradation A; Type III; or Type IV, Gradation A as specified in the contract documents.

Glass beads for red and pink paint shall meet the requirements for Type I, Gradation A or Type IV, Gradation A as specified. Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

For Type IV, Gradation A beads used with TT-P-1952F, Type III paint, the contractor shall also provide flow promoting, and/or flotation additives in accordance with manufacturer recommendations.

CONSTRUCTION METHODS

620-3.1 Weather limitations. Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations in accordance with paragraph 620-2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer's recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time.

620-3.2 Equipment. Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

620-3.3 Preparation of surfaces. Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminants that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the RPR. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

a. Preparation of new pavement surfaces. The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the RPR to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.

b. Preparation of pavement to remove existing markings. Existing pavement markings shall be removed by rotary grinding, water blasting, or by other methods approved by the RPR minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to ‘block out’ the removal area to eliminate ‘ghost’ markings.

c. Preparation of pavement markings prior to remarking. Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the RPR. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the RPR prior to the initial application of markings.

620-3.4 Layout of markings. The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans.

620-3.5 Application. A period of **30** days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the RPR.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±1/2 inch (12 mm)
greater than 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
greater than 60 feet (18.3 m)	±3 inch (76 mm)

The paint shall be mixed in accordance with the manufacturer’s instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

620-3.6 Application--preformed thermoplastic airport pavement markings.

Preformed thermoplastic pavement markings not used.

620-3.7 Control strip. Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the RPR. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

620-3.8 Retro-reflectance. Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 reading shall be taken over a 6 square foot area with 3 readings taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m ² /lux		
	White	Yellow	Red
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35
All materials, remark when less than ¹	100	75	10

¹ Prior to remarking determine if removal of contaminants on markings will restore retro-reflectance

620-3.9 Protection and cleanup. After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the RPR. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

METHOD OF MEASUREMENT

620-4.1a The quantity of markings shall be paid for shall be measured by the number of square feet (square meters) of painting.

620-4.1b The quantity of temporary markings to be paid for shall be the number of square feet of painting performed in accordance with the specifications and accepted by the RPR. Temporary marking includes surface preparation, application and complete removal of the temporary marking.

BASIS OF PAYMENT

620-5.1 Payment shall be made at the contract unit price per square foot for pavement marking, and pavement marking removal. This price shall be full compensation for furnishing all materials, labor, equipment tools and incidentals necessary to complete the item. The application of the reflective media shall be considered incidental to the item of pavement marking for which is used and no additional compensation will be allowed.

620-5.2b Payment for markings shall be made at the contract price for the number of square feet (square meters) of painting and the number of pounds (kg) of reflective media.

Payment will be made under:

Item AW620520	PAVEMENT MARKING – WATERBORNE – per square foot
Item AW620590	TEMPORARY MARKING – WATERBORNE – per square foot
Item AW620610	PAVEMENT MARKING – SURFACE PAINTED HOLD - per square foot

REFERENCES

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

ASTM International (ASTM)

ASTM D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1652	Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2074	Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D7585	Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments
ASTM E303	Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
ASTM E1710	Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer

ASTM E2302 Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer

ASTM G154 Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

Code of Federal Regulations (CFR)

40 CFR Part 60, Appendix A-7, Method 24
Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

29 CFR Part 1910.1200 Hazard Communication

Federal Specifications (FED SPEC)

FED SPEC TT-B-1325D Beads (Glass Spheres) Retro-Reflective

FED SPEC TT-P-1952F Paint, Traffic and Airfield Marking, Waterborne

FED STD 595 Colors used in Government Procurement

Commercial Item Description

A-A-2886B Paint, Traffic, Solvent Based

Advisory Circulars (AC)

AC 150/5340-1 Standards for Airport Markings

AC 150/5320-12 Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces

END OF ITEM P-620

Part 11 – Drainage

Item D-701 Pipe for Storm Drains and Culverts

DESCRIPTION

701-1.1 This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

701-2.1 Materials shall meet the requirements shown on the plans and specified below. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage shall be noncombustible and inert to fuel in accordance with National Fire Protection Association (NFPA) 415.

701-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C1479	Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
ASTM C1840	Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe

701-2.3 Concrete. Concrete for pipe cradles shall have a minimum compressive strength of 2000 psi (13.8 MPa) at 28 days and conform to the requirements of ASTM C94.

701-2.4 Rubber gaskets. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the “RE” closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

701-2.5 Joint mortar. Not used.

701-2.6 Joint fillers. Poured filler for joints shall conform to the requirements of ASTM D6690.

701-2.7 Plastic gaskets. Not used.

701-2.8. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153. When CLSM is used, all joints shall have gaskets.

701-2.9 Precast box culverts. Manufactured in accordance with and conforming to ASTM C1433.

701-2.10 Precast concrete pipe. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program.

CONSTRUCTION METHODS

701-3.1 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 12 inches (300 mm) on each side. The trench walls shall be approximately vertical.

The Contractor shall comply with all current federal, state and local rules and regulations governing the safety of men and materials during the excavation, installation and backfilling operations. Specifically, the Contractor shall observe that all requirements of the Occupational Safety and Health Administration (OSHA) relating to excavations, trenching and shoring are strictly adhered to. The width of the trench shall be sufficient to permit satisfactorily jointing of the pipe and thorough compaction of the bedding material under the pipe and backfill material around the pipe, but it shall not be greater than the widths shown on the plans trench detail.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inch (200 mm) or 1/2 inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The excavation below grade should be filled with granular material to form a uniform foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

The excavation for pipes placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

701-3.2 Bedding. The bedding surface for the pipe shall provide a foundation of uniform density to support the pipe throughout its entire length.

a. Rigid pipe. The pipe bedding shall be constructed uniformly for the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 in when the bedding thickness is less than 6 inches, and 1-1/2 in when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe.

b. Flexible pipe. For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

Flexible Pipe Bedding

Pipe Corrugation Depth		Minimum Bedding Depth	
inch	mm	inch	mm
1/2	12	1	25
1	25	2	50
2	50	3	75
2-1/2	60	3-1/2	90

c. Other pipe materials. For PVC, polyethylene, polypropylene, or fiberglass pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075

mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

701-3.3 Laying pipe. The pipe laying shall begin at the lowest point of the trench and proceed up grade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing up grade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of the pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

701-3.4 Joining pipe. Joints shall be made with (1) cement mortar, (2) cement grout, (3) rubber gaskets, (4) plastic gaskets, (5) coupling bands.

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

a. Concrete pipe. Concrete pipe may be either bell and spigot or tongue and groove. Pipe sections at joints shall be fully seated and the inner surfaces flush and even. Concrete pipe joints shall be sealed with rubber gaskets meeting ASTM C443 when leak resistant joints are required.

b. Metal pipe. Not Used.

c. PVC, Polyethylene, or Polypropylene pipe. Not Used.

d. Fiberglass pipe. Not Used.

701-3.5 Embedment and Overfill. Pipes shall be inspected before any fill material is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced at the Contractor's expense.

701-3.5-1 Embedment Material Requirements

a. Concrete Pipe. Embedment material and compaction requirements shall be in accordance with the applicable Type of Standard Installation (Types 1, 2, 3, or 4) per ASTM C1479. If a concrete cradle or CLSM embedment material is used, it shall conform to the plan details.

b. Plastic and fiberglass Pipe. Not Used.

c. Metal Pipe. Not Used.

701-3.5-2 Placement of Embedment Material

The embedment material shall be compacted in layers not exceeding 6 inches (150 mm) on each side of the pipe and shall be brought up one foot (30 cm) above the top of the pipe or to natural ground level, whichever is greater. Thoroughly compact the embedment material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on each side of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the embedment material shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. All embedment material shall be compacted to a density required under Item P-152.

Concrete cradles and flowable fills, such as controlled low strength material (CLSM) or controlled density fill (CDF), may be used for embedment provided adequate flotation resistance can be achieved by restraints, weighing, or placement technique.

It shall be the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

701-3.6 Overfill

Pipes shall be inspected before any overfill is in place. Any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be placed and compacted in layers as required to achieve compaction to at least 95 percent standard proctor per ASTM D1557. The soil shall contain no debris, organic matter, frozen material, or stones with a diameter greater than one half the thickness of the compacted layers being placed.

701-3.7 Inspection Requirements

An initial post installation inspection shall be performed by the RPR no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

Incorporate specific inspection requirements for the various types of pipes beneath the general inspection requirements.

Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. The zoom ratio shall be provided for all still or video images that document any issues of concern by the inspection firm.

METHOD OF MEASUREMENT

701-4.1 The length of pipe shall be measured in linear feet (m) of pipe in place, completed, and accepted. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The identify each class, types and size of pipe shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipe being measured.

BASIS OF PAYMENT

701-5.0 These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

701-5.1 Payment will be made at the contract unit price per linear foot (meter) for Reinforced Concrete Pipe, Class IV.

Payment will be made under:

AW701524	24” RCP, Class IV – per linear foot
AW701530	30” RCP, Class IV – per linear foot

REFERENCES

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

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter

ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe

ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C94	Standard Specification for Ready Mixed Concrete
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D3282	Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
National Fire Protection Association (NFPA)	
NFPA 415	Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways

END ITEM D-701

Item D-705 Pipe Underdrains for Airports

DESCRIPTION

705-1.1 This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans. Specifically this item will consist of the underdrain network that will be constructed adjacent to proposed pavement and the network to drain water away from the pavement structure.

MATERIALS

705-2.0 PROOF OF BUY AMERICAN NOTICE: All tier contractors and subcontractors shall provide proof of Buy American compliance for all manufactured products in accordance with statutes established under Title 49 U.S.C. Section 50101. The AIP Buy American preference does not recognize US trade agreements such as NAFTA. If upon submittal, sufficient information to confirm compliance is not included, the submittal will be returned with no action.

705-2.1 General. Materials shall meet the requirements shown on the plans and specified below.

705-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

	American Association of State Highway and Transportation Officials (AASHTO) M196 Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500- mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter
ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C444	Standard Specification for Perforated Concrete Pipe
ASTM C654	Standard Specification for Porous Concrete Pipe
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe

ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F758	Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

705-2.3 Joint mortar. Pipe joint mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

705-2.4 Elastomeric seals. Elastomeric seals shall conform to the requirements of ASTM F477.

705-2.5 Porous backfill. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

Table 1. Gradation of Porous Backfill

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
	Porous Material No. *
1-1/2 inch (37.5 mm)	
1 inch (25.0 mm)	
3/8 inch (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 8 (2.36 mm)	
No. 16 (1.18 mm)	45-80
No. 50 (300 μm)	10-30
No. 100 (150 μm)	0-10

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

705-2.6 Granular material. Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials.

705-2.7 Filter fabric. The filter fabric shall conform to the requirements of AASHTO M288 Class 2 or equivalent.

Table 2. Fabric Properties

Fabric Property	Test Method	Test Requirement
Grab Tensile Strength, lbs	ASTM D4632	125 min
Grab Tensile Elongation %	ASTM D4632	50 min
Burst Strength, psi	ASTM D3785	125 min
Trapezoid Tear Strength, lbs	ASTM D4533	55 min
Puncture Strength, lbs	ASTM D4833	40 min
Abrasion, lbs	ASTM D4886	15 max loss
Equivalent Opening Size	ASTM D4751	70-100
Permittivity sec⁻¹	ASTM D4491	0.80
Accelerated Weathering (UV Stability) (Strength Retained - %)	ASTM D4355 *(500 hrs exposure)	70

705-2.8 Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153. All joints shall have elastomeric seals.

705-2.9 Filter Fabric Sock. Filter fabric sock shall meet the requirements of ASTM D6706.

705-2.10 Collection Structures and Cleanouts. Collection structures and cleanouts shall be constructed in accordance with the applicable sections of item D-751.

CONSTRUCTION METHODS

705-3.1 Equipment. All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the RPR before construction is permitted to start.

705-3.2 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the RPR. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the RPR and compacted to the density of the surrounding material.

The pipe bedding shall be constructed uniformly over the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 inch when the bedding thickness is less than 6 inches, and

1-1/2 inch when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed, uncompacted material under the middle third of the pipe prior to placement of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

705-3.3 Laying and installing pipe.

a. Concrete pipe. The laying of the pipe in the finished trench shall be started at the lowest point and proceed upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and re-laid by the Contractor at no additional expense. Making adjustments in grade by exerting force on the barrel of the pipe with excavating equipment, by lifting and dropping the pipe, or by lifting the pipe and packing bedding material under it shall be prohibited. If the installed pipe section is not to grade, the pipe section shall be completely removed, the grade corrected, and the pipe rejoined.”

b. Metal pipe. The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands that is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

c. PVC, fiberglass, or polyethylene pipe. PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321. Perforations shall meet the requirements of AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade. Fiberglass per ASTM D3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe.

d. All types of pipe. The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the RPR.

Unless otherwise shown on the plans, a 4-inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

e. Filter fabric. The filter fabric shall be installed in accordance with the manufacturer's recommendations, or in accordance with the AASHTO M288 Appendix, unless otherwise shown on the plans.

705-3.4 Mortar. The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

705-3.5 Joints in concrete pipe. When open or partly open joints are required or specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, mortar shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 in Table 1 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches (75 mm) nor more than 6 inches (150 mm), unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2 (Table 1), as shown on the plans or as directed by the RPR.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the RPR.

705-3.6 Embedment and Backfill

a. Earth. All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The embedment material shall be select material from excavation or borrow and shall be approved by the RPR. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and one foot (30 cm) over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the RPR. The material shall be moistened or dried, as required to aid compaction. Placement of the embedment material shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The embedment material shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe. Backfill material over the pipe shall be placed in lifts not exceeding 8 inches (200 mm). Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the RPR, until the trench is completely filled and brought to the planned elevation. Embedment and backfilling shall be done to avoid damaging top or side of the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

b. Granular backfill. When granular backfill is required, placement in the trench and about the pipe shall be as shown on the plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the granular backfill. When required by the RPR, a template shall be used to properly place and separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The granular backfill shall extend to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the

granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

c. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153.

705-3.7 Flexible Pipe Ring Deflection. Not used.

705-3.8 Connections. When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

705-3.9 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the RPR. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

METHOD OF MEASUREMENT

705-4.1 The length of pipe shall be the number of linear feet (meters) of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

705-4.2 Collection structures, cleanouts and connection shall be measured by the unit.

BASIS OF PAYMENT

705-5.1 Pipe underdrains, Complete. Pipe underdrains, complete including porous backfill and filter fabric sock shall be made at the contract unit price per linear foot COMPLETE (including porous backfill and filter fabric).

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

The contract unit price per each for collection structures and cleanouts for underdrains shall be full compensation for furnishing and installing all materials, excavation and for all labor, equipment and tools necessary to complete this item to the satisfaction of the RPR.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

705-5.2 Structures. The accepted quantities of collection structures, cleanouts or connections will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; required to complete the item as shown on the plans: and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

AW705504	4" PERFORATED UNDERDRAIN W/ SOCK – per linear foot.
AW705544	4" NON-PERFORATED UNDERDRAIN – per linear foot.
AW705635	UNDERDRAIN COLLECTION STRUCTURE – per each.
AW705640	UNDERDRAIN CLEANOUT – per each.
AW705645	UNDERDRAIN CONNECTION - per each.

REFERENCES

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

ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C444	Standard Specification for Perforated Concrete Pipe
ASTM C654	Standard Specification for Porous Concrete Pipe
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F758	Standard Specification for Smooth Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M190	Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M288	Standard Specification for Geotextile Specification for Highway Applications
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter
AASHTO	Standard Specifications for Highway Bridges

END OF ITEM D-705

Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the RPR.

MATERIALS

751-2.1 Brick. The brick shall conform to the requirements of ASTM C32, Grade MS.

751-2.2 Mortar. Mortar shall consist of one part Portland cement and two parts sand. The cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

751-2.3 Concrete. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

751-2.4 Precast concrete pipe manhole rings. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

751-2.5 Corrugated metal. Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

751-2.6 Frames, covers, and grates. The castings shall conform to one of the following requirements:

- a. ASTM A48, Class 35B: Gray iron castings
- b. ASTM A47: Malleable iron castings
- c. ASTM A27: Steel castings
- d. ASTM A283, Grade D: Structural steel for grates and frames
- e. ASTM A536, Grade 65-45-12: Ductile iron castings
- f. ASTM A897: Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

751-2.7 Steps. The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of asphalt paint, when directed.

751-2.8 Precast inlet structures. Manufactured in accordance with and conforming to ASTM C913.

CONSTRUCTION METHODS

751-3.1 Unclassified excavation.

a. The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown on the plans, or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the RPR may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the RPR. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. All bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After excavation is completed for each structure, the Contractor shall notify the RPR. No concrete or reinforcing steel shall be placed until the RPR has approved the depth of the excavation and the character of the foundation material.

751-3.2 Brick structures.

a. Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item P-610.

b. Laying brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it that can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and re-laid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

c. Joints. All joints shall be filled with mortar at every course. Exterior faces shall be laid up in advance of backing. Exterior faces shall be plastered or parged with a coat of mortar not less than 3/8 inch (9 mm) thick before the backing is laid up. Prior to parging, all joints on the back of face courses shall be

cut flush. Unless otherwise noted, joints shall be not less than 1/4 inch (6 mm) nor more than 1/2 inch (12 mm) wide and the selected joint width shall be maintained uniform throughout the work.

d. Pointing. Face joints shall be neatly struck, using the weather-struck joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

e. Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing with water. If necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of water.

f. Curing and cold weather protection. The brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost on the brick or when the air temperature is below 50°F (10°C) unless the Contractor has, on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60°F (16°C) for the duration of the curing period.

751-3.3 Concrete structures. Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the RPR before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

751-3.4 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall: (1) be smoothed to a uniform surface on both interior and exterior of the structure or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal or metal encapsulated steps that are embedded or built into the side walls shall be aligned and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 Corrugated metal structures. Corrugated metal structures shall be prefabricated. All standard or special fittings shall be furnished to provide pipe connections or branches with the correct dimensions and of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to allow the fastening of a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, the structures shall be placed on a reinforced concrete base.

751-3.6 Inlet and outlet pipes. Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with

the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

751-3.7 Placement and treatment of castings, frames, and fittings. All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the RPR, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the RPR. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

751-3.8 Installation of steps. The steps shall be installed as indicated on the plans or as directed by the RPR. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least seven (7) days. After seven (7) days, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete structures they shall meet the requirements of ASTM C478. The steps shall be cast into the side of the sections at the time the sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches (300 mm).

Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the RPR.

751-3.9 Backfilling.

a. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

b. Backfill shall not be placed against any structure until approved by the RPR. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

c. Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

751-3.10 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the RPR. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

METHOD OF MEASUREMENT

751-4.1 Manholes, catch basins, inlets, and inspection holes shall be measured by the unit.

BASIS OF PAYMENT

751-5.1 The accepted quantities of manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

AW751410	Inlet – per each
AW751530	Manhole – per each

REFERENCES

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

ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C32	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M36 Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for
Sewers and Drains

END OF ITEM D-751

Part 12 – Turfing

Item T-901 Seeding

DESCRIPTION

901-1.1 This item shall consist of soil preparation, seeding the shoulders and grading areas shown on the plans or as directed by the RPR in accordance with these specifications.

MATERIALS

901-2.1 Seed. The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the RPR duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seeds shall be applied as follows:

Seed Properties and Rate of Application

Seed	Minimum Seed Purity	Minimum Germination	Application Rate of lb/acre
*Tall Fescue	98%	90%	60
Annual Rye	98%	90%	20
*Red Fescue	98%	90%	30
*Hard Fescue	96%	90%	30

*Seed shall be of a variety bred to contain high levels of endophyte.

In locations where poor soil conditions exist, the Resident Engineer may require that Perennial Ryegrass be substituted for the Annual Ryegrass.

Seeding shall be performed during the period between April 1 and June 1 or September 1 and November 1 provided that the ground is not frozen or in any way detrimental to the seed.

If the Contractor elects to use their own seed mixture, the Contractor shall ensure seed recommended is not a hazardous wildlife attractant (high endophyte variety).

901-2.2 Lime. Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 (850 μ m) mesh sieve and 50% will pass through a No. 100 (150 μ m) mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate determined by the Contractor. All liming materials shall conform to the requirements of ASTM C602.

901-2.3 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be spread at the rate determined by the Contractor.

901-2.4 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the RPR before being placed.

CONSTRUCTION METHODS

901-3.1 Advance preparation and cleanup. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 Dry application method.

a. Liming. Lime shall be applied separately and prior to the application of any fertilizer or seed and only on seedbeds that have previously been prepared as described above. The lime shall then be worked

into the top 3 inches (75 mm) of soil after which the seedbed shall again be properly graded and dressed to a smooth finish.

b. Fertilizing. Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity stated in paragraph 901-2.3.

c. Seeding. Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

d. Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

901-3.3 Wet application method.

a. General. The Contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

b. Spraying equipment. The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons (190 liters) over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb / sq inches (690 kPa). The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch (16 mm) solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length shall be provided to which the nozzles may be connected.

c. Mixtures. Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds (100 kg) of lime shall be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds (100 kg) of these combined solids shall be added to and mixed with each 100 gallons (380 liters) of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. The Contractor shall identify to the RPR all sources of water at least two (2) weeks prior to use. The RPR may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor shall not use any water from any source that is disapproved by the RPR following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

d. Spraying. Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches (75 mm), after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces that are to be mulched as indicated by the plans or designated by the RPR, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

901-3.4 Maintenance of seeded areas. The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the RPR. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the RPR. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded.

METHOD OF MEASUREMENT

901-4.1 The quantity of seeding to be paid for shall be the number of units acre (sq m) measured on the ground surface, completed and accepted.

BASIS OF PAYMENT

901-5.1 Payment shall be made at the contract unit price per acre (sq m) or fraction thereof, which price and payment shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Payment will be made under:

Item AW901510 SEEDING, per acre

REFERENCES

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

ASTM International (ASTM)

ASTM C602 Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-901

Item T-904 Sodding

DESCRIPTION

904-1.1 This item shall consist of furnishing, hauling, and placing approved live sod on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the RPR.

MATERIALS

904-2.1 Sod. Sod furnished by the Contractor shall have a good cover of living or growing grass. This shall be interpreted to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted turf relatively free of weeds or other undesirable foreign plants, large stones, roots, or other materials that might be detrimental to the development of the sod or to future maintenance. At least 70% of the plants in the cut sod shall be composed of the species stated in the special provisions, and any vegetation more than 6 inches (150 mm) in height shall be mowed to a height of 3 inches (75 mm) or less before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness not less than that stated in the special provisions.

904-2.2 Lime. Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 (850 μ m) mesh sieve and 50% will pass through a No. 100 (150 μ m) mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate determined by the Contractor. All liming materials shall conform to the requirements of ASTM C602.

904-2.3 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be spread at the rate determined by the Contractor.

904-2.4 Water. The water shall be sufficiently free from oil, acid, alkali, salt, or other harmful materials that would inhibit the growth of grass.

904-2.5 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free

from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the RPR before being placed.

CONSTRUCTION METHODS

904-3.1 General. Areas to be solid, strip, or spot sodded shall be shown on the plans. Areas requiring special ground surface preparation such as tilling and those areas in a satisfactory condition that are to remain undisturbed shall also be shown on the plans.

Suitable equipment necessary for proper preparation of the ground surface and for the handling and placing of all required materials shall be on hand, in good condition, and shall be approved by the RPR before the various operations are started. The Contractor shall demonstrate to the RPR before starting the various operations that the application of required materials will be made at the specified rates.

904-3.2 Preparing the ground surface. After grading of areas has been completed and before applying fertilizer and limestone, areas to be sodded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris which might interfere with sodding, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes occurs after grading of areas and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

904-3.3 Applying fertilizer and ground limestone. Following ground surface preparation, fertilizer shall be uniformly spread at a rate which will provide not less than the minimum quantity of each fertilizer ingredient, as stated in the special provisions. If use of ground limestone is required, it shall then be spread at a rate that will provide not less than the minimum quantity stated in the special provisions. These materials shall be incorporated into the soil to a depth of not less than 2 inches (50 mm) by discing, raking, or other suitable methods. Any stones larger than 2 inches (50 mm) in any diameter, large clods, roots, and other litter brought to the surface by this operation shall be removed.

904-3.4 Obtaining and delivering sod. After inspection and approval of the source of sod by the RPR, the sod shall be cut with approved sod cutters to such a thickness that after it has been transported and placed on the prepared bed, but before it has been compacted, it shall have a uniform thickness of not less than 2 inches (50 mm). Sod sections or strips shall be cut in uniform widths, not less than 10 inches (250 mm), and in lengths of not less than 18 inches (0.5 m), but of such length as may be readily lifted without breaking, tearing, or loss of soil. Where strips are required, the sod must be rolled without damage with the grass folded inside. The Contractor may be required to mow high grass before cutting sod.

The sod shall be transplanted within 24 hours from the time it is stripped, unless circumstances beyond the Contractor's control make storing necessary. In such cases, sod shall be stacked, kept moist, and protected from exposure to the air and sun and shall be kept from freezing. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. Where the soil is too dry, approval to cut sod may be granted only after it has been watered sufficiently to moisten the soil to the depth the sod is to be cut.

904-3.5 Laying sod. Sodding shall be performed only during the seasons when satisfactory results can be expected. Frozen sod shall not be used and sod shall not be placed upon frozen soil. Sod may be transplanted during periods of drought with the approval of the RPR, provided the sod bed is watered to moisten the soil to a depth of at least 4 inches (100 mm) immediately prior to laying the sod.

The sod shall be moist and shall be placed on a moist earth bed. Pitch forks shall not be used to handle sod, and dumping from vehicles shall not be permitted. The sod shall be carefully placed by hand, edge to edge and with staggered joints, in rows at right angles to the slopes, commencing at the base of the area to be sodded and working upward. The sod shall immediately be pressed firmly into contact with the sod

bed by tamping or rolling with approved equipment to provide a true and even surface, and ensure knitting without displacement of the sod or deformation of the surfaces of sodded areas. Where the sod may be displaced during sodding operations, the workmen, when replacing it, shall work from ladders or treaded planks to prevent further displacement. Screened soil of good quality shall be used to fill all cracks between sods. The quantity of the fill soil shall not cause smothering of the grass. Where the grades are such that the flow of water will be from paved surfaces across sodded areas, the surface of the soil in the sod after compaction shall be set approximately one inch (25 mm) below the pavement edge. Where the flow will be over the sodded areas and onto the paved surfaces around manholes and inlets, the surface of the soil in the sod after compaction shall be placed flush with pavement edges.

On slopes steeper than one (1) vertical to 2-1/2 horizontal and in v-shaped or flat-bottom ditches or gutters, the sod shall be pegged with wooden pegs not less than 12 inches (300 mm) in length and have a cross-sectional area of not less than 3/4 sq inch (18 sq mm). The pegs shall be driven flush with the surface of the sod.

904-3.6 Watering. Adequate water and watering equipment must be on hand before sodding begins, and sod shall be kept moist until it has become established and its continued growth assured. In all cases, watering shall be done in a manner that will avoid erosion from the application of excessive quantities and will avoid damage to the finished surface.

904-3.7 Establishing turf. The Contractor shall provide general care for the sodded areas as soon as the sod has been laid and shall continue until final inspection and acceptance of the work. All sodded areas shall be protected against traffic or other use by warning signs or barricades approved by the RPR. The Contractor shall mow the sodded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. Weeds or other undesirable vegetation shall be mowed and the clippings raked and removed from the area.

904-3.8 Repairing. When the surface has become gullied or otherwise damaged during the period covered by this contract, the affected areas shall be repaired to re-establish the grade and the condition of the soil, as directed by the RPR, and shall then be sodded as specified in paragraph 904-3.5.

METHOD OF MEASUREMENT

904-4.1 This item shall be measured on the basis of the area in square yards (square meters) of the surface covered with sod and accepted.

BASIS OF PAYMENT

904-5.1 This item will be paid for on the basis of the contract unit price per square yard (square meter) for sodding, which price shall be full compensation for all labor, equipment, material, staking, and incidentals necessary to satisfactorily complete the items as specified.

Payment will be made under:

Item AW904510

SODDING – per square yard.

REFERENCES

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

ASTM International (ASTM)

ASTM C602

Standard Specification for Agricultural Liming Materials

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-904

Item T-908 Mulching

DESCRIPTION

908-1.1 This item shall consist of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or designated by the RPR.

MATERIALS

908-2.1 Mulch material. Acceptable mulch shall be the material listed below or any approved locally available material that is similar to those specified. Mulch shall be free from noxious weeds, mold, and other deleterious materials. Mulch materials, which contain matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farmland, will not be acceptable.

- a. Manufactured mulch .** Cellulose-fiber or wood-pulp mulch shall be products commercially available for use in spray applications.

The mulch component shall be comprised of a minimum of 70% biodegradable material such as wood cellulose, paper fibers, straw or cotton and shall contain no growth or germination inhibiting factors. The remainder of the components shall consist of the manufacturer's choice of tackifiers and/or strengthening fibers needed to meet the performance specifications. Tackifiers shall be non-toxic and LC 50 test results shall be provided along with the certificate of analysis (COA). Hydraulic mulch shall disperse evenly and rapidly and remain in slurry when agitated with water. When uniformly applied, the slurry shall form an absorbent cover allowing percolation of water to the underlying surface. Hydraulic mulch shall be packaged in UV and moisture resistant factory labeled packages or bags with the net quantity of the packaged material plainly shown on each package. The biodegradable material shall be relatively free of glossy papers and shall not be water soluble. The hydraulic mulches shall be according to the following.

Light-Duty Hydraulic Mulch

Property ¹	Value
Functional Longevity ²	3 Months
Typical Maximum Slope Gradient (V:H)	< 1:3
Maximum Uninterrupted Slope Length	50 Feet
Maximum C Factor	0.15
Minimum Vegetation Establishment ³	200%

1. This table sets minimum requirements only. Refer to manufacturer recommendations for application rates, instructions, gradients, maximum continuous slope lengths and other site specific recommendations.

2. Manufacturer's estimated time period, based upon field observations, that a material can be anticipated to provide erosion control as influenced by its composition and site-specific conditions.
3. Minimum vegetation establishment shall be calculated according to ASTM D7322.

The certificate of analysis (COA) shall be provided with each shipment of hydraulic mulch stating the number of packages or bags furnished and that the material complies with these requirements.

908-2.2 Inspection. The RPR shall be notified of sources and quantities of mulch materials available and the Contractor shall furnish him with representative samples of the materials to be used 30 days before delivery to the project. These samples may be used as standards with the approval of the RPR and any materials brought on the site that do not meet these standards shall be rejected.

CONSTRUCTION METHODS

908-3.1 Mulching. Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.

Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the RPR. Other organic material shall be spread at the rate directed by the RPR. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose will be permitted to the extent that at least 95% of the mulch in place on the slope shall be 6 inches (150 mm) or more in length.

908-3.2 Securing mulch. Not used.

908-3.3 Care and repair.

a. The Contractor shall care for the mulched areas until final acceptance of the project. Care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the RPR, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

b. The Contractor shall be required to repair or replace any mulch that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the RPR, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the Contractor.

METHOD OF MEASUREMENT

908-4.1 Mulching shall be measured in acres on the basis of the actual surface area acceptably mulched.

BASIS OF PAYMENT

908-5.1 Payment will be made at the contract unit price per acre for mulching. The price shall be full compensation for furnishing all materials and for placing and anchoring the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item AW908514 LIGHT-DUTY HYDRAULIC MULCH, per acre

REFERENCES

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

ASTM International (ASTM)

ASTM D977 Standard Specification for Emulsified Asphalt

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-908

Item L-107 Airport Wind Cones

DESCRIPTION

107-1.1 This item shall consist of removal of existing airport wind cones; furnishing and installing an airport wind cone per these specifications and per the dimensions, design, and details shown in the plans.

The work shall include the furnishing and installation of a support for mounting the wind cone, the specified interconnecting wire, and a concrete foundation. The item shall also include all cable connections, conduit power pedestal with disconnect, photocell, transformer and conduit fittings, the furnishing and installation of all lamps, ground rod and ground connection, the testing of the installation, and all incidentals necessary to place the wind cone in operation (as a completed unit) to the satisfaction of the RPR.

EQUIPMENT AND MATERIALS

PROOF OF BUY AMERICAN NOTICE: All tier contractors and subcontractors shall provide proof of Buy American compliance for all manufactured products in accordance with statutes established under Title 49 U.S.C. Section 50101. The AIP Buy American preference does not recognize US trade agreements such as NAFTA or the American Recovery and Reinvestment Act. If, upon submittal sufficient information to confirm compliance is not included, the submittal will be returned with no action.

107-2.1 General.

a. Airport lighting equipment and materials covered by advisory circulars (ACs) shall be certified in AC 150/5345-53, Airport Lighting Equipment Certification Program (ALECP) and listed in the ALECP Addendum.

b. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the RPR.

c. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications, at the Contractor's cost.

d. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

e. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be in electronic pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures, that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

107-2.2 Wind cones. The supplemental wind cone assembly shall be Type L 806 (LED), Style 1-A, Size 1.

107-2.3 Electrical wire and cable. Cable rated up to 5,000 volts in conduit shall conform to AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits. For ratings up to 600 volts, moisture and heat resistant thermoplastic wire conforming to Commercial Item Description A-A-59544A Type THWN-2 shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

107-2.4 Conduit. Rigid steel conduit and fittings shall conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242.

107-2.5 Plastic conduit (for use below grade only). Plastic conduit and fittings shall be per the following:

- UL 514B covers W-C-1094 - Conduit fittings all types, Classes 1 thru 3 and 6 thru 10
- UL 514C covers W-C-1094 - all types, Class 5 junction box and cover in plastic (polyvinyl chloride (PVC))
- UL 651 covers W-C-1094 - Rigid PVC Conduit, types I and II, Class 4
- UL 651A covers W-C-1094 - Rigid PVC Conduit and high-density polyethylene (HDPE) Conduit type III and Class 4

Underwriters Laboratories Standard UL-651 shall be one of the following, as shown in the plans:

- a. Type I–Schedule 40 PVC suitable for underground use either direct-buried or encased in concrete.
- b. Type II–Schedule 40 PVC suitable for either above ground or underground use.

Plastic conduit adhesive shall be a solvent cement manufactured specifically for the purpose of gluing the type of plastic conduit and fitting.

107-2.6 Concrete. The concrete for foundations shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

107-2.7 Paint.

a. Priming paint for non-galvanized metal surfaces shall be a high solids alkyd primer compatible with the manufacturer's recommendations for the intermediate or topcoat.

b. Priming paint for galvanized metal surfaces shall be zinc dust-zinc oxide primer paint conforming to MIL-DTL-24441C/19B. Use MIL-24441 thinner per paint manufacturer's recommendations.

c. Orange paint for the body and the finish coats on metal and wood surfaces shall consist of a ready-mixed non-fading paint per Master Painter's Institute (MPI) Reference #9 (gloss). The color shall be per Federal Standards 595, International Orange, Number 12197.

d. White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to the MPI, Reference #9, Exterior Alkyd, Gloss.

e. Priming paint for wood surfaces shall be mixed on the job by thinning the above specified aviation-orange or white paint by adding 1/2 pint (0.24 liter) of raw linseed oil to each gallon (liter).

CONSTRUCTION METHODS

107-3.1 Installation. The windcone pole with frangible coupling shall be installed on a concrete foundation per the plans.

107-3.2 Support pole erection. The Contractor shall erect the pole on the foundation following the manufacturer's requirements and erection details. The pole shall be level and secure.

107-3.3 Electrical connection. The Contractor shall furnish all labor and materials and shall make complete electrical connections per the wiring diagram furnished with the project plans. The electrical installation shall conform to the requirements of the latest edition of National Fire Protection Association, NFPA-70, National Electric Code (NEC).

Underground cable and duct for cable installation shall be installed in accordance with Item L-108, Underground Power Cables for Airports, and Item L-110, Airport Underground Electrical Duct Banks and Conduits in locations as shown on the plans.

107-3.4 Power Pedestal. The Contractor shall furnish all labor and materials for the installation of power pedestal for windcone as detailed on the plans and specified herein. The power pedestal shall include but not limited to support, concrete foundation, 480V disconnect, photocell and 480-120/240V step down transformer. All equipment for power pedestal shall be suitable of outdoor installation in NEMA 3R enclosures. Power pedestal shall be mounted on frangible coupling.

107-3.5 Ground connection and ground rod. The Contractor shall furnish and install a ground rod, grounding cable, and ground clamps for grounding the "A" frame of the 12-foot (3.7-m) assembly or pipe support of the 8-foot (2.4-m) support near the base. The ground rod shall be of the type, diameter and length specified in Item L-108, Underground Power Cable for Airports. The ground rod shall be driven into the ground adjacent to the concrete foundation (minimum distance from foundation of 2 feet (60 cm)) so that the top is at least 6 inches (150 mm) below grade. The grounding cable shall consist of No. 6 American wire gauge (AWG) minimum stranded copper wire or larger and shall be firmly attached to the ground rod by exothermic welding. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. The other end of the grounding cable shall be securely attached to a leg of the frame or to the base of the pipe support with non-corrosive metal and shall be of substantial construction. The resistance to ground shall not exceed 25 ohms. If a single rod grounding electrode has a resistance to earth of over 25 ohms, then install one supplemental rod not less than 10 feet from the first rod. If desired resistance to ground levels are still not achieved, see FAA-STD-019 for guidance on the application of coke breeze.

107-3.6 Painting. Three coats of paint shall be applied (one prime, one body, and one finish) to all exposed material installed under this item except the fabric cone, obstruction light globe, and lamp reflectors. The wind cone assembly, if already painted upon receipt, shall be given one finish coat of paint in lieu of the three coats specified above. The paint shall be per MPI Reference #9 (gloss). The color shall be per Federal Standard 595, International Orange, Number 12197.

107-3.7 Light sources. The Contractor shall furnish and install lamps (LED) per the manufacturer's instruction book.

107-3.8 Chain and padlock. The Contractor shall furnish and install a suitable operating chain for lowering and raising the hinged top section. The chain shall be attached to the pole support in a manner to prevent the light fixture assembly from striking the ground in the lowered position.

A padlock shall also be furnished by the Contractor on the 8-foot (2.4-m) wind cone for securing the hinged top section to the fixed lower section. Keys for the padlock shall be delivered to the RPR.

107-3.9 Segmented circle. Not used.

METHOD OF MEASUREMENT

107-4.1 The quantity to be paid shall be the number of wind cones installed as completed units in place, accepted, and ready for operation. This item shall also include all components of power pedestal, including but not limited to support, foundation, photocell, disconnects, transformer, grounding, frangible coupling and all required items for a complete and operational system.

BASIS OF PAYMENT

107-5.1 Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for removal of existing airport wind cones; furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item AW107408	L-806 WIND CONE -8' LIGHTED, per each
Item AW107900	REMOVE WIND CONE, per each

REFERENCES

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

Advisory Circulars (AC)

AC 150/5340-5	Segmented Circle Airport Marker System
AC 150/5340-30	Design and Installation Details for airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-27	Specification for Wind Cone Assemblies
AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description

A-A-59544	Cable and Wire, Electrical (Power, Fixed Installation)
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Federal Standard (FED STD)

FED STD 595	Colors Used in Government Procurement
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Master Painter's Institute (MPI)

MPI Reference #9	Alkyd, Exterior, Gloss (MPI Gloss Level 6)
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Mil Standard

MIL-DTL-24441C/19B Paint, Epoxy-Polyamide, Zinc Primer, Formula 159, Type III

Underwriters Laboratories (UL)

UL Standard 6	Electrical Rigid Metal Conduit – Steel
UL Standard 514B	Conduit, Tubing, and Cable Fittings
UL Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit
UL Standard 1242	Electrical Intermediate Metal Conduit - Steel

National Fire Protection Association (NFPA)

NFPA-70	National Electric Code (NEC)
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END OF ITEM L-107

Item L-108 Underground Power Cable for Airports

DESCRIPTION

108-1.1 This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the RPR. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities.

Specifically, this item shall cover the installation of underground cables for the following items:

- PAPI cable for the Airport owned PAPI unit.
- RTR control cable for the FAA owned RTR system.
- RTR guard wire for RTR control cable.
- Wind Cone cable for the new supplementary wind cone.
- Underground cable for the taxiway lighting circuits.
- Counterpoise for the protection of the lighting circuits.

EQUIPMENT AND MATERIALS

PROOF OF BUY AMERICAN NOTICE: All tier contractors and subcontractors shall provide proof of Buy American compliance for all manufactured products in accordance with statutes established under Title 49 U.S.C. Section 50101. The AIP Buy American preference does not recognize US trade agreements such as NAFTA. If, upon submittal sufficient information to confirm compliance is not included, the submittal will be returned with no action.

108-2.1 General.

a. Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.

b. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the RPR.

c. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

d. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment

and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

e. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format. The RPR reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. The Contractor shall maintain a minimum insulation resistance in accordance with paragraph 108-3.10e with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period when tested in accordance with AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

108-2.2 Cable. Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge (AWG), L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 Type C, 5,000 volts, non-shielded, with cross-linked polyethylene insulation. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Commercial Item Description A-A-59544A and shall be type XLP-USE, 75°C for installation in conduit and RHW-2, 75°C for direct burial installations. Conductors for parallel (voltage) circuits shall be type and size and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, XLP-USE, 600-volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of XLP-USE, 600-volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors, pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

108-2.3 Bare copper wire (counterpoise, bare copper wire ground and ground rods). Wire for counterpoise or ground installations for airfield lighting systems shall be No. 6 AWG bare solid copper wire for counterpoise and/or No. 6 AWG insulated stranded for grounding bond wire per ASTM B3 and

ASTM B8, and shall be bare copper wire. For voltage powered circuits, the equipment grounding conductor shall comply with NEC Article 250.

Ground rods shall be copper-clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 10 feet long and 3/4 inch in diameter.

108-2.4 Cable connections. In-line connections or splices of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

a. The cast splice. A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M™ Company, “Scotchcast” Kit No. 82-B, or an approved equivalent, used for potting the splice is acceptable.

b. The field-attached plug-in splice. Field attached plug-in splices shall be installed as shown on the plans. The Contractor shall determine the outside diameter of the cable to be spliced and furnish appropriately sized connector kits and/or adapters. Tape or heat shrink tubing with integral sealant shall be in accordance with the manufacturer’s requirements. Primary Connector Kits manufactured by Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.

c. The factory-molded plug-in splice. Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

d. The taped or heat-shrink splice. Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits that are designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made per the manufacturer’s recommendations and listings.

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. All exothermic connections shall be made per the manufacturer’s recommendations and listings.

108-2.5 Splicer qualifications. Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the RPR proof of the qualifications of each proposed cable splicer for the airport cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splicing medium voltage cable.

108-2.6 Concrete. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

108-2.7 Flowable backfill. Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

108-2.8 Cable identification tags. Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

108-2.9 Tape. Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

108-2.10 Electrical coating. Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

108-2.11 Existing circuits. Whenever the scope of work requires connection to an existing circuit, the existing circuit's insulation resistance shall be tested, in the presence of the RPR. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the RPR. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the RPR. The Contractor shall record the results on forms acceptable to the RPR. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the existing circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

108-2.12 Detectable warning tape. Plastic, detectable, American Public Works Association (APWA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables shall be orange. Detectable warning tape color code shall comply with the APWA Uniform Color Code.

108-2.13 Unit Duct. New cabling for runway and taxiway circuits shall be installed in unit duct. The plans indicate where two-conductor and single-conductor cabling is to be installed. Two-conductor applications shall be installed in 1" (inside diameter) unit duct. Single-conductor applications shall be installed in 3/4" (inside diameter) unit duct. The duct shall comply with NEMA Standards Publication No. TC7-1990, Part 4, ASTM D 3485, and ASTM D 3350, with additions, options, and exceptions as detailed herein. The duct shall be annealed during the extrusion process. The duct shall be manufactured from black, virgin, high density polyethylene resin.

108-2.14 PAPI Cable. New PAPI cable shall be spliced into existing PAPI cable inside new splice can and relocated as shown on the plans. Existing cable is 3- 1/C #2, 600V, Type USE, 1-1/C #8 Ground. Contractor shall verify cable type of existing prior to installation of new cable splice. Cable shall be installed in 1 1/2" unit duct.

108-2.15 RTR Cable. New RVR cable to be spliced at location shown on the plans and shall be 1-50 PR#19 Control Cable, 1#0 Bare Copper Guard Wire with ground rods installed every 90' when in turf (compliance with FAA-STD-019F).

1-50 PR#19 control cable used in this installation shall be copper of the type and size shown on the plans and in accordance with FAA-GL-918D, Division 16 – Electrical in Appendix A. Aluminum wire will not be allowed.

FAA Specifications FAA-GL-918D, *Specification for Construction of Terminal Navigational Facilities*, FAA-STD-019f, *Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*, FAA Supplemental Specifications and FAA Special Specifications are included as Appendix A. In the event of conflicts between the FAA Specifications and this Special Provision, the Appendix A FAA Specifications shall govern, unless otherwise approved by the FAA.

108-2.16 Wind Cone Cable. New cabling for the wind cone circuit shall be 2-1/C#6 USE, 1-1/C#8 Ground, Direct Buried in 1” unit duct. Wind Cone cable shall connect to New 20A, 2P circuit breaker at existing power panel at the Airfield Lighting Vault.

CONSTRUCTION METHODS

108-3.1 General. The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Cable shall be run without splices, from fixture to fixture.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections unless otherwise authorized in writing by the RPR or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

Provide not less than 3 feet (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the RPR.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, hand holes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

108-3.2 Installation in duct banks or conduits. This item includes the installation of the cable in duct banks or conduit per the following paragraphs. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be per the latest version of the National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any

reason shall be re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the RPR of any blockage in the existing ducts.

The cable shall be installed in a manner that prevents harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended pulling tension values to the RPR prior to any cable installation. If required by the RPR, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the RPR. Cable pull tensions shall be recorded by the Contractor and reviewed by the RPR. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) shall apply. Cable installation, handling and storage shall be per manufacturer's recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the RPR, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

108-3.3 Installation of direct-buried cable in trenches. Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S curves. Sharp bends or kinks in the cable shall not be permitted.

Where cables must cross over each other, a minimum of 3 inches (75 mm) vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

a. Trenching. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 inches (0.5 m) below finished grade per NEC Table 300.5, except as follows:

- When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches (91 cm) unless otherwise specified.
- Minimum cable depth when crossing under a railroad track, shall be 42 inches (1 m) unless otherwise specified.

The Contractor shall excavate all cable trenches to a width not less than 6 inches (150 mm). Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill material may alternatively be used.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

(1) Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.

(2) Trenching, etc., in cable areas shall then proceed, with approval of the RPR, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

b. Backfilling. After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall encompass all cables ; be 3 inches (75 mm) deep, loose measurement; and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. This layer shall not be compacted. The second layer shall be 5 inches (125 mm) deep, loose measurement, and shall contain no particles that would be retained on a one inch (25.0 mm) sieve. The remaining third and subsequent layers of backfill shall not exceed 8 inches (20 cm) of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches (100 mm) maximum diameter.

The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent material. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be backfill with controlled low strength material (CLSM) in accordance with P-153.

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turfing operation to be accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of per the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the RPR. If not shown on the plans, the warning tape shall be located 6 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. A 3-6 inch (75 - 150 mm) wide polyethylene film detectable tape, with a metalized foil core, shall be installed above all direct buried cable or counterpoise. The tape shall be of the color and have a continuous legend as indicated on the plans. The tape shall be installed 8 inches (200 mm) minimum below finished grade.

c. Restoration. Following restoration of all trenching near airport movement surfaces, the Contractor shall visually inspect the area for foreign object debris (FOD) and remove any that is found. Where soil

and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the seeding as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration shall be equal to existing conditions. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be backfill with controlled low strength material (CLSM) in accordance with P-153. Restoration shall be considered incidental to the pay item of which it is a component part.

108-3.4 Cable markers for direct-buried cable. The location of direct buried circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4-6 inch (10 - 15 cm) thick, extending approximately one inch (25 mm) above the surface. Each cable run from a line of lights and signs to the equipment vault shall be marked at approximately every 200 feet (61 m) along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed directly above the cable. The Contractor shall impress the word “CABLE” and directional arrows on each cable marking slab. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep. Stencils shall be used for cable marker lettering; no hand lettering shall be permitted.

At the location of each underground cable connection/splice, except at lighting units, or isolation transformers, a concrete marker slab shall be installed to mark the location of the connection/splice. The Contractor shall impress the word “SPLICE” on each slab. The Contractor also shall impress additional circuit identification symbols on each slab as directed by the RPR. All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete. After placement, all cable or splice markers shall be given one coat of high-visibility aviation orange paint as approved by the RPR. Furnishing and installation of cable markers is incidental to the respective cable pay item.

108-3.5 Splicing. Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

a. Cast splices. These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured per the manufacturer’s instructions and to the satisfaction of the RPR.

b. Field-attached plug-in splices. These shall be assembled per the manufacturer’s instructions. These splices shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint or (3) On connector kits equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

c. Factory-molded plug-in splices. These shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) Wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint. (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint. or (3) On connector kits so equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

d. Taped or heat-shrink splices. A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6

mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. The manufacturer's recommendation for stretching tape during splicing shall be followed. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer's instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminants prior to application.

e. Assembly. Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

108-3.6 Bare counterpoise wire installation for lightning protection and grounding. If shown on the plans or included in the job specifications, bare solid #6 AWG copper counterpoise wire shall be installed for lightning protection of the underground cables. The RPR shall select one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

The guard wire for FAA owned RTR cable shall be 1/C#1/0 AWG as specified and in compliance with FAA-STD-019f.

a. Equipotential. – may be used by the RPR for areas that have high rates of lightning strikes. The counterpoise size is determined by the RPR. The equipotential method is applicable to all airfield lighting systems; i.e. runway, taxiway, apron – touchdown zone, centerline, edge, threshold and approach lighting systems. The equipotential method is also successfully applied to provide lightning protection for power, signal and communication systems. The light bases, counterpoise, etc – all components - are bonded together and bonded to the vault power system ground loop/electrode.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. The counterpoise is centered over the cable/conduit/duct to be protected.

The counterpoise conductor shall be installed no less than 8 inches (200 mm) minimum or 12 inches (300 mm) maximum above the raceway or cable to be protected, except as permitted below:

(1) The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

(2) The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90 degree angle).

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

All components rise and fall at the same potential; with no potential difference, no damaging arcing and no damaging current flow.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Equipotential Method of lightning protection.

Reference FAA STD-019F, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.

b. Isolation – used in areas where lightning strikes are not common. Counterpoise size is selected by the RPR. The isolation method is an alternate method for use only with edge lights installed in turf and stabilized soils and raceways installed parallel to and adjacent to the edge of the pavement. NFPA 780 uses 15 feet to define “adjacent to”.

The counterpoise conductor shall be installed halfway between the pavement edge and the light base, mounting stake, raceway, or cable being protected.

The counterpoise conductor shall be installed 8 inches (203 mm) minimum below grade. The counterpoise is not connected to the light base or mounting stake. An additional grounding electrode is required at each light base or mounting stake. The grounding electrode is bonded to the light base or mounting stake with a 6 AWG solid copper conductor.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Isolation Method of lightning protection.

c. Common Installation requirements. When a metallic light base is used, the grounding electrode shall be bonded to the metallic light base or mounting stake with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

When a nonmetallic light base is used, the grounding electrode shall be bonded to the metallic light fixture or metallic base plate with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

Grounding electrodes may be rods, ground dissipation plates, radials, or other electrodes listed in the NFPA 70 (NEC) or NFPA 780.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

d. Parallel Voltage Systems. Provide grounding and bonding in accordance with NFPA 70, National Electrical Code.

108-3.7 Counterpoise installation above multiple conduits and duct banks. Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete area of protection measured 45 degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

108-3.8 Counterpoise installation at existing duct banks. When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

108-3.9 Exothermic bonding. Bonding of counterpoise wire shall be by the exothermic welding process or equivalent method accepted by the RPR. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the RPR, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:

a. All slag shall be removed from welds.

b. Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See AC 150/5340-30 for galvanized light base exception.

c. If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

108-3.10 Testing. The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the RPR. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the RPR. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

a. Earth resistance testing methods shall be submitted to the RPR for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the RPR. All such testing shall be at the sole expense of the Contractor.

b. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The RPR shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

After installation, the Contractor shall test and demonstrate to the satisfaction of the RPR the following:

- c. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.
- d. That all affected circuits (existing and new) are free from unspecified grounds.
- e. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than 100 megohms. Verify continuity of all series airfield lighting circuits prior to energization.
- f. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.
- g. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.
- h. That all affected circuits (existing and new) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.
- i. That the impedance to ground of each ground rod does not exceed 25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the RPR prior to performing the testing.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the RPR. Where connecting new cable to existing cable, insulation resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved “repair” procedures for items that have failed testing other than complete replacement.

108-3.11 RTR Cable Installation. All work on the FAA owned RTR cable shall be coordinated with the local FAA SSC. Contractor shall provide meggar readings before and after the installation of the cable. Meggar testing shall be end to end testing of the cable. Contractor shall terminate the cable at the existing location in the Air Traffic Control Cable. RTR communication shall not be down for more than 48 hours during the replacement and termination of the cables. Existing RTR cable shall remain active until the contractor is capable of installing and terminating the new cabling.

The Contractor shall remove existing (unused) 2- 25PR#19 control cables from existing conduits, cable tray and chase to install new 1-50PR#19 cable prior to the disconnection and removal of the existing 1-50PR#19 cable to minimize downtime. New cable shall be terminated inside the FAA cabinet in ATCT as directed and approved by FAA. New cable termination shall match with existing cable color coding at both end of the new cable. The Contractor shall provide all testing, termination, removal of existing cables, labeling of new cables and coordination with FAA. All work associated with the installation of the new cable shall be in strict accordance with FAA-GL-918 and FAA-STD-019F specifications.

METHOD OF MEASUREMENT

108-4.1 Single-Conductor #8 5KV Cable in ¾” Unit Duct shall be measured by the number of linear feet of cable and unit duct installed with grounding connectors, trench marking tape, cable markers, ready for operation, and accepted as proven to be compatible with new electrical equipment and existing regulator

equipment at the vault. The measurement shall be the total length of cable installed inside the unit duct. Cable slack is considered incidental to this item and will not be measured for payment.

108-4.2 Two-Conductor #8 5KV Cable in 1” Unit Duct shall be measured by the number of linear feet of cable and unit duct installed with grounding connectors, trench marking tape, cable markers, ready for operation, and accepted as proven to be compatible with new electrical equipment and existing regulator equipment at the vault. The measurement shall be the total length of cable installed inside the unit duct. Cable slack is considered incidental to this item and will not be measured for payment.

108-4.3 PAPI cable shall be measured by the number of linear feet of cable and unit duct installed with grounding connectors, splicing, trench marking tape, cable markers, ready for operation, and accepted as proven to be compatible with new electrical equipment and existing regulator equipment at the vault. The measurement be the total length of cable installed inside the unit duct. Cable slack is considered incidental to this item and will not be measured for payment.

108-4.4 RTR cable shall be measured by the number of linear feet of cable installed with guard wire, ground rods, grounding connectors, trench marking tape, cable markers, ready for operation, and accepted by FAA and RPR and in compliance with FAA-GL-918 and FAA-STD-019F specifications. The measurement be the total length of cable installed with guard wire and ground rods. The removal of existing FAA control cables from conduits, cable tray and chase will not be measured for payment and it shall be included in this pay item. The installation of cable inside FAA ATCT, termination, testing and coordination with FAA will not be measured for payment and it shall be included in this pay item. Cable slack is considered incidental to this item and will not be measured for payment.

108-4.5 Wind Cone cable shall be measured by the number of linear feet of cable and unit duct installed with grounding connectors, trench marking tape, cable markers, ready for operation, and accepted as proven to be compatible with new electrical equipment and power panel at the vault. The measurement be the total length of cable installed inside the unit duct. Cable slack is considered incidental to this item and will not be measured for payment.

108-4.6 Counterpoise cable shall be measured by the number of linear feet of cable installed with grounding connectors, ground rods, trench marking tape, cable markers, ready for operation, and accepted as proven to be compatible with new electrical equipment. The measurement be the total length of counterpoise installed with ground rods.

108-4.7 Cable installed in existing duct bank or conduit shall be measured by the number of linear feet installed with grounding connectors, ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable installed in existing duct bank or conduit. The measurement for this item shall not include additional quantities required for slack.

108-4.8 Removal of existing cable and conduit will not be measured for payment and shall be incidental to the associated pay item for the installation of new cable.

108-4.9 Ground Rods at the locations described in the plans and specifications will not be measured for payment and shall be considered incidental to the contract.

BASIS OF PAYMENT

108-5.1 Payment will be made at the contract unit price for trenching, cable and bare counterpoise wire installed in trench (direct-buried), or cable and equipment ground installed in duct bank or conduit, in place by the Contractor and accepted by the RPR. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and

incidentals, including ground rods and ground connectors and trench marking tape, necessary to complete this item.

Payment shall include any splices and termination of cables; and removal of existing cable from the conduits as required to make installation of new cable possible.

Payment will be made under:

Item AW108067	PAPI CABLE, per foot
Item AW108068	RTR CABLE , per foot
Item AW108069	WIND CONE CABLE, per foot
Item AW108108	1/C #8 5KV UG CABLE, per foot
Item AW108158	1/C #8 5KV UG CABLE IN UD, per foot
Item AW108258	2/C #8 5KV UG CABLE IN UD, per foot
Item AW108706	1/C #6 COUNTERPOISE, per foot
Item AW800200	1/C # 1/0 GUARD WIRE, per foot

REFERENCES

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

Advisory Circulars (AC)

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description

A-A-59544A	Cable and Wire, Electrical (Power, Fixed Installation)
A-A-55809	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

ASTM International (ASTM)

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

Mil Spec

MIL-PRF-23586F Performance Specification: Sealing Compound (with Accelerator),
Silicone Rubber, Electrical

MIL-I-24391 Insulation Tape, Electrical, Plastic, Pressure Sensitive

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

NFPA-780 Standard for the Installation of Lightning Protection Systems

American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

ANSI/IEEE STD 81 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and
Earth Surface Potentials of a Ground System

Federal Aviation Administration Standard

FAA STD-019E Lightning and Surge Protection, Grounding Bonding and Shielding
Requirements for Facilities and Electronic Equipment

END OF

ITEM L-108

Item L-109 Airport Transformer Vault and Vault Equipment

DESCRIPTION

109-1.1 This item shall consist of vault modifications as shown on the plans and as specified herein. This work shall also include the marking and labeling of equipment and the labeling or tagging of wires; the testing of the installation; and the furnishing of all conduit, cable, and incidentals necessary to place it in operating condition as a completed unit to the satisfaction of the RPR.

The scope of vault improvements shall include but not be limited to the following items as shown on the plans:

- a. Relabel all existing regulators, S-1 cutouts and Taxiway circuits inside cabinets, manholes and hanhdoles.
- b. Install new circuit breakers, cable/conduit for Wind Cone circuit.
- c. Install and connect new Wind Cone circuit as shown in the plans.
- d. Label all new circuits, L-823 connectors and circuit breakers.
- e. Lock-out/Tag-out, testing and commission of new and existing circuits.

EQUIPMENT AND MATERIALS

109-2.1 General.

a. Airport lighting equipment and materials covered by advisory circulars (AC) shall be certified in AC 150/5345-53, Airport Lighting Equipment Certification Program (ALECP) and listed in the ALECP Addendum.

b. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the RPR.

c. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

d. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

e. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be provided in electronic pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-3.1 Electrical vault building. Not Used.

109-3.2 Concrete. Not used

109-3.3 Precast concrete structures. Not Used.

109-3.4 Reinforcing steel. Reinforcing steel bars shall be intermediate or structural grade deformed-type bars and shall be per ASTM A615.

109-3.5 Brick. Brick shall be per ASTM C62, Grade SW.

109-3.6 Rigid steel conduit. Rigid steel conduit and fittings shall be per Underwriters Laboratories Standards 6 and 514B.

109-3.7 Plastic Conduit and fittings. Plastic Conduit and fittings shall conform to the requirements of UL-651 and UL-654 schedule 40 polyvinyl chloride (PVC) suitable for use above or below ground.

109-3.8 Lighting. Vault or metal-housing light fixtures shall be of a vapor-proof type.

109-3.9 Outlets. Convenience outlets shall be heavy-duty duplex units designed for industrial service.

109-3.10 Switches. Vault or metal-housing light switches shall be single-pole switches.

109-3.11 Paint.

a. Priming paint for non-galvanized metal surfaces shall be a high solids alkyd primer compatible with the manufacturer's recommendations for the intermediate or topcoat.

b. White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to the Master Painter's Institute (MPI), Reference #9, Exterior Alkyd, Gloss.

c. Priming paint for wood surfaces shall be mixed on the job by thinning the specified white paint by adding 1/2 pint (0.24 liter) of raw linseed oil to each gallon (liter).

d. Paint for the floor, ceiling, and inside walls shall be per Porter Paint Company 69, 71, and 79 or equivalent. Walls and ceiling shall be light gray and the floor shall be medium gray.

e. The roof coating shall be hot asphalt material per ASTM D2823. Asbestos-free roof coating per ASTM D4479 may be substituted if required by local codes.

109-3.12 Ground bus. Ground bus shall be 1/8 × 3/4 inch (3 × 19 mm) minimum copper bus bar.

109-3.13 Square duct. Duct shall be square similar to that manufactured by the Square D Company (or equivalent), or the Trumbull Electric Manufacturing Company (or equivalent). The entire front of the duct on each section shall consist of hinged or removable cover for ready access to the interior. The cross-section of the duct shall be not less than 4 × 4 inch (100 × 100 mm) except where otherwise shown in the plans.

109-3.14 Ground rods. Ground rods shall be in accordance with Item L-108.

109-3.15 Vault prefabricated metal housing. The prefabricated metal housing shall be a commercially available unit.

109-3.16 FAA-approved equipment. Certain items of airport lighting equipment installed in vaults are covered by individual ACs listed below:

AC 150/5345-3	Specification for L-821, Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.
AC 150/5345-49	Specification for L-854, Radio Control Equipment
AC 150/5345-56	Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)

109-3.17 Other electrical equipment. Distribution transformers, oil switches, cutouts, relays, terminal blocks, transfer relays, circuit breakers, and all other regularly used commercial items of electrical equipment not covered by FAA equipment specifications and ACs shall conform to the applicable rulings and standards of the Institute of Electrical and Electronic Engineers (IEEE) or the National Electrical Manufacturers Association (NEMA). When specified, test reports from a testing laboratory indicating that the equipment meets the specifications shall be supplied. In all cases, equipment shall be new and a first-grade product. This equipment shall be supplied in the quantities required for the specific project and shall incorporate the electrical and mechanical characteristics specified in the proposal and plans. Equipment selected and installed by the Contractor shall maintain the interrupting current rating of the existing systems or specified rating whichever is greater.

109-3.18 Wire. Wire (in conduit) rated up to 5,000 volts shall be per AC 150/5345-7, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits. For ratings up to 600 volts, moisture and heat resistant thermoplastic wire conforming to Commercial Item Description A-A-59544A Type THWN-2 shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

a. Control circuits. Unless otherwise indicated on the plans, wire shall be not less than No. 12 American wire gauge (AWG) and shall be insulated for 600 volts. If telephone control cable is specified, No. 19 AWG telephone cable per ANSI/Insulated Cable Engineers Association (ICEA) S-85-625 specifications shall be used.

b. Power circuits.

- (1) 600 volts maximum – Wire shall be No. 6 AWG or larger and insulated for at least 600 volts.
- (2) 3,000 volts maximum – Wire shall be No. 6 AWG or larger and insulated for at least 3,000 volts.
- (3) Over 3,000 volts-Wire shall be No. 6 AWG or larger and insulated for at least the circuit voltage.

109-3.19 Short circuit / coordination / device evaluation / arc flash analysis. The Contractor shall, based upon the equipment provided, include as a part of the submittal process the electrical system “Short

Circuit / Coordination / Device evaluation / Arc Flash Analysis". The analysis shall be performed by the equipment manufacturer and submitted in a written report. The analysis shall be signed and sealed by a registered professional Engineer from the state in which the project is located. The analysis shall comply with NFPA-70E and IEEE 1584.

The analysis will include: one line diagrams, short circuit analysis, coordination analysis, equipment evaluation, arc flash analysis and arc flash labels containing at a minimum, equipment name, voltage/current rating, available incident energy and flash protection boundary.

The selected firms field service Engineer shall perform data gathering for analysis completion and device settings, perform device setting as recommended by the analysis and will furnish and install the arc flash labels. The components worst case incident energy will be considered the available arc flash energy at that specific point in the system. Submit three written copies and one electronic copy of the report.

CONSTRUCTION METHODS

CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-4.1 General. Not Used.

109-4.2 Foundation and walls. Not Used.

109-4.3 Roof. Not Used.

109-4.4 Floor. Not Used.

109-4.6 Conduits in floor and foundation. Not Used.

109-4.7 Doors. Not Used.

109-4.8 Painting. Not Used.

109-4.9 Lights and switches. Not Used.

109-4.10 Wiring and connections. The Contractor shall make all necessary electrical connections in the vault per the wiring diagrams furnished and as directed by the RPR. In wiring to the terminal blocks, the Contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

109-4.11 Marking and labeling. All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

a. Wire identification. The Contractor shall furnish and install self-sticking wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks. Wire labels, if used, shall be of the self-sticking preprinted type and of the manufacturer's recommended size for the wire involved. Identification -markings designated in the plans shall be followed. Tags, if used, shall be of fiber not less than 3/4 inch (19 mm) in diameter and not less than 1/32 inch (1 mm) thick. Identification markings designated in the plans shall be stamped on tags by means of small tool dies. Each tag shall be securely tied to the proper wire by a nonmetallic cord.

b. Labels. The Contractor shall stencil identifying labels on the cases of regulators, breakers, and distribution and control relay cases with white oil paint as designated by the RPR. The letters and numerals shall be not less than one inch (25 mm) in height and shall be of proportionate width. The Contractor shall also mark the correct circuit designations per the wiring diagram on the terminal marking strips, which are a part of each terminal block.

109-4.12 Vault Modifications. The vault modifications shall include installation of new circuit breakers, power/control wires in existing and new conduits, grounding, labeling testing and installation of new Wind Cone homerun circuit in existing conduits and underfloor trench as shown on the plans. Label all new L-823 connectors, cables and circuit breakers and match with existing condition. Relabel existing regulators, circuit breakers, S-1 cutouts, circuits inside manhole/handholes for Taxiway circuits as shown on the plans.

METHOD OF MEASUREMENT

109-5.1 The quantity of vault modifications to be paid for under this item shall be measured as a lump sum item and shall consist of, but not limited to, power/control cable and conduits, circuit breakers, installation of Wind Cone homerun circuit in the vault, and labeling/relabeling of all circuits and all required components for a complete and operational system. The quantity of vaults to be paid for under this item shall consist of the number of vaults constructed in place and accepted as a complete unit.

BASIS OF PAYMENT

109-6.1 Payment will be made at the contract unit price for each completed and accepted vault or prefabricated metal housing equipment installation. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item AW109210	Vault Modifications, per lump sum
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REFERENCES

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

Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-3	Specification for L-821, Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
AC 150/5345-49	Specification L-854, Radio Control Equipment;
AC 150/5345-53	Airport Lighting Equipment Certification Program

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/ICEA S-85-625 Standard for Telecommunications Cable Aircore, Polyolefin Insulated, Copper Conductor Technical Requirements

ASTM International (ASTM)

ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM C62 Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)

ASTM C90 Standard Specification for Loadbearing Concrete Masonry Units

ASTM D2823 Standard Specification for Asphalt Roof Coatings, Asbestos Containing

ASTM D4479 Standard Specification for Asphalt Roof Coatings – Asbestos-Free

Commercial Item Description (CID)

A-A 59544 Cable and Wire, Electrical (Power, Fixed Installation)
Institute of Electrical and Electronic Engineers (IEEE)

IEEE 1584 Guide for Performing Arc-Flash Hazard Calculations

Master Painter's Institute (MPI)

MPI Reference #9 Alkyd, Exterior, Gloss (MPI Gloss Level 6)

Underwriters Laboratories (UL)

UL Standard 6 Electrical Rigid Metal Conduit – Steel

UL Standard 514B Conduit, Tubing, and Cable Fittings

UL Standard 514C Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL Standard 651 Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

UL Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

NFPA-70E Standard for Electrical Safety in the Workplace

NFPA-780 Standard for the Installation of Lightning Protection Systems

END OF ITEM L-109

Item L-110 Airport Underground Electrical Duct Banks and Conduits

DESCRIPTION

110-1.1 This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete or buried in sand) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits and removal of existing duct banks. It shall also include all turving trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

EQUIPMENT AND MATERIALS

PROOF OF BUY AMERICAN NOTICE: All tier contractors and subcontractors shall provide proof of Buy American compliance for all manufactured products in accordance with statutes established under Title 49 U.S.C. Section 50101. The AIP Buy American preference does not recognize US trade agreements such as NAFTA or the American Recovery and Reinvestment Act. If, upon submittal sufficient information to confirm compliance is not included, the submittal will be returned with no action.

110-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the RPR.

b. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the RPR. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the RPR and replaced with materials, that comply with these specifications, at the Contractor's cost.

c. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in project that accrue directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format,

tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

110-2.2 Steel conduit. Not Used

110-2.3 Plastic conduit. Plastic conduit and fittings shall conform to the following requirements:

- UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10.
- UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
- UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
- UL 651A covers W-C-1094-Rigid PVC Conduit and high-density polyethylene (HDPE) Conduit type III and Class 4.

Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

a. Type I–Schedule 40 and Schedule 80 PVC suitable for underground use either direct-buried or encased in concrete.

b. Type II–Schedule 40 PVC suitable for either above ground or underground use.

c. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.

d. Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

110-2.4 Split conduit. Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

110-2.5 Conduit spacers. Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads. They shall be designed to accept No. 4 reinforcing bars installed vertically.

110-2.6 Concrete. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

110-2.7 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program. Precast concrete structures shall conform to ASTM C478.

110-2.8 Flowable backfill. Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

110-2.9 Detectable warning tape. Plastic, detectable, American Public Works Association (APWA) red (electrical power lines, cables, conduit and lighting cable), orange (telephone/fiber optic cabling) with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

CONSTRUCTION METHODS

110-3.1 General. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The RPR shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. Under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade; in other locations, the top of the duct bank or underground conduit shall be not less than 18 inches (0.5 m) below finished grade.

The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed the light bases, manholes, pull boxes, etc., and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor's expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the RPR of any blockage in the existing ducts.

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200-pound (90 kg) test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m).

Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching

equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill may alternatively be used

Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the RPR. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet (60 cm).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the RPR, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Additional duct bank supports shall be installed, as approved by the RPR.

All excavation shall be unclassified and shall be considered incidental to Item L-110. Dewatering necessary for duct installation, and erosion per federal, state, and local requirements is incidental to Item L-110.

Unless otherwise specified, excavated materials that are deemed by the RPR to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

Any excess excavation shall be filled with suitable material approved by the RPR and compacted per Item P-152.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

a. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred

b. Trenching, etc., in cable areas shall then proceed with approval of the RPR, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.

110-3.2 Duct banks. Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (0.5 m) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (0.5 m) below finished grade where installed in unpaved areas.

Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (1 m) beyond the edges of the pavement or 3 feet (1 m) beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. The Contractor shall space the conduits not less than 3 inches (75 mm) apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the RPR for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals.

All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

Install a plastic, detectable, color as noted, 3 to 6 inches (75 to 150 mm) wide tape, 8 inches (200 mm) minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch (75-mm) wide tape only for single conduit runs. Utilize the 6-inch (150-mm) wide tape for multiple conduits and duct banks. For duct banks equal to or greater than 24 inches (600 mm) in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the RPR shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the RPR.

110-3.3 Conduits without concrete encasement. Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.

Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4-inch (6.3 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction.

Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the RPR for review prior to use.

110-3.4 Markers. The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

The Contractor shall impress the word “DUCT” or “CONDUIT” on each marker slab. Impression of letters shall be done in a manner, approved by the RPR, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the RPR. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the RPR. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

110-3.5 Backfilling for conduits. For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during back filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the RPR.

110-3.6 Backfilling for duct banks. After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 “Excavation and Embankment” except that the material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter. In addition to the requirements of Item P-152, where duct banks are installed under pavement, one moisture/density test per

lift shall be made for each 250 linear feet (76 m) of duct bank or one work period's construction, whichever is less.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the RPR.

110-3.7 Restoration. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include sodding shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

METHOD OF MEASUREMENT

110-4.1 Underground conduits and duct banks shall be measured by the linear feet (meter) of conduits and duct banks installed, including encasement, locator tape, trenching and backfill with designated material, and restoration, and for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

110-4.2 Electrical manhole adjustment shall be measured by the unit.

BASIS OF PAYMENT

110-5.1 Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including trench and backfill with the designated material, and, for drain lines, the termination at the drainage structure. This price shall be full compensation for removal and disposal of existing duct banks and conduits as shown on the plans, furnishing all materials and for all preparation, assembly, and installation of conduit and concrete and other materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

110-5.2 Payment for accepted quantities of work performed by the Contractor and measurement by the RPR shall be at the contract unit price as specified in paragraph 110-4.2 of this section. Payment shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections; and for all labor equipment, tools and incidentals necessary to complete the work as specified.

Payment will be made under:

AW110504	4-Way Concrete Encased Duct – per foot
AW110920	Remove Duct - per foot

REFERENCES

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

Advisory Circular (AC)

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| AC 150/5340-30 | Design and Installation Details for Airport Visual Aids |
| AC 150/5345-53 | Airport Lighting Equipment Certification Program |

ASTM International (ASTM)

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| ASTM A615 | Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement |
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National Fire Protection Association (NFPA)

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|---------|--------------------------------|
| NFPA-70 | National Electrical Code (NEC) |
|---------|--------------------------------|

Underwriters Laboratories (UL)

- | | |
|------------------|---|
| UL Standard 6 | Electrical Rigid Metal Conduit - Steel |
| UL Standard 514B | Conduit, Tubing, and Cable Fittings |
| UL Standard 514C | Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers |
| UL Standard 1242 | Electrical Intermediate Metal Conduit Steel |
| UL Standard 651 | Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings |
| UL Standard 651A | Type EB and A Rigid PVC Conduit and HDPE Conduit |

END OF ITEM L-110

Item L-115 Electrical Manholes and Junction Structures

DESCRIPTION

115-1.1 This item shall consist of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations, and/or adjusted, and conforming to the lines, grades and dimensions shown on the plans or as required by the RPR. This item shall include the installation, adjustment or removal of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the RPR, including removal of existing manholes and junction structures as shown on the plans.

EQUIPMENT AND MATERIALS

115-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the RPR.

b. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

c. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be neatly bound in a properly sized 3-ring binder, tabbed by specification section. Three (3) copies of each submittal shall be provided to the RPR for review and approval. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve 12 months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

115-2.2 Concrete structures. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. Cast-in-place concrete structures shall be as shown on the plans.

115-2.3 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to support loading in accordance with FAA AC 150/5320-6F, *Appendix B, Design of Structures*, for a Boeing 747-8 aircraft, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

Threaded inserts and pulling eyes shall be cast in as shown on the plans.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the RPR shall be submitted by the Contractor to allow for a full evaluation by the RPR. The RPR shall review per the process defined in the General Provisions.

115-2.4 Junction boxes/splice cans. Junction boxes/splice cans shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases that are encased in concrete. The light bases shall have a L-894 blank cover, gasket, and stainless-steel hardware. All bolts, studs, nuts, lock washers, and other similar fasteners used for the light fixture assemblies must be fabricated from 316L (equivalent to EN 1.4404), 18-8, 410, or 416 stainless steel. If 18-8, 410, or 416 stainless steel is utilized it shall be passivated and be free from any discoloration. Covers shall be 3/8-inch (9-mm) thickness for L-867 and 3/4-inch (19-mm) thickness for L-868. All junction boxes/splice cans shall be provided with both internal and external ground lugs.

115-2.5 Mortar. The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

115-2.6 Concrete. All concrete used in structures shall conform to the requirements of Item P-610, Concrete for Miscellaneous Structures.

115-2.7 Frames and covers. The frames shall conform to one of the following requirements and as shown in the plan details:

- a. ASTM A48 Gray iron castings
- b. ASTM A47 Malleable iron castings
- c. ASTM A27 Steel castings
- d. ASTM A283, Grade D Structural steel for grates and frames
- e. ASTM A536 Ductile iron castings
- f. ASTM A897 Austempered ductile iron castings

All castings specified shall withstand a maximum tire pressure of 250 psi and maximum load of 200,000 lbs.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word “ELECTRIC” or other approved designation cast on it as noted in the plans. Covers for manhole containing fiber optic cable shall have the word “FIBER” cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a “DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER” safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

115-2.8 Ladders. Ladders, if specified, shall be galvanized steel or as shown on the plans.

115-2.9 Reinforcing steel. All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

115-2.10 Bedding/special backfill. Bedding or special backfill shall be as shown on the plans.

115-2.11 Flowable backfill. Flowable material used to backfill shall conform to the requirements of Item P-153, Controlled Low Strength Material.

115-2.12 Cable trays. Cable trays shall be of galvanized steel, plastic or aluminum. Cable trays shall be located as shown on the plans.

115-2.13 Plastic conduit. Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

115-2.14 Conduit terminators. Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

115-2.15 Pulling-in irons. Pulling-in irons shall be manufactured with 7/8-inch (22 mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

115-2.16 Ground rods. Ground rods shall be one piece, copper clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet (2.4 m) long nor less than 5/8 inch (16 mm) in diameter.

CONSTRUCTION METHODS

115-3.1 Unclassified excavation. It is the Contractor’s responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the RPR without additional expense to the Owner.

The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item L-115. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item L-115.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the RPR. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the RPR. Structures shall be placed after the RPR has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the RPR as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

115-3.2 Concrete structures. Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the RPR before the concrete is placed.

115-3.3 Precast unit installations. Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

115-3.4 Placement and treatment of castings, frames and fittings. All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the RPR and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written approval is granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the RPR and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor's expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

115-3.5 Installation of ladders. Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.

115-3.6 Removal of sheeting and bracing. In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with

selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The RPR may direct the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

115-3.7 Backfilling. After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

Backfill shall not be placed against any structure until approval is given by the RPR. In the case of concrete, such approval shall not be given until tests made by the laboratory under supervision of the RPR establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the RPR may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

115-3.8 Connection of duct banks. To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

115-3.9 Grounding. A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch (100 mm) diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtailed shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

115-3.10 Cleanup and repair. After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer's recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

115-3.11 Restoration. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective Item L-115 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

115-3.12 Inspection. Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

115-3.13 Manhole elevation adjustments. The Contractor shall adjust the tops of existing manholes in areas designated in the Contract Documents to the new elevations shown. The Contractor shall be responsible for determining the exact height adjustment required to raise or lower the top of each manhole to the new elevations. The existing top elevation of each manhole to be adjusted shall be determined in the field and subtracted/added from the proposed top elevation.

The Contractor shall remove/extend the existing top section or ring and cover on the manhole structure or manhole access. The Contractor shall install precast concrete sections or grade rings of the required dimensions to adjust the manhole top to the new proposed elevation or shall cut the existing manhole walls to shorten the existing structure, as required by final grades. Other options of adjustment will be acceptable as determined by the RPR. The Contractor shall reinstall the manhole top section or ring and cover on top and check the new top elevation.

115-3.14 Duct extension to existing ducts. Where existing concrete encased ducts are to be extended, the duct extension shall be concrete encased plastic conduit. The fittings to connect the ducts together shall be standard manufactured connectors designed and approved for the purpose. The duct extensions shall be installed according to the concrete encased duct detail and as shown on the plans.

METHOD OF MEASUREMENT

115-4.1 Electrical manholes and junction structures shall be measured by each unit completed in place and accepted. The following items shall be included in the price of each unit: All required excavation and dewatering, sheeting and bracing; all required backfilling with on-site materials; restoration of all surfaces and finished grading and turfing; all required connections; temporary cables and connections; and ground rod testing.

BASIS OF PAYMENT

115-5.1 The accepted quantity of electrical manholes and junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

AW110947	Adjust Electrical Manhole - per each
AW115610	Electrical Handhole - per each

REFERENCES

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

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
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Advisory Circular (AC)

AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description (CID)

A-A 59544	Cable and Wire, Electrical (Power, Fixed Installation)
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ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C206	Standard Specification for Finishing Hydrated Lime

FAA Engineering Brief (EB)

EB #83 In Pavement Light Fixture Bolts

Mil Spec

MIL-P-21035 Paint High Zinc Dust Content, Galvanizing Repair

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

END OF ITEM L-115

Item L-125 Installation of Airport Lighting Systems

DESCRIPTION

125-1.1 This item shall consist of airport lighting systems furnished and installed in accordance with this specification, the referenced specifications, and the applicable advisory circulars (ACs). The systems shall be installed at the locations and in accordance with the dimensions, design, and details shown in the plans. This item shall include the furnishing of all equipment, materials, services, and incidentals necessary to place the systems in operation as completed units to the satisfaction of the RPR.

This item shall include the relocation of existing taxiway lights and guidance signs.

EQUIPMENT AND MATERIALS

PROOF OF BUY AMERICAN NOTICE: All tier contractors and subcontractors shall provide proof of Buy American compliance for all manufactured products in accordance with statutes established under Title 49 U.S.C. Section 50101. The AIP Buy American preference does not recognize US trade agreements such as NAFTA or the American Recovery and Reinvestment Act. If, upon submittal sufficient information to confirm compliance is not included, the submittal will be returned with no action.

125-2.1 General.

a. Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified under the Airport Lighting Equipment Certification Program in accordance with AC 150/5345-53, current version. FAA certified airfield lighting shall be compatible with each other to perform in compliance with FAA criteria and the intended operation. If the Contractor provides equipment that does not perform as intended because of incompatibility with the system, the Contractor assumes all costs to correct the system for to operate properly.

b. Manufacturer's certifications shall not relieve the Contractor of their responsibility to provide materials in accordance with these specifications and acceptable to the RPR. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the RPR and replaced with materials, which do comply with these specifications, at the sole cost of the Contractor.

c. All materials and equipment used shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Clearly mark each copy to identify pertinent products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be clearly made with arrows or circles (highlighting is not acceptable). The Contractor shall be responsible for delays in the project accruing directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be submitted in electronic PDF format, tabbed by specification section. The RPR reserves the right to reject any or all equipment, materials or procedures, which, in the RPR's opinion, does not meet the system design and the standards and codes, specified herein.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

EQUIPMENT AND MATERIALS

125-2.2 Conduit/Duct. Conduit shall conform to Specification Item L-110 Airport Underground Electrical Duct Banks and Conduits.

125-2.3 Cable and Counterpoise. Cable and Counterpoise shall conform to Item L-108 Underground Power Cable for Airports.

125-2.4 Tape. Rubber and plastic electrical tapes shall be Scotch Electrical Tape Numbers 23 and 88 respectively, as manufactured by 3M Company or an approved equal.

125-2.5 Cable Connections. Cable Connections shall conform to Item L-108 Installation of Underground Cable for Airports.

125-2.6 Retroreflective Markers. Retroreflective markers shall be type L-853 and shall conform to the requirements of AC 150/5345-39.

125-2.7 Runway and Taxiway Lights. Runway and taxiway lights shall conform to the requirements of AC 150/5345-46. Lamps shall be of size and type indicated, or as required by fixture manufacturer for each lighting fixture required under this contract. Filters shall be of colors conforming to the specification for the light concerned or to the standard referenced.

1. L-861T Medium Intensity Taxiway Edge Lights (LED) with arctic kit: shall be of size and type as shown on the plans, including removal and replacement of existing fixtures with new fixtures on existing light bases.

125-2.8 Runway and Taxiway Signs. Runway and Taxiway Guidance Signs should conform to the requirements of AC 150/5345-44.

- a. L-858(L) LED Guidance Signs, shall be of the size, style, class and mode as shown on the plans.
- b. L-858(Y) Unlighted airfield guidance include unlighted taxiway directional signs installed where airport roadways interest taxiways. These signs shall be Size 1, Style 4.

125-2.9 Runway End Identifier Light (REIL). Not required.

125-2.10 Precision Approach Path Indicator (PAPI). Not required.

125-2.11 Circuit Selector Cabinet. Not required.

125-2.12 Light Base and Transformer Housings. Not required.

125-2.13 Isolation Transformers. Isolation Transformers shall be Type L-830, size as required for each installation. Transformer shall conform to AC 150/5345-47.

125-2.14 Bolting Hardware. All airfield bolting hardware shall be stainless steel and meet FAA requirements. All bolts 1/4 inch and larger shall be hex head type. All bolts smaller than 1/4- inch trade size shall be recessed Allen type. All bolted connections shall utilize an anti-rotational locking type device. Anti-Seize compound shall be used on all bolt hardware installation.

125-2.15 Safety Ground: Each airfield light fixture shall be installed with safety ground. Safety ground shall conform to the requirements of 150/5340-30 (latest edition). As a minimum, install a 3/4" Diameter x

10'-0" long copper clad stainless-steel ground rod at each light base as shown on the plans. Ground rod shall be bonded to the light can with 1/C # 6 bare copper ground conductor.

125-2.16 Spare Parts: Contractor shall supply the following spare parts:

- Three transformers for MITL L-861T(L) with arctic kit,
- Three base plates compatible with MITL installed elsewhere on the project,
- Three L-823 Connectors,
- Three light stems and fixtures for MITL L-861T(L) with arctic kit.

The spare parts shall be the same parts installed in each MITL under item L-125. The spare materials shall be delivered to the Airport in their original packaging material.

125-2.17 Light and Sign Identification Tag: The Contractor shall install identification tags on each new light and sign as detailed on the plans. The Contractor shall coordinate with the airport and RPR regarding the numbering scheme of the tags prior to ordering the tags.

INSTALLATION

125-3.1 Installation. The Contractor shall furnish, install, connect and test all equipment, accessories, conduit, cables, wires, buses, grounds and support items necessary to ensure a complete and operable airport lighting system as specified here and shown in the plans.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and state and local code agencies having jurisdiction.

The Contractor shall install the specified equipment in accordance with the applicable advisory circulars and the details shown on the plans.

125-3.2 Temporary Connections. This item shall include all temporary electrical items necessary to maintain the existing airport light and sign circuits on adjacent airfield pavements operational at all times during the course of the project. To maintain the existing airfield electrical systems, the contractor will need to provide temporary circuiting/ cable/ connections / lighting and temporary conduits. This work shall be closely coordinated with the Airport and the FAA for the duration of the project. This item shall also include temporarily covering and uncovering existing lights on active circuits within a closure area on a nightly or an extended basis as necessary. The covering method shall be reviewed and approved by airport operation. Unsatisfactory methods shall be replaced at the discretion of Airport Operations. This work shall be included in the cost the project and not measured for payment separately.

Temporary Covers used within active Runway/Taxiway Safety Areas and blank covers for use on L-868 light bases shall be certified or designed to withstand aircraft and other heavy vehicular loadings.

125-3.3 New Lighting Installations.

a. New fixtures shall meet current FAA requirements and be listed on the FAA Advisory Circular list of equipment approved for use on an airport. The new lights shall utilize transformers of the size recommended by the manufacturer to provide the luminance standards according to AC 150/5345-46 (latest edition) and Engineering Brief 67C (LED's).

1. New elevated base mounted light fixtures installed on new concrete bases shall include the concrete encased light can, transformer, support, light fixture, protective apron, stems, frangible coupling, grounding system, base plate(s) and L-823 connectors and shall be installed at the location as shown on the plans.

2. New elevated base mounted light fixtures installed on existing concrete bases shall include new transformer, support, light fixture, stems, frangible coupling, base plate(s), internal ground lug, ¾" x 10" ground rod, and L-823 connectors and shall be installed at the location as shown on the plans.
3. This item shall include the installation of new ground rods and bare copper wire to ground all electrical equipment (equipment grounds) including new and relocated lights, signs located in PCC pavement, shoulder and turf. This work shall be included in the cost of each item and not measured for payment separately.
4. This item shall include new taxiway guidance signs installed on new concrete bases including the concrete encased light can, transformer, light fixture, stems, frangible coupling, base plate(s), and L-823 connectors at the location as shown on the plans. The new signs shall utilize transformers of the size recommended by the manufacturer to provide the luminance standards according to AC 150/5345-46 (latest edition) and Engineering Brief 67C (LED's).
5. Items requiring the installation of new L-867 splice cans in turf installed at locations as shown on the plans and per the details presented in the plans. L-867 junction cans shall be used for new installations in shoulder and turf. The contractor shall provide a reinforced concrete ring or pad around junction cans installed in turf as detailed in the plans.

125-3.4 Testing. All lights shall be fully tested by continuous operation for not less than 24 hours as a completed system prior to acceptance. The test shall include operating the constant current regulator in each step not less than 10 times at the beginning and end of the 24-hour test. The fixtures shall illuminate properly during each portion of the test.

125-3.5 Shipping and Storage. Equipment shall be shipped in suitable packing material to prevent damage during shipping. Store and maintain equipment and materials in areas protected from weather and physical damage. Any equipment and materials, in the opinion of the RPR, damaged during construction or storage shall be replaced by the Contractor at no additional cost to the owner. Painted or galvanized surfaces that are damaged shall be repaired in accordance with the manufacturer's recommendations.

125-3.6 Elevated and In-pavement Lights. Water, debris, and other foreign substances shall be removed prior to installing fixture base and light.

A jig or holding device shall be used when installing each light fixture to ensure positioning to the proper elevation, alignment, level control, and azimuth control. Light fixtures shall be oriented with the light beams parallel to the runway or taxiway centerline and facing in the required direction. The outermost edge of fixture shall be level with the surrounding pavement. Surplus sealant or flexible embedding material shall be removed. The holding device shall remain in place until sealant has reached its initial set.

125-3.7 Removals: Removed light fixtures, signs, bases, foundations and other miscellaneous components not to be reinstalled in this project shall be offered to the airport. If the airport declines, the material shall become the property of the contractor, removed from the site and disposed of offsite at a commercial disposal facility. Prior to removal the contractor and engineer shall verify the light fixtures and/or signs the airport elects to keep are in good physical and operable condition.

- a. The existing elevated base mounted taxiway edge lights, and guidance signs noted on the plans to be removed, shall be removed, salvaged, preserved and protected without damage and either reinstalled where noted or offered to the airport. This includes the light fixture, globe, stem, transformer, frangible coupling and base plate. The contractor shall be responsible to disconnect the light fixture, transformers and all existing wiring from the light

- can prior to removal. No differentiation in measurement or payment will be made for stake mounted lights versus base mounted edge lights.
- b. Existing light cans, junction cans, concrete duct bank, and concrete sign bases noted to be removed shall become the property of the contractor, removed from airport property and disposed of offsite at a commercial disposal facility. The contractor shall be responsible to disconnect the fixture, transformers and all existing wiring from the light can prior to removal. If conduits are present, assure adequate access to the conduit is maintained for the construction phase of the project until the conduit is connected into the new system.

125-3.8 In-Turf Splice Can

Junction cans in turf shall be L-867 cans with 3/8" blank lids as detailed in the plans. Junction cans installed in turf areas shall be single piece cans with a reinforced concrete mow strip ring installed around each can. Junction cans installed in bituminous shoulders shall be installed as specified above for lights. The top of the 3/8" inch lid shall be flush with the new bituminous shoulder pavement surface. Equipment grounding shall be provided for in-turf junction cans.

125-3.9 Elevated Retroreflective Marker. The reflectors shall meet the requirements of AC 150/5345-39D (or latest), L-853 Retroreflective Markers. The Reflector shall be Type II, solid blue in color, omnidirectional, sealed plastic lenses or sheet retroreflector, stake-in-turf mounted marker with a total above ground height of 24". The post shall be white with high-Intensity blue reflective tape with a locking pin connection to base. The base shall have a frangible connection to the blue marker, able to withstand a wind speed of 100 mph and a tether anchor to the stake that is weather and corrosion resistant material.

METHOD OF MEASUREMENT

125-4.1 Taxiway lights will be measured by the number of each type installed as completed units in place, ready for operation, compatible with existing vault equipment, and accepted by the RPR.

125-4.2 Guidance signs will be measured by the number of each type and size installed as completed units, in place, ready for operation, compatible with existing vault equipment, and accepted by the RPR.

125-4.3 Installation of unlighted airfield signs shall include the sign, post supports in concrete, frangible coupling, and all other incidentals necessary to complete this item. A completed unit in place shall include all items above and will be measured per each.

125-4.4 Installation of Roadway Signs (unlighted L-858Y No Entry signs on concrete base) shall be measured per each sign installed and completed in place.

125-4.5 Splice cans will be measured by the number of completed units in place.

125-4.6 Removal of edge lights and taxiway guidance signs will be measured by the number of each type removed, completed in place, and backfilled and graded to the satisfaction of the RPR. Removed equipment shall become the property of the Contractor and disposed of offsite at a beneficial reuse or disposal facility.

125-4.7 The ground rod, bare copper wire and bonding the light fixture to the can connections for grounding of all airfield lighting equipment (equipment ground) as shown in the plans including new elevated and in-pavement lights, splice cans and airfield guidance signs; relocated elevated and in-pavement lights and signs shall be included in the cost of each individual item and not measured separately for payment.

125-4.8 Spare parts shall not be measured separately for payment and shall instead be considered incidental to Item AR125416.

125-4.9. Elevated Retroreflective Markers shall be measured by the number of each installed as completed units in place, ready for operation, and accepted by the RESIDENT ENGINEER.

125-4.10 Costs associated with excavation, backfill, grading, identification tags, vault testing, circuit testing, and temporary connections necessary to complete the items in this specification shall be included in the cost of each individual item and not measured separately for payment.

BASIS OF PAYMENT

125-5.1 Payment will be made at the Contract unit price for each complete runway or taxiway light, guidance sign, reflective marker, runway end identification light, precision approach path indicator, or abbreviated precision approach path indicator installed by the Contractor and accepted by the RPR. This payment will be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item.

Payment will be made under:

Item AW125100	ELEVATED RETROREFLECTIVE MARKER, per each
Item AW125443	TAXI GUIDANCE SIGN, 3 CHARACTER, per each
Item AW125444	TAXI GUIDANCE SIGN, 4 CHARACTER, per each
Item AW125445	TAXI GUIDANCE SIGN, 5 CHARACTER, per each
Item AW125565	SPLICE CAN, per each
Item AW125902	REMOVE BASE MOUNTED LIGHT, per each
Item AW125904	REMOVE TAXI GUIDANCE SIGN, per each
Item AW125906	REMOVE SPLICE CAN, per each
Item AW125932	REPLACE SIGN PANEL, per each
Item AW125962	RELOCATE BASE MOUNTED LIGHT, per each
Item AW125964	RELOCATE TAXI GUIDANCE SIGN, per each
Item AW125966	RELOCATE SPLICE CAN, per each

REFERENCES

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

Advisory Circulars (AC)

AC 150/5340-18	Standards for Airport Sign Systems
AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors

AC 150/5345-28	Precision Approach Path Indicator (PAPI) Systems
AC 150/5345-39	Specification for L-853, Runway and Taxiway Retroreflective Markers
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5345-44	Specification for Runway and Taxiway Signs
AC 150/5345-46	Specification for Runway and Taxiway Light Fixtures
AC 150/5345-47	Specification for Series to Series Isolation Transformers for Airport Lighting Systems
AC 150/5345-51	Specification for Discharge-Type Flashing Light Equipment
AC 150/5345-53	Airport Lighting Equipment Certification Program
Engineering Brief (EB)	
EB No. 67	Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures

END OF ITEM L-125

Item SP-1 Reflective Crack Control Treatment

DESCRIPTION

SP-1.1 This item shall consist of constructing reflective crack control treatment of the type as specified in the contract documents or as directed by the Resident Engineer.

MATERIALS

SP-2.1 Reflective Crack Control System. Asphalt materials. The reinforcing fabric shall be a nonwoven polypropylene or other approved plastic fabric and conform to the following.

Property	Value
Weight (ASTM D3776) oz./sq yd, min.	4.0
Grab Tensile Strength (ASTM D4632) lb., min.	90.0
Grab Elongation at Break (ASTM D4632) %, min. - max.	40-100
Asphalt Retention gal/sq yd, min.	0.20

The asphalt binder shall be PG 58-22 or PG 64-22 meeting the requirements of AASHTO M 320.

CONSTRUCTION METHODS

SP-3.1 Surface Preparation. The surface on which reflective crack control system is to be constructed shall be clean and dry. Base failures shall be repaired. Cracks, spalls, potholes, or other depressions shall be sealed with an approved crack sealer or filled with mixture for cracks, joints, and flangeways.

SP-3.2 Placing Asphalt Mix. When an asphalt mix leveling binder, binder course, or surface course is placed on top of any reflective crack control system, the mixture shall be placed at a maximum temperature of 300°F.

SP-3.3 Reflective Crack Control System. The area to be covered with fabric shall be sprayed uniformly with asphalt binder at a rate of 0.25 to 0.30 gallons per square yard as directed by the Resident Engineer. Asphalt binder application shall be accomplished with a pressure distributor for all surfaces, except where the distributor does not have room to operate, hand spraying will be allowed. The width of the spray application shall be no more than 6 inches wider than the fabric and no less than the fabric width plus two (2) inches. The asphalt binder shall not be applied at a temperature greater than 325°F to avoid damage to the fabric.

After the asphalt binder has been sprayed, the fabric shall be unrolled, or hand placed onto the asphalt binder without delay. Every effort must be made to lay the fabric as smoothly as possible to avoid wrinkles. Wrinkles large enough to cause laps of the fabric shall be cut and laid out flat. The fabric shall be broomed or squeegeed to remove air bubbles and make complete contact with the road surface.

The fabric shall overlap the adjacent fabric panel a minimum of two (2) inches. Additional asphalt binder shall be applied by hand to make the joints where overlap is greater than two (2) inches. The transverse joints shall be made in such a manner to avoid pickup by the paver. The direction of paving shall be in the direction of fabric placement. emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

When placed as a strip treatment, the strip shall be 36 inches wide.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the RPR prior to application.

METHOD OF MEASUREMENT

SP-4.1 The quantity of strip reflective crack control treatment shall be measured for payment by the number of linear feet as specified, complete, and accepted by the RPR. It shall be measured along the joint or crack.

BASIS OF PAYMENT

SP-5-1 Payment for accepted quantities of work performed by the Contractor and measured by the RPR shall be at the contract unit price as specified in paragraphs SP-4.1 of this section. Payment shall be full compensation for furnishing all materials, for all preparation and for all labor, equipment, tools, and incidentals necessary to complete the item as specified.

Payment will be made under:

AW201672 **Crack Control Fabric - per linear foot**

REFERENCES

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

ASTM International (ASTM)

ASTM D 36	Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D 70	Standard Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method)
ASTM D 86	Standard Test Method for An American National Standard Distillation of Petroleum Products at Atmospheric Pressure
ASTM D 146	Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
ASTM D 297	Standard Test Methods for Rubber Products-Chemical Analysis ASTM D 412 Tensile Strength Properties of Rubber and Elastomers
ASTM D 517	Standard Specification for Asphalt Plank

ASTM D 882	Standard Test Method for Tensile Properties of Thin Plastic Sheeting ASTM D 1151 Standard Practice for Effect of Moisture and Temperature on Adhesive
Bonds	
ASTM D 1777	Standard Test Method for Thickness of Textile Materials
ASTM D 3776	Standard Test Methods for Mass Per Unit Area (Weight) of Fabric
ASTM D 3786	Standard Test Method for Bursting Strength of Textile Fabrics- Diaphragm Bursting Strength Tester Method
ASTM D 4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide- Width Strip Method
ASTM D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM E 96	Standard Test Methods for Water Vapor Transmission of Materials ASTM E 154 Standard Test Methods for Water Vapor Retarders used in Contact with
Earth Under Concrete Slabs, on Walls, or as Ground Cover	
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M 288	Standard Specification for Geosynthetic Specification for Highway Applications
AASHTO M 320	Standard Specification for Performance-Graded Asphalt Binder
AASHTO T 202	Standard Method of Test for Viscosity of Asphalts by Vacuum Capillary Viscometer

END ITEM SP-1

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Storm Water Pollution Prevention Plan

Route N/A
 Section Champaign – Willard Airport
 County Champaign

Marked N/A
 Project No. CMI-4793

This plan has been prepared to comply with the provisions of the NPDES Permit Number ILR10, issued by the Illinois Environmental Protection Agency for storm water discharges from Construction Site Activities.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

 Signature
 CMI Willard Airport Executive Director

 Title

 Date

1. Site Description

- a. The following is a description of the construction activity which is the subject of this plan (use additional pages, as necessary):

The University of Illinois and the Illinois Department of Transportation – Division of Aeronautics propose to reconfigure the intersections of taxiway A, B, C, D and E at Willard Airport in Savoy, IL. The project includes the removal of existing pavement structures and construction of new bituminous pavement, pavement marking, airfield lighting, grading/drainage and other incidental work as shown in the plans.

- b. The following is a description of the intended sequence of major activities which will disturb soils for major portions of the construction site, such as grubbing, excavation and grading (use additional pages, as

The improvements will consist of the following: Removal of existing concrete and bituminous pavement, constructing new bituminous pavement, new pavement markings, installing new lighting and underground utility and electric cabling. All disturbed areas will be turfed at the completion of the project.

- c. The total area of the construction site is estimated to be 7± acres.

The total area of the site that it is estimated will be disturbed by excavation, grading or other activities 7± acres.

- d. ~~The estimated runoff coefficients of the various areas of the site after construction activities are completed are contained in the project drainage study which is hereby incorporated by reference in this plan. Information describing the soils at the site is contained either in the Soils Report for the project, which is hereby incorporated by reference, or in an attachment to this plan.~~
- e. The design/project report, hydraulic report, or plan documents, hereby incorporated by reference, contain site map(s) indicating drainage patterns and approximate slopes anticipated after major grading activities, areas of major soil disturbance, the location of major structural and nonstructural controls identified in the plan, the location of areas where stabilization practices are expected to occur, surface waters (including wetlands), and locations where storm water is discharged to a surface water.
- f. ~~The names of receiving water(s) and areal extent of wetland acreage at the site are in the design/project report or plan documents which are incorporated by reference as a part of this plan.~~

2. Controls

This section of the plan addresses the various controls that will be implemented for each of the major construction activities described in 1.b. above. For each measure discussed, the contractor that will be responsible for its implementation is indicated. Each such contractor has signed the required certification on forms which are attached to, and a part of, this plan:

a. Erosion and Sediment Controls

- (i) Stabilization Practices. Provided below is a description of interim and permanent stabilization practices, including site-specific scheduling of the implementation of the practices. Site plans will ensure that existing vegetation is preserved where attainable and disturbed portions of the site will be stabilized. Stabilization practices may include: temporary seeding, permanent seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of trees, preservation of mature vegetation, and other appropriate measures. Except as provided in 2.a.(i).(A) and 2.b., stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased on all disturbed portions of the site where construction activity will not occur for a period of 21 or more calendar days.
 - (A) Where the initiation of stabilization measures by the 14th day after construction activity temporarily or permanently ceases is precluded by snow cover, stabilization measures shall be initiated as soon as practicable thereafter.

Description of Stabilization Practices (use additional pages, as necessary):

1. **Temporary Stabilization - In areas of new soil embankments, existing vegetation and inlet protection will serve to intercept the waterborne silts and prevent it from entering the storm drain system or leaving the site.**
2. **Permanent Stabilization - All areas disturbed by construction operations will be stabilized with permanent seeding and mulching following final grading. Erosion control blanket will be placed in problem locations as needed. Sod will be placed along the airfield pavements to dissipate runoff velocity and stabilize shoulders. See plan sheets.**
 - **Sodding - Stabilization of fine-grained disturbed areas by laying a continuous cover of grass sod. The purposes of this practice are to prevent erosion and damage from sediment by stabilizing the soil surface and to improve the visual quality and utility of the area quickly.**

- (ii) **Structural Practices.** Provided below is a description of structural practices that will be implemented, to the degree attainable, to divert flows from exposed soils, store flows or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Such practices may include silt fences, earth dikes, drainage swales, sediment traps, check dams, subsurface drains, pipe slope drains, level spreaders, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions and temporary or permanent sediment basins. The installation of these devices may be subject to Section 404 of the Clean Water Act.

Description of Structural Practices (use additional pages, as necessary):

- **Inlet Protection - In-place before all earthmoving activities to prevent waterborne silts from entering the existing storm drain system. The purpose of this practice is to help prevent sediment from entering storm drains until the contributing watershed is stabilized and allows early use of the storm drainage system.**

b. Storm Water Management

Provided below is a description of measures that will be installed during the construction process to control pollutants in storm water discharges that will occur after construction operations have been completed. The installation of these devices may be subject to Section 404 of the Clean Water Act.

- (l) Such practices may include: storm water detention structures (including wet ponds); storm water retention structures; flow attenuation by use of open vegetated swales and natural depressions; infiltration of runoff on site; and sequential systems (which combine several practices).

The practices selected for implementation were determined on the basis of the technical guidance in Section 10-300 (Design Considerations) in Chapter 10 (Erosion and Sedimentation Control) of the Illinois Department of Transportation Drainage Manual. If practices other than those discussed in Section 10-300 are selected for implementation or if practices are applied to situations different from those covered in Section 10-300, the technical basis for such decisions will be explained below.

- (ii) Velocity dissipation devices will be placed at discharge locations and along the length of any outfall channel as necessary to provide a non-erosive velocity flow from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected (e.g., maintenance of hydrologic conditions, such as the hydroperiod and hydrodynamics present prior to the initiation of construction activities).

Description of Storm Water Management Controls (use additional pages, as necessary):

The existing storm water management system will continue to be utilized after construction.

c. Other Controls

- (i) Waste Disposal. No solid materials, including building materials, shall be discharged into Waters of the State, except as authorized by a Section 404 permit.
- (ii) The provisions of this plan shall ensure and demonstrate compliance with applicable State and/or local waste disposal, sanitary sewer or septic system regulations.
- (iii) Prevent offsite tracking of sediments and generation of dust. Stabilized construction entrances or vehicle washing racks should be installed at locations where vehicles leave the site. Where dust may be a problem, implement dust control measures such as irrigation.

d. Approved State or Local Plans

The management practices, controls and provisions contained in this plan will be in accordance with IDOT specifications, which are at least as protective as the requirements contained in the Illinois Environmental Protection Agency's Illinois Urban Manual, 1995. Procedures and requirements specified in applicable sediment and erosion site plans or storm water management plans approved by local officials shall be described or incorporated by reference in the space provided below. Requirements specified in sediment and erosion site plans or site permits or storm water management site plans or site permits approved by local officials that are applicable to protecting surface water resources are, upon submittal of an NOI to be authorized to discharge under permit ILR10 incorporated by reference and are enforceable under this permit even if they are not specifically included in the plan.

Description of procedures and requirements specified in applicable sediment and erosion site plans or storm water management plans approved by local officials:

Not applicable.

3. Maintenance

The following is a description of procedures that will be used to maintain, in good and effective operating conditions, vegetation, erosion and sediment control measures and other protective measures identified in this plan (use additional pages, as necessary):

During construction, the contractor shall:

- **Clean up, stabilize and grade work area to eliminate concentration of runoff.**
- **Maintain or replace erosion control items as directed by the Resident Engineer.**

All maintenance of erosion control systems will be the responsibility of the contractor. All locations where vehicles enter and exit the construction site and all other areas subject to erosion should also be inspected periodically. Inspection of these areas shall be made at least once every seven days and within 24 hours of the end of each 0.5 inches or greater rainfall, or an equivalent snowfall.

Contractor shall follow inspection procedures as described in the Inspections section below. The contractor's responsibility shall end *after* final acceptance of the project.

4. Inspections

Qualified personnel shall inspect disturbed areas of the construction site which have not been finally stabilized, structural control measures, and locations where vehicles enter or exit the site. Such inspections shall be conducted at least once every seven (7) calendar days and within 24 hours of the end of a storm that is 0.5 inches or greater or equivalent snowfall.

- a. Disturbed areas and areas used for storage of materials that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. Erosion and sediment control measures identified in the plan shall be observed to ensure that they are operating correctly. Where discharge locations or points are accessible, they shall be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the site shall be inspected for evidence of off site sediment tracking.
- b. Based on the results of the inspection, the description of potential pollutant sources identified in section 1 above and pollution prevention measures identified in section 2 above shall be revised as appropriate as soon as practicable after such inspection. Any changes to this plan resulting from the required inspections shall be implemented within 7 calendar days following the inspection.
- c. A report summarizing the scope of the inspection, name(s) and qualifications of personnel making the inspection, the date(s) of the inspection, major observations relating to the implementation of this storm water pollution prevention plan, and actions taken in accordance with section 4.b. shall be made and retained as part of the plan for at least three (3) years after the date of the inspection. The report shall be signed in accordance with Part VI. G of the general permit.
- d. If any violation of the provisions of this plan is identified during the conduct of the construction work covered by this plan, the Resident Engineer or Resident Technician shall complete and file an "Incidence of Noncompliance" (ION) report for the identified violation. The Resident Engineer or Resident Technician shall use forms provided by the Illinois Environmental Protection Agency and shall include specific information on the cause of noncompliance, actions which were taken to prevent any further causes of noncompliance, and a statement detailing any environmental impact which may have resulted from the noncompliance. All reports of noncompliance shall be signed by a responsible authority in accordance with Part VI. G of the general permit.

The report of noncompliance shall be mailed to the following address:

Illinois Environmental Protection Agency
Division of Water Pollution Control
Attn: Compliance Assurance Section
1021 North Grand East
Post Office Box 19276
Springfield, Illinois 62794-9276

5. Non-Storm Water Discharges

Except for flows from fire fighting activities, sources of non-storm water that is combined with storm water discharges associated with the industrial activity addressed in this plan must be described below. Appropriate pollution prevention measures, as described below, will be implemented for the non-storm water component(s) of the discharge. (Use additional pages as necessary to describe non-storm water discharges and applicable pollution control measures).

Not applicable.



Contractor Certification Statement

This certification statement is a part of the Storm Water Pollution Prevention Plan for the project described below, in accordance with NPDES Permit No. ILR10, issued by the Illinois Environmental Protection Agency on May 14, 1998.

Project Information: Realign and Widen Taxiway C

Route	<u>N/A</u>	Marked	<u>N/A</u>
Section	<u>Champaign – Willard Airport</u>	Project No.	<u>CMI-4793</u>
County	<u>Champaign</u>		

I certify under penalty of law that I understand the terms of the general National Pollutant Discharge Elimination System (NPDES) permit (ILR 10) that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

Signature

Date

Title

Name of Firm

Street Address

City IL
State

Zip Code

Telephone Number

Appendix A

The following technical documents supplement the project Technical Specifications as they relate to the vertical relocation of an existing RVR communication cable and are attached.

- FAA-GL-918D, *Specification for Construction of Terminal Navigational Aid Facilities*, April 25, 2013
- FAA-STD-019f, *Lighting and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*, October 18, 2017

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
GREAT LAKES REGION
CHICAGO, ILLINOIS

FAA-GL-918D
April 25, 2013

SPECIFICATION FOR CONSTRUCTION OF
TERMINAL NAVIGATIONAL
AID FACILITIES

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DIVISION 1 - GENERAL REQUIREMENTS
SECTION 1A
SPECIAL CONDITIONS

1A.1 SCOPE.

- a. This Specification covers general requirements for construction of an Instrument Landing System (ILS) and Visual Guidance Lighting Systems. The complete ILS consists of several component facilities. The term, visual guidance lighting systems, covers lighting facilities. Refer to the solicitation package for types of facilities to be constructed. This Specification includes requirements common to all facilities and requirements specific to individual facility types. In general, all parts of this Specification covering construction required on project drawings and in other Contract documents, are applicable to this Contract.
- b. The Contractor shall furnish all plant, labor, materials (except Government-furnished property), equipment, energy, transportation, and other services necessary to construct all elements of the systems required in the Specifications, Drawings, and other Contract documents. Construction shall include all miscellaneous and incidental work necessary for a complete and operational system, whether or not such work is specifically shown or specified.

1A.2 GOVERNMENT-FURNISHED PROPERTY. Government-furnished property (GFP) is also known as Government-furnished material (GFM). Government-furnished property for this Contract is shown on the Government-Furnished Property List. The Government-Furnished Property List is the sole Contract document which validly identifies Government-furnished property under this Contract. The Contract Drawings give little or no indication of which items are Government-furnished. To determine whether an item of equipment or other material is Government-furnished, see the Government-Furnished Property List. For Government-furnished property, the Contractor shall provide for and pay for loading of this property at the storage location (location indicated on the Government-Furnished Property List) and transportation to, and unloading at, the job site.

1A.3 CONTRACTOR-FURNISHED MATERIAL. The Contractor shall furnish all material under this contract per Paragraph 1A.1b, except the Government-furnished property identified on the Government-Furnished Property List. The instruction "provide" on the drawings means furnish and install unless the item(s) to which the instruction applies is Government-furnished property included in the Government-Furnished Property List. The Contractor shall be aware that certain materials to be furnished by the Contractor, may be long-lead-time items. Therefore, the successful bidder should determine the availability of all material immediately after Contract award, and initiate procurement action on long-lead-time items at the earliest possible date. Where the Specifications mention material or equipment by brand, it is regarded as a known acceptable source, as it meets Specifications.

1A.4 SUBMITTALS AND BRAND NAME USAGE.

- a. Introduction. Each product required for use in the Contract Drawings and Specifications must meet the actual minimum needs of the Government as demonstrated in the salient characteristics for that product. If a brand name product is used in the Drawings or Specifications, it should be regarded as a "known acceptable source" (i.e., a product that meets the actual minimum needs, and demonstrates the appropriate salient characteristics). The product used can be identical or equal to the brand name product or known acceptable source in meeting the salient characteristics, but it need not exceed the actual minimum requirements. Any brand name product or known acceptable source mentioned will, however, not be required for use in order to comply with the Specification or Drawing unless those documents make it clear that the brand name product is required, and substitution is prohibited. The following submittal procedure shall be followed in order to:
- (1) Insure adherence to functional and quality standards in substitute Contractor-furnished material.
 - (2) Inform the FAA of the Contractor's plans to use certain material and equipment, e.g., splicing materials and tools, even if they are a known acceptable source.
- b. Definition. A submittal is a collection of information required by Specifications, or by the Contracting Officer, presenting detailed information on:
- (1) Material or equipment items the Contractor proposes to use.
 - (2) Methods or plans of action which the Contractor intends to employ in specific situations.
- c. Requirements. Each product that a Contractor wishes to use that is not a known acceptable source, must be approved before use, by the Contracting Officer or the Contracting Officer's designee. To gain approval, the Contractor must submit documents and/or samples that demonstrates the product clearly meets the Government's minimum needs, and demonstrates appropriate salient characteristics. All submittals must be in writing. The Contracting Officer shall have the right to require submittals from the Contractor where the Contractor makes an unsolicited change proposal. The information presented in a submittal shall be sufficient to demonstrate that all Specification requirements for the subject material, equipment, methods, or plans, are met by the Contractor's proposal. The informational materials may include documents such as shop drawings, sketches, calculations, data sheets, written plans of action, manufacturers' catalog cuts, brochures, and/or specification sheets. If the Specifications or Contracting Officer requires actual samples of material or equipment, the Contractor shall provide them. For any documentary submittal, the Contractor shall submit three identical sets of documents.

- d. Submittal Review. When submitting before the Notice to Proceed date, the Contractor shall send the submittal package(s) directly to the Contracting Officer. When submitting after Contract work has begun, the Contractor shall give submittal packages to the Contracting Officer's Representative (COR), who will forward them promptly to the Contracting Officer. The Contracting Officer may personally evaluate the submittal, or request FAA engineers to evaluate it. In either case, the submittal will return directly from the Contracting Officer to the Contractor, with the Contracting Officer's approval, approval with comments, or disapproval.

- e. Submittal Time Frame. To provide adequate time for document transmission and submittal review, the FAA reserves the right to take two weeks to complete a review, transmission date to transmission date. Terminal navigational aid contracts are brief contracts. The review process can therefore span a substantial portion of the contract period. For this reason:
 - (1) The Contractor is urged to initiate submittals as soon as feasible after contract award, and to expedite document transmission.
 - (2) The Contracting Officer and other reviewers (if any) will expedite reviews and document transmission insofar as feasible.

Maximum use of fast document transmission modes (e.g. email, fax, etc.) is encouraged.

- f. Procurement Before Approval. The Contractor is advised not to procure any item for which submittal approval is required but not yet granted. If approval is denied, the Contractor will be prevented from installing the disapproved item(s). The Contractor must transmit a new submittal package for the new items replacing the disapproved items, and must procure only approved items. The Contractor shall take responsibility for the delivery and installation of any items installed before submittal approval is granted. The FAA reserves the right to discontinue field work on any item furnished without submittal approval. Procuring and/or installing material which is later disapproved could result in substantial losses of money and time for the Contractor.
- 1A.5 PRE-CONSTRUCTION CONFERENCE. The Contractor shall attend a pre-construction conference when required by the Contracting Officer or airport management. The Contractor shall abide by all agreements reached at the conference regarding safety practices, ingress and egress routes to the site, maintenance of airport security (locking gates, etc.), deference to air traffic, and other operational procedures.
- 1A.6 COORDINATION. All coordination between the Contractor and the airport management and local FAA personnel, shall be accomplished through the COR.

1A.7 PROJECT DRAWINGS.

- a. Conflict Between Site Drawings and Standard Drawings. If any conflict should exist between site Drawings (location-specific Drawings) and standard Drawings (Drawings not referring to a particular location), the site Drawings shall govern.
- b. Drawings Referenced But Not Provided. Unless otherwise specified, Drawings which are referenced on Contract Drawings, but which are not listed in the list of Specifications and Drawings, do not apply to the Contract.

1A.8 TEMPORARY ELECTRICAL POWER. Unless otherwise specified, the Contractor shall make all arrangements and pay all costs for temporary electrical power needed for construction of the facility.

1A.9 COMPLIANCE WITH LOCAL AND OTHER CODES. The Contractor shall comply with standards (e.g., National Electrical Code) adopted by the Contract documents, and with local and other codes. Where the requirements of the Specifications and Drawings exceed those of the adopted and local codes, the Contractor shall comply with the requirements of the Specifications and Drawings.

1A.10 SANITARY FACILITIES. Sanitary facilities are not available at the work sites. The Contractor shall provide temporary toilet facilities as required for his employees. The locations of the toilet facilities shall be where directed by the COR.

DIVISION 3 - CONCRETE
SECTION 3A
CONCRETE FORMWORK AND REINFORCEMENT

3A.1 DESCRIPTION OF WORK. Extent of work is indicated on the drawings and by the requirements of this section.

3A.2 CONCRETE FORMWORK.

- a. Design of Forms. Forms shall conform to shapes, lines, and dimensions of the members shown on the plans, and shall be sufficiently tight to prevent leakage of mortar. They shall be properly tied together so as to maintain position and shape.
- b. Form Removal. Forms shall not be loosened or removed until the concrete members have acquired strength sufficient to support their own weight. No additional loads shall be placed on the concrete for at least 48 hours after placing.
- c. Form Ties. Form ties for concrete shall be of a type that will break back 1 1/2 inches from the concrete surface. Ties shall be removed to a minimum depth of 1 1/2 inches, and the surface patched.

3A.3 CONCRETE REINFORCEMENT.

- a. Materials. Reinforcement bars shall conform to "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement", ASTM A-615. All bars shall be Grade 60 deformed bars.
- b. Cleaning and Bending Reinforcement. At the time concrete is placed, metal reinforcement shall be free from rust scale or other coatings that will destroy or reduce the bond. All bent bars shall be bent cold. No bars partially embedded in concrete shall be field bent except as shown on plans.
- c. Placing Reinforcement. Metal reinforcement shall be accurately placed according to the plans, and adequately secured in position by concrete, metal, or other approved chairs, spacers, or ties.
- d. Splices in Reinforcement. No splices or reinforcement shall be made except as shown on the plans or as authorized by the COR.

- e. Concrete Protection for Reinforcement. The reinforcement shall be protected by the thickness of concrete shown on the drawings. Where not shown, the thickness of concrete over the reinforcement shall be as follows:
- (1) Where concrete is deposited against the ground without the use of forms, not less than 3 inches.
 - (2) Where concrete is exposed to the weather or to the ground but placed in forms, not less than 2 inches for bars larger than number 5, and 1 1/2 inches for number 5 bars or smaller.

DIVISION 5 - METALS
SECTION 5A
MISCELLANEOUS METALS

5A.1 DESCRIPTION OF WORK. Extent of metal work is indicated on the drawings and by the provisions of this section.

5A.2 MATERIALS.

- a. Structural Steel Shapes and Plates. ASTM A992 for W-shapes, and ASTM A36 for S, C, MC, and L-shapes, as well as steel plates.
- b. Steel Pipe. ASTM A53, Type E or S, Grade B steel or ASTM 501. Weight schedules shall be as specified on the drawings.
- c. Anchor Bolts. ASTM F1554, grade 36, without heads.
- d. Unfinished Threaded Fasteners. Where not otherwise indicated, ASTM A 307, Grade A, regular low-carbon steel bolts and nuts of hexagonal design, hot-dipped galvanized.
- e. Finished Threaded Fasteners. Stainless steel cap screws and heavy semi-finished nuts of hexagonal design for exterior connections, unless otherwise indicated.

5A.3 FABRICATION.

- a. General.
 - (1) After performing all fabrication and welding operations, remove all sharp edges and burrs that could cause injury. Properly finish surfaces of exposed items so as to be free of visible defects.
 - (2) Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes.
- b. Welding. Comply with AWS D1.1 Code for procedures, appearance, and quality of welds. Weld all work to produce assemblies free of warpage.
- c. Galvanizing.
 - (1) All steel members, plates, and assemblies shall be hot-dipped galvanized in accordance with ASTM A123, unless otherwise specified.

- (2) Prepare all structural steel items for galvanizing by solvent cleaning, hand and power tool cleaning, and/or sandblasting as required for permanent adhesion of galvanizing.

5A.4 INSTALLATION.

- a. Install all work plumb, level, and square in accordance with the drawings.
- b. Apply high zinc-dust-content paint for repair of galvanized surfaces damaged by welding. Paint shall conform to ASTM A780.

DIVISION 6 - WOOD AND PLASTICS
SECTION 6A
ROUGH CARPENTRY

6A.1 DESCRIPTION OF WORK. The extent of exterior carpentry work is indicated on the drawings and by the provisions of this section. Refer to Section 13E for MALSR and ILS shelter carpentry.

6A.2 MATERIALS.

a. Service Pole.

- (1) Electrical service pole, if required, shall be Southern Pine, Douglas Fir, or Western Red Cedar, complying with American National Standard Specifications and Dimensions for Wood Poles, ANSI O5.1, American National Standards Institute.
- (2) Poles shall be ANSI O5.1 class 6 or larger as dictated by height requirements.
- (3) Poles shall be pressure preservative treated in accordance with American Wood Protection Association (AWPA) Standard U1, Commodity Specification D: Poles, to the requirements of AWPA Use Category 4 (UC4B).

b. Lumber. Lumber shall be stress-rated and marked #2 structural grade, regardless of species. Sizes indicated are nominal. All lumber shall be dressed S4S, seasoned, and have 19 percent moisture content. Hand select all lumber pieces for straightness and freedom from defects.

c. Plywood. Plywood shall be all-veneer construction of sizes indicated on the drawings, and comply with APA- The Engineered Wood Association, grade designation: APA BC, Exterior, or better.

d. Lumber and Plywood Preservative Treatment.

- (1) All exterior lumber and plywood shall be preservative treated, and shall comply with AWPA Standard U1, Commodity Specification A: Sawn Products (Lumber) and Commodity Specification F: Composites (Plywood) to the requirements of AWPA Use Category UC3B. All material shall be quality marked in accordance with AWPA Standard U1 and shall bear the mark of an agency accredited by the American Lumber Standard Committee.
- (2) Pressure treatments for lumber and plywood shall be with water-borne preservatives.
- (3) Treat all cut surfaces and drilled holes in accordance with AWPA Standard M4.

- e. Fasteners. Provide type, size, and finish of fasteners indicated on the drawings. All exterior fasteners shall be hot-dipped galvanized or stainless steel.

6A.3 CONSTRUCTION.

- a. Discard units of material with defects that could impair quality of work. Set carpentry work to required lines and levels with members plumb, level, and square. Accurately cut and fit all work.
- b. Secure all carpentry work by anchoring or fastening as required by recognized standards. Make tight connections between members. Install all fasteners without splitting wood. Pre-drill as required.
- c. Coat all exterior exposed cut edges and ends of lumber and plywood pieces with wood preservatives as required above.

DIVISION 9 - FINISHES
SECTION 9A
PAINTING

9A.1 DESCRIPTION OF WORK. Extent of work is indicated on the drawings, in the special specifications and by the provisions of this section. Refer to Section 13E for MALSR and ILS shelter painting.

9A.2 GENERAL REQUIREMENTS.

- a. Unless otherwise specified all surfaces to be painted shall receive one coat of primer and two finish coats of paint. Primer shall be compatible with the surface being painted as recommended by the paint manufacturer.
- b. At completion of painting or work of other trades, painted surfaces shall be touched-up and restored where damaged or defaced, to the satisfaction of the COR.
- c. A completely finished job is required, regardless of whether every individual item is specified or not. Work requiring paint, which is not specifically mentioned, shall be finished in the same manner specified for other similar work.
- d. Work shall be accomplished by skilled tradesmen, and resulting work shall be uniform in appearance.

9A.3 APPLICABLE MASTER PAINTER INSTITUTE (MPI) STANDARDS.

MPI #9	"Alkyd, Exterior Gloss (MPI Gloss Level 6) (for Exterior and Interior Surfaces)"
MPI #79	"Primer, Alkyd, Anti-Corrosive for Metal"
MPI #80	"Primer, Vinyl Wash"
MPI #95	"Primer, Quick Dry, for Aluminum"
MPI #134	"Primer, Galvanized, Water Based"

9A.4 MATERIALS.

- a. Only materials listed in the latest edition of the Master Painters Institute (MPI) Approved Product List (APL) are acceptable for use. All such material shall be from a single manufacturer for each system used.
- b. Other painting materials such as linseed oil, shellac, thinners, solvents, etc., shall be the highest quality product of an MPI listed manufacturer and shall be compatible with paint materials being used as required.
- c. Where required, use only materials having a minimum MPI "Environmentally Friendly" E rating based on VOC (EPA Method 24) content levels. Where indoor air quality (odor) is an issue, use only MPI listed materials having a minimum E# rating.

9A.5 PREPARATION OF METAL SURFACES.

- a. Unpainted or shop painted ferrous metal shall first be washed free of grease, dirt, and oil with mineral spirits, and primed or spot primed if the metal is exposed. Prime with rust prohibitive primer after removing any existing rust.
- b. Previously painted existing ferrous metal shall be cleansed of grease, dirt, oil, and all other foreign substances. Existing paint which shows signs of deterioration, loosening, or chalking shall be removed. Further surface preparation shall be made as recommended by the paint manufacturer for the particular surface and type of paint being used.
- c. Exposed galvanized surfaces shall be solvent cleaned as necessary to remove all oil, grease, and other foreign substances. Nonferrous metal surfaces to be painted shall be treated with vinyl type wash coat. The vinyl type wash coat shall have a dry film thickness of .5 mils. The wash coat shall be permitted to dry as recommended by the manufacturer.

9A.6 APPLICATION.

- a. Do not apply exterior paint in damp, rainy weather, or until the surface has dried thoroughly from the effects of such weather.
- b. The temperature of the surface to be painted and the surrounding air temperature shall be maintained between 45°F and 95° during the application and drying period.
- c. The surface to be painted shall be clean, dry, smooth, and adequately protected from dampness. Each coat of paint shall be applied smoothly, worked out evenly, and allowed to dry completely before the subsequent coat is applied.
- d. Finished work shall be uniform and of the approved color. It shall be completely covered and shall be smooth and free from runs and sags. Make edges of paint adjoining other materials or colors sharp and clean without overlapping.
- e. All painting shall be completed according to the manufacturer's printed instructions.

9A.7 PAINT SYSTEM SCHEDULE.

- a. Ferrous Metals (Unpainted).
 - (1) Primer - MPI #79
 - (2) Intermediate and Finish Coats - MPI #9

b. Galvanized Metal.

- (1) Primer - MPI #134
- (2) Intermediate and Finish Coats - MPI #9

c. Aluminum.

- (1) Primer - MPI #95 (or #80 for non-anodized aluminum)
- (2) Intermediate and Finish Coats - MPI #9

DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13F
RVR SYSTEMS

13F.1 SCOPE. This section applies to special construction of Runway Visual Range (RVR) systems. The work includes all non-electronics facility construction, such as the installation of Visibility Sensor sites (VS), Runway Light Intensity Monitors (RLIM), and Ambient Light Sensors (ALS). RVR electronics installation will be performed by others.

13F.2 VISIBILITY SENSOR SITE (VS).

- a. General. Fiberglass LIR tilt-down poles will support the electronic sensors used to measure runway visibility. The Contractor shall fabricate and furnish the VS foundation adapter base plate. All of these parts shall be assembled and mounted on screw anchor foundations furnished by the Contractor. For screw anchor foundations, see 13D above. Install all items per drawings and manufacturers' instructions. See the site plan for anchor location.
- b. LIR Pole Cutting and Assembly. The Contractor shall calculate the pole length required to put the RVR lamp centerline 14'-0" above the adjacent runway centerline elevation. The top of the fiberglass pole must be cut 1'-6" below the required RVR lamp centerline elevation. Do not cut the pole before the COR verifies the required length. The Contractor shall cut the fiberglass pole to proper length, according to the instructions shown on the project Drawings. The pole shall be cut only in the presence of the COR. See standard drawing GLSD-D-RVR-S001 for pole cutting and assembly details.
- c. Vertical Tolerance. After the assembled tube and preassembled mounting frame have been installed on the screw anchor foundation, adjust the leveling nuts on the base plate of the LIR structure such that the mast centerline is vertical within a tolerance of 1/2-inch between top and bottom of tube.
- d. Test. The Contractor shall demonstrate to the satisfaction of the COR that the installed LIR structure will tilt down smoothly without evidence of binding or use of undue force. The pole must also rest squarely between the pole maintenance stand supports when in the down position. Adjust as necessary and repeat testing until accepted by the COR.

e. Power and Control Stand.

- (1) Structure. A power and control stand shall be constructed not more than 4 feet away from the visibility sensor pole. The stand shall be located to prevent interference with tilting down the sensor pole, as indicated on the drawings. The base channel shall be shimmed, if necessary, to level it.
- (2) Electrical Components. SIE boxes will be installed later by others. The power disconnects and control junction boxes shall be Contractor-furnished and installed. Power and control wiring that is above grade shall be run thru 3/4" UV resistant liquid-tight conduits to the SIE box location. If more than one SIE box is shown on the Drawings, separate sets of power and control cables shall be run in 3/4" liquid-tight conduits to each SIE box location. Install 3/4" female end connectors on the ends of all conduits that will attach to the future SIE boxes.

13F.3 AMBIENT LIGHT SENSOR (ALS). One or two Ambient Light Sensor (ALS), will be required per airport, as per project Drawings, to check lighting conditions on the field. The ALS shall be collocated with one of the visibility sensor sites where shown on the Drawings. The 1 1/2" ALS mounting pipe position shall be such that the sensor unit will have an unobstructed view of the north horizon sky 6° above the horizon combined with a 6° field of view. To prevent false readings, the ALS sensor unit shall not be pointed parallel to the runway, towards brightly lighted areas, or toward the VS pole. Also ensure that the obstruction light is positioned to the side of or behind the ALS sensor. Take these criteria into account when positioning the 1 1/2" ALS mounting pipe on the power and control stand.

13F.4 OBSTRUCTION LIGHTS.

- a. General. Obstruction lights for an RVR are only required when a runway requires a midpoint RVR, or a rollout RVR not collocated with another facility. However, where one is required, a double (L-810) steady-burning aviation red obstruction light fixture shall be installed 3'-0" above the top of the power and control stand as shown on the Drawings. The lights shall be made to operate from the first night and thereafter following the installation of the LIR structure. The lights shall operate continuously, and be operational before the VS pole is raised. Do not install the obstruction light where the illumination will interfere with the operation of the Ambient Light Sensor.
- b. Obstruction Light Fixtures. Fixtures shall be FAA certified type L-810 double-lamp steady-burning LED units, with cast aluminum fittings, aviation red fresnel lens globes, or red polycarbonate lens, and a 1" inch threaded conduit bottom fitting. Dialight Model Number 860-1R01-002 or RTO-1R01-002, is among the products that meet this Specification. These

dual light fixtures shall be mounted on a 1" rigid galvanized conduit.

- c. Photo Cell. All obstruction lights shall be controlled by a photo cell installed on rigid conduit with protection from being damaged. The photo cell shall be adequately rated for the installation, but not to exceed 3000W and shall be installed in a weaterproof housing. The cell shall be pointed north, and shall turn on when the northern sky illuminance reaching a vertical surface falls below a level of approximately 35 foot candles (376.7 LUX). The control device should turn off the lights when the northern sky illuminance rises to a level of not more than 60 foot candles (645.8 LUX).

13F.5 RLIM INSTALLATION. Runway Light Intensity Monitoring (RLIM) equipment shall be installed in the appropriate power vault(s) to sense the appropriate runway edge and/or centerline cable current. All conduits shall be routed around or over existing conduits, and shall avoid all "live" or exposed wires. Extreme care shall be exercised while working in the vaults, due to the numerous high voltage cables.

13F.6 AC SURGE ARRESTER. The AC surge arrester shall be Rayvoss 120-1P-M3-2-06-A. No substitutions are allowed for this product.

13F.7 CONTROL JUNCTION BOX. The exterior control junction box mounted on the power and control stand shall be a 12" x 12" x 6", 16-gauge stainless steel NEMA 4X hinged cover enclosure, meeting the requirements of Paragraph 16A.15 below. Hoffman Cat. No. A-1212CHNFSS hinged cover enclosure with a A-12P12SS panel is one of the products that meets this Specification.

13F.8 TERMINAL BLOCKS. The terminal blocks in the control junction box on the power and control stand, shall be fastened in a vertical array to the left side of the interior panel. This arrangement reserves space on the right side for later installation, by others, of lightning protection equipment. The terminal blocks shall be as specified in Paragraph 16A.19.

DIVISION 16 - ELECTRICAL
SECTION 16A
BASIC METHODS AND MATERIALS

16A.1 APPLICABLE DOCUMENTS.

- a. Standards. The following UL standards in effect on the date of the invitation for bids or request for proposals, form a part of this Specification.
- (1) UL 6 Electrical Rigid Metal Conduit - Steel,
 - (2) UL 797 Electrical metallic Tubing - Steel
 - (3) UL 360 Standard for Liquid-Tight Flexible Steel Conduit
- b. Electrical Codes. The following publications and regulations, in effect on date of the invitation for bids or request for proposals, form a part of this Specification and are applicable to the extent specified herein.
- (1) NFPA Number 70 National Electrical Code.
 - (2) The rules and regulations of local utility companies providing service.
 - (3) Local governing body rules and regulations.

16A.2 REQUIREMENTS.

- a. General. The Contractor shall install all electrical work in accordance with the applicable Drawings and Specifications. All electrical work shall be installed to meet the provisions of the current issue of the National Electrical Code, NFPA-70, and all state and local regulations.
- b. Contract Drawings.
- (1) Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the functions to be performed (even though some minor details are not shown), the Contractor shall furnish all equipment, material (other than Government-furnished items) and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation.

- (2) Minor departures from exact dimensions shown on the drawings may be permitted where required to avoid conflict or unnecessary difficulty in placement of the dimensioned item, provided all other contract requirements are met. The Contractor shall promptly obtain approval from the FAA Contracting Officer's Technical Representative (COR) for any such proposed departure.
- c. Materials. Materials and equipment, to be acceptable, must comply with all Contract requirements. Materials to be furnished by the Contractor under this Specification shall be new and, unless specified otherwise, the standard products of a manufacturer's latest designs. Wherever standards have been established by Underwriters Laboratories, Inc., the materials shall bear the UL label.

16A.3 WIRING METHODS.

- a. General. All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.
- (1) Conductor Routing. Panelboards, surge arresters, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures.
 - (2) Conductor Separation. Power conductors shall be routed separately from all other conductor types. This may be accomplished by routing power conductors and other conductors in separate raceways, or by a metallic divider between the power conductors and the other conductors in the same raceway.
 - (3) Neutral Conductor: Shared/common neutrals shall not be permitted, i.e. each overcurrent device shall have its own separate neutral conductor. Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.
- b. Conductors.
- (1) Uninsulated Conductors: Uninsulated conductors shall be copper and in accordance with Military Specification A-A-59551.

- (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 locations only. All insulated for 600 volts in accordance with Federal Specification A-A-59544. Unless otherwise indicated, conductors #10 AWG and smaller shall be solid, conductors #8 AWG and larger shall be stranded. Minimum branch circuit conductor size shall be #12 AWG. Stranded conductors may be used with wire compression connectors or a pressure washer type lug; lugs with screw only compression are not allowed. Minimum control wire size shall be #14 AWG unless noted otherwise. Stranded conductors smaller than #10 AWG are allowed in applications where vibration and flexing may be encountered.
- (3) Fixture Wiring: fixture wiring shall be thermoplastic insulated copper, rated for 600 volts, in accordance with federal Specification A-A-59544 and the NEC.
- (4) Color Coding: 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 shrink embossed labels only. The color coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable. 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 120/208/240 volt systems and gray insulated for 277/480 volt systems. For conductors #4 AWG and larger, where appropriate insulation color is not available, color coded tape, half lapped for a minimum length of 3 inches shall be used. Switch leg conductors shall be violet insulated. Green, white, and gray insulated conductors shall not be reidentified. All conductor color codes, including reidentified conductors, shall be visible at all junction boxes, pullboxes, panelboards, outlets, switches, access locations in closed raceways, every 3 feet in open raceways, under all raised floors, and at all terminations. Phase conductors shall be color coded as follows:

Single Phase

120 Volts

Line 1 - Black
Neutral - White

120/208/240 Volts

Line 1 - Black
Line 2 - red
Neutral - White

Three Phase

120/208/240 Volts

Phase A - Black
Phase B - Red
Phase C - Blue

277/480 Volts

Phase A - Yellow
Phase B - Brown
Phase C - Orange

Color coding for conductors in control cables shall be in accordance with Standard ICEA S-61-402. DC power conductors shall be color coded as follows: positive conductor, red with brown tracer; negative conductor, brown with red tracer; neutral conductors, if used, shall be white.

16A.4 CONDUIT.

- a. Where electrical metallic tubing is shown on the drawings, at exterior or interior locations, it shall be used without substitution.
- b. Except where specified otherwise, conduit exposed to the weather, in concrete, or below grade shall be galvanized rigid steel with threaded joints. All conduit and conduit fittings in contact with earth shall have a factory PVC coating.
- c. Except where otherwise specified, conduit used entirely indoors shall be rigid or electrical metallic tubing. Compression type fittings shall be used with metallic tubing.
- d. Minimum size of conduit shall be 3/4-inch unless otherwise noted on the drawings. Each conduit run shall be installed complete before cable is pulled through.

- e. All outdoor connections of conduit to enclosures shall be made with weatherproof hub fittings unless otherwise specified. Hub fittings shall have an external ground to maintain raceway grounding and be UL listed for grounding. Indoor connections of rigid conduit to enclosures shall be made with double locknuts and bushings. Refer to grounding section for disconnect switch conduit terminations.
- f. Ends of conduits installed but not used, shall be closed with bushings and pennies. All underground conduit shall be temporarily plugged during construction to prevent entrance of foreign material.
- g. Wherever conduit from outdoors or underground enters an enclosure or junction box, either indoors or outdoors, seal space between conduit and cables with conduit seal.
- h. Exposed conduit shall be installed parallel to or at right angles with equipment and building wall surfaces unless shown otherwise. Field bends shall be avoided where possible, and where necessary shall be made with a hickey or conduit-bending device. Radius of field bends shall not be less than ten times the inside diameter of the conduit. Conduit shall be fastened securely to adjacent members or surfaces with galvanized clamps, straps.
- i. Flexible metal conduit shall be used for terminal connections to motors or motor driven equipment, and in lengths only up to 6 feet for other applications permitted by the NEC. Liquid-tight flexible metal conduit shall be used outdoors and in wet locations. All flexible metal conduit shall be of a type where both the conduit and fittings are listed for grounding.

16A.5 GROUNDING.

- a. Equipment, Structures, and Raceways.
 - (1) All metallic non-current carrying parts of electrical equipment (including enclosures) and supporting structures installed under this contract, whether used either for power or control, shall be grounded with an equipment grounding conductor, whether or not shown on the drawings. The grounding conductor shall be sized in accordance with the National Electrical Code, but shall be of larger gauge if so shown on the drawings. In no case shall the grounding conductor be smaller than #12 AWG, unless shown otherwise on the drawings.
 - (2) A service entrance conduit or any other power feeder conduit emerging from below grade and supplying power to another facility or system component shall terminate with grounding bushings at both ends. These

requirements apply unless shown otherwise on the drawings.

- (3) The equipment grounding conductor shall be:
 - (a) connected to the grounded conductor (neutral) only at the service entrance disconnecting means.
 - (b) installed in the same conduit as its related branch and feeder conductors, and connected to the ground bus in the branch or distribution panelboard.
 - (c) connected to all grounding bushings on conduits through which the conductor passes.
 - (d) connected to all other grounding conductors in enclosures and bodies through which the conductor passes.

Each overcurrent device shall have its own equipment grounding conductor. No sharing of grounds between circuits is permitted.

- (4) Where there are parallel feeders installed in more than one raceway, a properly sized equipment grounding conductor shall be installed in each raceway. The metallic conduit carrying the equipment grounding conductor shall be electrically continuous, forming a path parallel to the equipment grounding conductor. Under no circumstances shall the equipment grounding conductor be omitted from the electrical system. Nor shall any separate grounding system such as the signal ground, be used for an alternate grounding system or an alternate path to the grounding electrode, unless so shown on the drawings.
- (5) All connections to the equipment to be grounded shall be made with a grounding connector specifically intended for that purpose. Connecting screws or mounting bolts and screws are not suitable for use as grounding connections. All ground lugs shall be of a non-corroding material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. Remove paint and other non-conducting materials from surfaces of grounding connections. After the connection is completed, apply touch-up paint or cold galvanizing to match existing.
- (6) Unless otherwise specified, control equipment enclosures, pull boxes, and raceways, shall be grounded as above for power wiring.
- (7) Where metallic conduit, surface-mounted square duct, or cable tray systems are installed, a separate copper

conductor shall be installed in the raceway, and shall be properly bonded to each section. Unless otherwise specified, the minimum size ground conductor shall be #6 AWG green insulated copper.

- b. Service Entrance Disconnect Switches and Breakers. All facility service entrance disconnect switches and breakers shall be grounded as follows:
- (1) The neutral bar or lug shall be grounded with a green insulated copper grounding electrode conductor, running directly to the grounding electrode. The grounding electrode conductor size shall be in accordance with the NEC, but in no case shall the wire size be smaller than #2 AWG.
 - (2) The switch box or panelboard enclosure shall be grounded to the grounded neutral bar or lug with a green insulated conductor, or other service grounding means.
- c. Grounding Electrode. Grounding electrodes (rods) shall be copper clad steel, 3/4-inch by 10 feet, except where otherwise specified. The top of the grounding electrode shall be a minimum of 12 inches below finished grade. Conductors shall be attached to electrodes with exothermic welds only, except where fire or explosion hazards exist, as near existing fuel tanks. Where such hazards exist, hydraulically crimped connections will be permitted as specified below.
- d. Grounding Conductor. All grounding conductors shall be copper. All grounding conductors which are totally above grade shall be green-insulated conductors. All grounding conductors which are either entirely or partially direct-earth buried, shall be #6 AWG bare conductors, unless noted otherwise on the drawings.
- e. Buried Guard Wire. A #1/0 AWG bare copper stranded guard wire shall be provided for all buried cables and conductors not routed in ferrous conduit. The guard wire shall be embedded in the soil a minimum of 10 inches above the cable to be protected and located directly above and parallel to the lines or cables being protected. When the width of the cable run or duct does not exceed 3 feet, one guard wire, centered over the cable run or duct, shall be installed. When the cable run or duct is more than 3 feet in width, two guard wires shall be installed. The guard wires shall be spaced at least 12 inches apart and be not less than 12 inches nor more than 18 inches inside the outermost wires or the edges of the duct. The guard wire shall be bonded to the earth electrode system (EES) at each end and to ground rods at approximately 90-foot intervals using exothermic welds. The spacing between ground rods must vary 10 percent to 20 percent to prevent resonance. Install the ground rods at approximately 6 feet on either side of the trench.

Where cables run parallel to the edge of a runway, they shall be located 10 feet from the edge lights on the outside of the lights.

- f. Exothermic Process for Connecting Grounding Conductors to Metal Objects. Where the Drawings and/or Specifications require connection of a grounding conductor to a metal object by exothermic process, the Contractor shall supply the correct exothermic welding kit for the application. The mold and cartridge used shall be selected on the basis of size, number, and type of conductors to be connected, composition and surface shape of object, and position in which the weld will be made. Regardless of the source of the kits selected, the Contractor shall submit catalog cuts or other manufacturer information, demonstrating that the kits fit their intended applications on the above described basis. See Paragraph 1A.4 above. The Contractor shall provide and use the proper preparation tools in applying the exothermic process to ensure an adequate weld. Torch welds and/or brazing will not be permitted. No single-use exothermic weld molds, such as Thermoweld "Single Shot" and Cadweld "One Shot", will be permitted.

- g. Hydraulically Crimped Connections. Hydraulically crimped connectors shall only be allowed where fire or explosion hazards prevent the use of exothermic welds. In such instances, grounding conductors shall be connected to each other or grounding electrodes with compression connectors crimped with a force of at least 24,000 pounds. Connectors, tools, dies, and crimping procedures shall be compatible to the application and to each other, and shall conform to the manufacturer's catalog and instructions. Each connector shall be clearly marked with catalog number, conductor size, and installation die information. The tooling shall be of the type that embosses or engraves the die index number on the connector in the crimping process. All connectors shall be listed in conformance with Underwriters Laboratories Standard UL467 and the National Electrical Code. Burndy Hyground Compression System connectors, matching tools, and crimping procedures, are one system of products which meet these Specifications. Regardless of the source of the connectors, tools, and dies selected, the Contractor shall submit catalog cuts or other manufacturer information, demonstrating that these items fit their intended applications as described above. See Paragraph 1A.4 above.

- h. Testing. The Contractor shall measure the resistance of the grounding electrode system in the presence of the COR. Tests shall not be conducted within 48 hours of a rainfall or in frozen soil. The resistance shall not exceed 10 ohms, unless otherwise indicated. If the measured resistance exceeds 10 ohms, the COR shall be notified immediately for further guidance. Upon project completion, the Contractor shall also submit a written test report to the COR. A tabulated report of the final resistance value at each location shall be provided in the report.

- 16A.6 GROUND FAULT INTERRUPTING RECEPTACLE. All outdoor receptacles provided by the Contractor shall be ground fault interrupting duplex receptacles in properly sized weatherproof boxes.
- 16A.7 CABLE ABANDONMENT. Ends of cables to be abandoned shall be buried two feet below grade unless otherwise specified. All above ground unused conduits, conductors, and cables shall be removed, unless the facility manager disapproves.
- 16A.8 WATERPROOFING CABLE ENDS. All cable ends which will be exposed to weather, water, ground, or corrosive environment prior to termination, shall be sealed against these elements while awaiting termination. This also applies to all cable ends in manholes or handholes. The sealing material shall be properly sized, easily removable heat shrinkable end caps, or electrical tape with an application of brushed-on protective electrical coating.
- 16A.9 CONDUIT AND CABLING FOR ENGINE GENERATOR. Where engine generator standby power will be extended to a facility, conduit shall run continuously, without intermediate manholes or handholes, from the engine generator to the facility. In the continuous conduit, power cables shall be installed without splices from the engine generator bypass switch to the facility service entrance switch.
- 16A.10 ELECTRICAL EQUIPMENT NAME PLATES.
- a. Each of the following types of equipment shall be identified with a name plate showing the functional name of the unit, voltage utilized, one or three phase as applicable, and additional information if specified or requested by the COR:
 - Switches (Except Local Lighting)
 - Panelboards
 - Main Circuit Breakers
 - Motor Controllers
 - b. Name plates shall be non-ferrous metal or rigid plastic, stamped, embossed, or engraved with 3/8-inch minimum height letters and numerals. Name plates shall be secured to the equipment with at least two screws, except main breaker plates may be epoxy glued.
- 16A.11 PANELBOARD CIRCUIT DIRECTORIES. The Contractor shall clearly and neatly mark panelboard circuit directories, identifying each circuit established, re-established, or changed, as to the circuit's function.

- 16A.12 COVERING HOLES IN ENCLOSURES. No electrical enclosure will be accepted which has an unused open hole, except weep holes or vent holes. Holes in enclosures where conduits, bolts, or other objects were removed and not reinstalled, shall be closed with panels of the same material, thickness, color, and shade as the enclosure.
- 16A.13 SAFETY DISCONNECT SWITCHES AND FUSES. Safety disconnect switches and fuses shall meet the following Specifications.
- a. General. Unless specified otherwise, all switches for circuit voltages of 600VAC or less, shall be heavy duty (Type HD), UL listed, and shall bear the UL label. The switches shall be NEMA 1 or NEMA 3R, as required by the drawings or special Specifications.
 - b. Switch Interiors. All switches shall have switch blades which are fully visible in the OFF position when the switch door is open. All current-carrying parts shall be of high-conductivity copper, designed to carry the rated load without excessive heating. Switches shall have removable arc suppressors where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL listed for 60°C or 75°C, aluminum or copper wires.
 - c. Switch Mechanism. Switches shall quick-make, quick-break, such that during normal operation of the switch, the operation of the contacts will not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started. The operating handle shall be an integral part of the box, not of the cover. Switches shall have provisions for padlocking the switches in the OFF position with at least three locks. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the ON position, and to prevent closing of the switch mechanism with the door open. The handle position shall indicate whether the switch is ON or OFF.
 - d. Enclosures. Covers on NEMA 1 enclosures shall be attached with pin type hinges. NEMA 3R enclosures shall be securable in the open position. NEMA 3R enclosures for switches through 200 amperes shall have provisions for interchangeable bolt-on hubs. Hubs shall accommodate the conduits of the diameters indicated on the drawings. NEMA 3R enclosures shall be manufactured from galvanized steel. All enclosures shall have a gray baked enamel finish, electrodeposited on cleaned, phosphatized steel.

- e. Ratings. All fusible switches rated 100 through 600 amperes at 240 volts, and 30 through 600 amperes at 600 volts, shall have a UL-approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses, and have provisions for field installation of a UL-listed rejection feature to reject all fuses except Class R. The UL-listed short circuit rating of the switches shall be 200,000 rms symmetrical amperes when Class R or Class J fuses are used with the appropriate rejection scheme. The UL-listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes.
- f. Fuses. All fused switches meeting the above Specifications shall be fused with dual element, time-delay, UL Class RK5 fuses, of the continuous current rating specified on the drawings. One set of spares shall be furnished for each fusible device. The fuses' interrupting rating shall be at least 10,000 rms symmetrical amperes.

16A.14 PANELBOARDS AND CIRCUIT BREAKERS.

- a. 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. Panelboards shall be mounted so that the height to the top of the panelboard shall not exceed 81 inches above the finished floor level. Unless otherwise specified, panelboards shall have a full hinged front cover with a hinged door in that cover for access to circuit breaker switches. 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 typewritten 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.
- b. 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.

- c. Circuit Breakers. All circuit breakers shall be UL listed thermal magnetic type or electronic solid state type, as described herein, and with a minimum rating of 10,000 AIC. Circuit breakers shall also have trip 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. Multi-pole circuit breakers shall have an internal 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.
- (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 readily accessible and visible from the front of the panelboard, after installation.
 - (2) Solid State. Adjustable, solid-state or microprocessor-controlled circuit breakers shall have adjustments readily accessible and visible from the front of the panelboard, after installation. Individual circuit breaker frame size shall not exceed the panelboard bus rating.
- d. Bussing Assembly and Temperature Rise. Panelboard bus structure and main lugs or main circuit breaker shall have current ratings as shown on the drawings. Such ratings shall be established by heat rise tests, conducted in accordance with UL Standard 67. Bus structures shall be insulated. All current carrying parts shall be of high-conductivity copper, designed to carry the rated load without excessive heating.
- e. Cabinets and Fronts. The panelboard bus assembly shall be enclosed in a steel cabinet. The rigidity and gauge of the steel shall be as specified in UL Standard 50 for cabinets. Wiring gutter space shall be in accordance with UL Standard 67 for panelboards. The box shall be fabricated from galvanized steel or equivalent rust-resistant steel. Fronts shall have adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Doors shall be mounted with completely concealed steel hinges. Fronts shall not be removable with the door in the locked position.

16A.15 ELECTRICAL ENCLOSURES AND WIREWAYS. Unless specified otherwise, electrical enclosures and wireways shall meet the following Specifications.

- a. Material. Electrical enclosures and wireways shall be constructed of code gauge sheet steel.
- b. Corrosion-Resistant Coating. Enclosure and wireway sheet steel shall be coated by ASTM 525 G90 (galvanneal) galvanizing or corrosion-resistant phosphate primer, or both.
- c. Finish. Finish shall be dark gray enamel inside and out, or ANSI 61 gray polyester coating inside and out, or ASA-49 gray epoxy paint inside and out.
- d. Industry Standards.
 - (1) Enclosures. NEMA 1 enclosures shall meet NEMA Type 1 and UL 50 Type 1 standards. NEMA 3R enclosures shall meet NEMA Type 3R and UL 50 Type 3R standards.
 - (2) Wireway. NEMA 1 wireway (including troughs) shall meet NEMA 1 and UL 870 standards. NEMA 3R wireway (including troughs) shall meet NEMA 3R and UL 870 standards.
- e. Hardware. All hardware shall be plated to prevent corrosion.

16A.16 ELECTRICAL SURGE PROTECTION

- a. General. All electrical surge protection systems shall be installed in accordance with FAA Standards.
- b. Supply Transformer. For utility owned transformers, protective devices shall be at the discretion of the utility. For FAA owned transformers, proper protection shall be provided on the primary side of the transformer.
- c. Service Entrance Surge Arrester. The arrester shall be compatible with the service voltage, and shall be wired to avoid loops, sharp bends and kinks, and to minimize the number of bends. There shall be no interconnection between neutral and ground within the arrester. Arrester conductors shall be #4 AWG insulated copper or larger, unless a smaller size is recommended by the arrester manufacturer.
- d. Transient Suppression Installations. Where transient suppression devices are installed in the electrical power distribution system, they shall be installed in accordance with the manufacturer's instructions unless otherwise specified.

- e. Landline/cable Penetration Installations. Supression systems shall be provided for landline and cable penetration systems. High energy grounding conductors shall be bonded directly to the earth electrode system or to the perimeter ground cable under raised floors in equipment rooms with an approved fastener not more than 24 inches from the box.

16A.17 WIRING DEVICES.

- a. Receptacles. All receptacles shall be specification grade in accordance with NEMA Standard WD-1. Unless otherwise indicated, general purpose duplex receptacles shall be specification grade, 20 ampere rating, 125 volt, ground type 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.

For all critical power circuits, the receptacles shall be twist lock type, except where the receptacles are not subject to being kicked or bumped (e.g., receptacles mounted inside an equipment rack).

- b. Ground Fault Circuit-Interrupter (GFCI) Receptacles. GFCI receptacles shall be installed in all locations required by the NEC and in other locations as indicated on the Drawings. GFCI receptacles shall be 125 volt, duplex, UL Group I, Class A, rated for 20 amperes minimum. All exterior GFCI receptacles shall be mounted in weatherproof boxes with weatherproof covers.
- c. Isolated Ground Terminal Receptacles. When isolated ground terminal receptacles are shown in the Contract documents, they shall be installed in accordance with the NEC. Isolated ground terminal receptacles shall only be used where shown on the Drawings. All isolated ground terminal receptacles shall be colored orange.

d. Plug-in Strip Outlets

- (1) General. Fixed multi-outlet 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.
- (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.

e. Emergency Light Receptacles. Emergency light receptacles shall be grounding type single receptacles in accordance with NEMA Standard WD-1.

f. Wall Switches. Single-pole and three-way wall switches shall be 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.

- g. 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.
- h. Photoelectric Control. Unless otherwise indicated, photoelectric controls for floodlighting or obstruction lighting shall be 120 volt, 3000 watt, single-pole, single-throw, double-break type. Photoelectric controls shall be mounted in an appropriate weatherproof housing installed on the building exterior. The housing should be vented if possible, faced in a northerly direction. At no time shall the controllers be mounted in the same enclosure with the batteries.

16A.18 SHELTER LIGHTNING PROTECTION EQUIPMENT. All shelters (buildings) shall have a lightning protection system installed per the requirements of the Lightning Protection Code, National Fire Protection Association (NFPA 78), and Underwriters Laboratories Master Labeled System (UL96A). Lightning protection equipment items shall meet the following Specifications:

- a. Air Terminal Point. Air terminal points shall be nickel-tipped copper, 1/2" diameter x 36" long.
- b. Point Bracket. For a roof ridge, the point bracket shall be made of pressed copper, shall bend to fit any roof slope, and shall hold the point and cable slightly above the center of the roof ridge. The bracket shall have a pressure cable clamp, and a stud to engage the point.
- c. Air Terminal Brace. The air terminal brace shall be a 24"-long galvanized tripod assembly, with legs adjustable to accommodate any roof slope.
- d. Roof and Down Conductors. Roof and down conductors shall each have 32 strands of #17 AWG copper wire, 7/16" overall diameter, braided smooth twist, 65,500 circular mils, and a net weight of 215 pounds per 1000 feet.

- e. Ridge Cable Support. Ridge cable supports shall be pressed copper cable supports at least 2" wide, to hold the roof cable above the top of the roof. The ridge cable supports shall be sized to accommodate the roof conductor.
- f. Cable Holder. Cable holders shall be 1"-wide copper bent-strap type loops with 1/4" mounting holes. The cable holders shall be sized to accommodate the roof conductor.
- g. Parallel Clamp. Parallel clamps shall be bronze 2"-long clamps for connecting two conductors together, one conductor of maximum diameter 1/2", and the other conductor from 1/6" diameter to 5/16" diameter.
- h. Flexible Bonding Strap. Flexible bonding straps, for connecting steel doors to steel door frames, shall be braids each composed of 480 #30 AWG copper wires, with flat bronze or copper connectors crimped on at each end. The connectors shall have holes to take either 5/16" or 3/8" machine screws.
- i. Pipe Clamp. Pipe clamps shall be adjustable tinned bronze clamps for bonding cables to pipes, and fitting pipes up to and including 1 1/4" O.D., and cables up to and including 1/2" diameter.
- j. Bonding Equipment. Bond the steel siding, vent fan, hood, door frame, junction boxes, and any miscellaneous exterior metal objects to down conductors. If included, air conditioners, junction boxes, and flight check antenna masts shall be likewise bonded. Use the following equipment to perform the bonding:
 - (1) Bonding Plate. Bonding plates shall be 8-sq. inch tinned bronze plates with 2"-long pressure type cable connectors, designed to bond a continuous run of cable to metallic objects along their path. Each plate shall have two holes fitting sheet metal screws or 1/4" machine screws.
 - (2) Bonding Conductor. Bonding conductor shall be minimum #6 AWG bare soft drawn copper, 1/6" diameter, 26,250 circular mils, net weight 80 pounds per 1000 feet.

16A.19 CONTROL CABLE TERMINAL STRIPS. Unless specified otherwise, Contractor furnished control (telephone) cable terminal strips shall be units assembled from compatible components all from the same manufacturer. The individual blocks of the strips shall be miniature style (6mm O.C.) nylon blocks with screw-activated tubular conductor clamps. The blocks shall be rated for a maximum voltage of at least 300 volts and a maximum current of at least 30 amperes. The conductor clamps shall accept wire sizes at least from #14 AWG to #22 AWG. Stab-in wire connection blocks shall not be used. The blocks shall be mounted in a standard 35mm DIN rail mounting channel. The assembled strip of blocks shall have a marking strip and holding plugs or end barriers. For terminating control cables on these strips, see Paragraph 16F.11 below.

16A.20 FRANGIBLE COUPLINGS.

- a. Material Specification. Unless specified otherwise, Contractor-furnished frangible couplings shall be 2" diameter cast aluminum couplings having a hexagonal clamping ring. The couplings shall accommodate 2"-diameter EMT conduit, and shall meet the FAA's testing, certification and approval requirements.
- b. Thread Remediation. Often, the conduit threads of frangible couplings (both Contractor-furnished and Government-furnished) are cast with mismatched halves. Often, this imperfection causes the threads to bind in the rigid coupling threads conduit threads of the required mating object, before the required engagement is reached, even when anti-seize compound is used. When this binding occurs, the Contractor shall rework the frangible coupling threads to achieve the required thread engagement. This remediation may consist of rethreading with a straight conduit thread die, and/or of grinding off the threads on the two diametrically opposite sides of the thread helix where the cast thread discontinuity is found. This remediation must continue until the required thread engagement is achieved. All burrs and galls must be removed from the reworked threads.

- 16A.21 ELECTRICAL TAPE. Unless specified otherwise, electrical tape shall meet the following Specifications. The tape material shall be based on PVC polyvinyl and/or PVC copolymers. The tape shall have a rubber-based, pressure-sensitive adhesive. The tape shall be 8.5 mils thick, and be UL listed and marked per UL Standard 510 as "Flame Retardant, Cold and Weather Resistant." The tape must be applicable at temperatures ranging from 0°F through 100°F (-18°C through 38°C). The tape shall be classified for both indoor and outdoor use. The tape shall be compatible with synthetic cable insulations, jackets, and splicing compounds. Scotch Super 88 Vinyl Electrical Tape by 3M is one of the products that meet these Specifications.
- 16A.22 PRE-STRETCHED RUBBER TUBING. Pre-stretched rubber tubing shall be open-ended tubular rubber sleeve, factory expanded and assembled onto a removable core. The tubing is supplied for field installation in this pre-stretched condition. The tube is positioned for installation over an inline connection, terminal lug, sleeve splice, or other cable insulation discontinuity requiring protection. Then the core is removed, allowing the tube to shrink to produce a waterproof seal.

The tubing shall be made of EPDM (ethylene propylene diene monomer) rubber containing no chlorides or sulfurs. The tubing must be capable of operation at emergency overload cable temperatures of 130°C. It must be usable without additional covering or adhesive, both indoors and outdoors, in overhead, direct buried or submerged applications, on cables rated up to 1,000 volts. The tubing must be applied without additional heat or flame and, when applied per the manufacturer's instructions, be immediately energizable. It must not be adversely affected by moisture, mild acids or alkalies, ozone or ultraviolet light. It must conform to the requirements of ANSI C119.1, appropriate sections of Western Underground Guide 2.14 and UL 486D. The tubing must have been accepted by the U.S. Department of Agriculture, Rural Utilities Service (RUS), for both submersible and aerial application. PST Cold Shrink Connector Insulators 8420 Series by 3M are among products which meet these Specifications. All applications must be performed per the manufacturer's instructions.

16A.23 FIRE AND ARC PROOFING. Fire and arc proofing shall consist of a flexible conformable unsupported (having no adhesive) intumescent elastomer. The intumescent property causes the tape to expand in fire, thus providing an insulating firewall between the flame and cable. The tape shall be not less than .030 inches thick. The tape shall be capable of over 100% elongation. The tape shall be non-corrosive to metallic cable sheaths. It shall be compatible with synthetic cable jackets such as semi-conducting URD type, polyethylene, and PVC. The tape shall be self-extinguishing, i.e., shall not support combustion. The tape shall not deteriorate when subjected to water, salt water, gases, and sewage. The wrapped tape shall be secured by a band consisting of two layers (the second wrapped directly over the first) of glass cloth electrical tape at both ends of the fire and arc proofing wrap. The completed installation of a single half-lapped layer of fire and arc proofing shall be capable of withstanding a high 60 Hz current fault arc temperature of 13,000°K for 70 cycles. Scotch 77 Fire and Arc Proofing tape secured with Scotch 69 Glass Cloth Electrical Tape are among products that meet these Specifications, when applied per the manufacturer's instructions. All applications must be performed per the manufacturer's instructions.

16A.24 CABLE CONNECTOR PROTECTION.

- a. Primary Connections. Where single-conductor plug and receptacle cable connectors are joined in light bases or other underground enclosures, the joint shall be sealed with heat-shrinkable tubing specifically designed for this purpose. Each tubing unit shall consist of a polyolephin heat-shrinkable sleeve with sealant at each end. The tubing shall meet the performance Specifications of ANSI C-119.1 and Western Underground Guide 2.5, and shall be RUS listed under "secondary" tap or splice cover, submersible.

The sleeve is placed over the cable connectors, their joint, and a short length of cable at the ends of the connectors. The sleeve is shrunk with a torch or heat gun, with heat applied from the center of the sleeve toward the ends, to avoid trapping air. The sleeve shrinks under the heat, to conform to the shape of the connectors and the cables. The sealant at the ends of the sleeve forms a watertight seal around the cables. These sleeves shall be applied to cable connector joints between two isolation transformer primary leads, a primary lead and a cable, or two cables, wherever these joints are specified in a light base or other underground enclosure. The sleeves must be of a type designed for easy removal by applying a small amount of heat, slitting the sleeve with a knife, and peeling away the sleeve.

- b. Secondary Connections. Where two-conductor plug and receptacle cable connectors are joined in light bases or other underground enclosures, the joint between the two connectors shall be sealed with at least two layers of electrical tape and an application of protective electrical coating. Where two-conductor plug and receptacle connectors are joined in a frangible coupling, apply no tape or any other protection.
- 16A.25 ELECTRICAL COATING. Cable connections, splices, or other joints wrapped with plastic electrical tape, shall be sealed with an electrical coating. Scotchkote Electrical Coating is among the products meeting this Specification.
- 16A.26 COMMERCIAL METAL FRAMING. Where specified for mounting of electrical equipment or other purpose, the Contractor shall furnish and install commercial metal framing. The channel framing members shall be formed from strip steel, with one side of the channel having a continuous slot with inturned lips. The principle of attachment is application of nuts which engage the inturned lips of the channel. For outdoor applications, framing members shall be hot-dip galvanized per ASTM Specification A-123 or A-153. For indoor applications, framing members shall be factory coated with enamel or epoxy coatings, or electro-galvanized per ASTM Specification B633. Uncoated framing members, or framing members coated only with oil, are not acceptable. Properly sized and matched channel framing members, fittings, and hardware from Unistrut Corporation of Wayne, Michigan, and from B-Line Systems, Inc. of Highland, Illinois are among products meeting the above Specifications. Installation shall be in accordance with manufacturer's instructions.
- 16A.27 EXPANSION COUPLING. Where shown on the drawings, rigid metal conduits which emerge vertically from below grade to make a direct connection to an above-grade junction box or structure, shall be fitted with an expansion coupling. The purpose of the expansion coupling is to accommodate relative vertical movement, such as the movement due to frost heave. The coupling shall be rigid metal, and shall be threaded onto the rigid conduits at both ends of the coupling. The coupling must accommodate 8 inches of movement, unless space limitations prohibit installing such a coupling. If there are such space limitations, a coupling allowing only 4 inches of movement may be substituted. Electrical continuity across the expansion coupling must be maintained by installing a bonding jumper.

16A.28 LAMPS AND LIGHTING FIXTURES

- a. General. Lamps and lighting fixtures shall be of the types indicated on the drawings. All lighting fixtures shall be UL approved and shall bear the UL label. All incandescent lamps shall be rated for 130 volts unless otherwise indicated. Flexible metal conduit, minimum 3/8 inch nominal trade size is permitted. External bonding jumpers are not required across the lighting fixture flexible conduit.
- b. Fluorescent Fixtures. Unless otherwise indicated, fluorescent fixture lenses shall be the prismatic-type, made or virgin acrylic. Fluorescent lamps shall be rapid, states, cool white, unless otherwise indicated. Ballasts for fluorescent fixtures shall be Class P, protected (including inherent automatic thermal reset and fuse) rapid start, high power factor type, conforming to UL Standard UL 935. Unless otherwise indicated, all ballasts shall be provided with factory installed choke-type radio frequency interference suppressers. Lampholders shall have silver plated contacts, and shall conform to standard UL 542.
- c. Recessed Fluorescent Fixtures. Recessed fluorescent fixtures shall conform to NEC Article 410, and shall be installed in suspended ceiling openings. These fixtures shall have adjustable fittings to permit alignment with ceiling panels.
- d. 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.
- e. Suspended Incandescent Fixtures. Pendant-mounted incandescent fixtures shall be provided with swivel hangers to insure a plumb installation.
- f. Emergency Lights. Emergency lights shall be as indicated on the drawings, and the light sets shall be connected to the wiring system by a cord no more than 3 feet in length to a single receptacle.
- g. High Intensity Discharge (HID) Lamps. HID lamps, including mercury vapor, metal halide, and high or low pressure sodium shall be as indicated on the drawings. High power factor, constant wattage ballasts shall be furnished with HID lamps. Mercury vapor lamps shall be the color improved type.

16A.29 SIGNAL AND COMMUNICATIONS

- a. Entrance Conduits. Conduit materials shall be rigid steel unless otherwise indicated. Except where otherwise indicated, underground conduits shall be a minimum of 2 feet below finished grade and extend at least 5 feet beyond the grounding electrode system. The conduits shall be bonded to the grounding electrode system with #2 AWG bare copper conductor by exothermic welds. Conduits installed for future use by others, such as for telephone, communications, electronic signals, etc., shall have both ends capped.
- b. Transient Protection Demarcation Box for Electronic Landlines. A metallic, appropriately rated NEMA junction box, shall be installed where electronics landlines or conduits enter the facility. This box will house terminal boards, cables, and circuit transient protectors as shown on the Contract Drawings.
- c. Fiber Optics. The use of fiber optics is recommended to replace metallic, control cables. Using fiber optics will eliminate outages and loss of service due to lightning strikes.

16A.30 PAINTING AND FINISHING. Where factory finishes are not adequate to protect metal surfaces from corrosion, the Contractor shall paint exposed surfaces prior to or after installation. All marred or damaged surfaces, except exposed metal for grounding purposes, shall be refinished to leave a smooth, uniform finish at final inspection.

16A.31 REPAIR OF EXISTING WORK. Electrical work shall be carefully planned. Where cutting, channeling, chasing, or drilling of floors, all partitions, ceilings, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, it shall be carefully done. The Contractor shall repair, with equal material by skilled workers, any damage to facilities caused by the Contractor's workers or equipment. The Contracting Officer's prior approval must be obtained for the materials, workers, time of day or night, repair method, and for temporary or permanent repair purposes. On completion, repair work shall be inspected and approved by the COR with the concurrence of any other affected parties such as utility companies and airport authorities.

16A.32 QUALITY ASSURANCE PROVISIONS

- a. List of Materials and Equipment. When required by the contract, the Contractor shall submit a list of materials and equipment to the Contracting Officer for approval.

- b. Information Required. This list shall include manufacturer's style or catalog numbers. Partial lists submitted from time to time shall not be considered as fulfilling this requirement. Approval of materials will be based on manufacturer's published data. Approval of materials and equipment will be tentative, subject to submission of complete shop drawings, when required, indicating compliance with the Contract documents.
- c. Statement. A manufacturer's statement indicating complete compliance with the applicable Federal Specification, Military Specification, or standards of ASTM, NEMA, or other commercial standard, is acceptable as indicating compliance with Contract documents.
- d. Shop Drawings. When required by the Contract or by direction of the Contracting Officer, the Contractor shall submit shop drawings for materials and equipment not completely identified by information submitted in the materials and equipment lists. This information shall include, but is not limited to, panelboards, lighting fixtures, cable trays, switchgear, transformers, busways, cabinets, and lightning protection systems.
- e. Coordination. Drawings and submitted data shall be checked and coordinated with the work of other construction trades involved, before they are submitted for approval, and shall bear the Contractor's stamp of approval as evidence of such checking and coordination.
- f. Required Data. Drawings and submitted data shall be complete, assembled in sets and shall bear the date, drawing revision number, name of project or facility, name of Contractor and subcontractor, and the clear identity of contents and location of work.
- g. Approval. The approval of drawings and submitted data shall not be construed as (1) permitting any departure from the Contract requirements; (2) relieving the Contractor of the responsibility for any errors, including details, dimensions, materials, etc.; or 3) approving departures from full size details furnished by the Contracting Officer.
- h. Variations. If drawings show variations from the contract requirements because of standard shop practice or for other reasons, the Contractor shall describe such variations in a letter of transmittal to the Contracting officer. If acceptable, the Contracting Officer may approve any or all such variations, subject to a proper adjustment in the Contract. Contractors failing to describe such variations shall not be relieved of the responsibility for executing the work in accordance with the Contract, even though such drawings have been approved.
- i. Submission. The Contractor shall submit and obtain approval of shop drawings by the Contracting Officer before ordering materials or proceeding with any work associated with the shop drawings.

16A.33 TESTS

- a. 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 COR. All instruments shall have been calibrated within a period of 2 years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.
- b. Load Balancing. After the electrical installation has been completed, the Contractor shall take current readings with a true RMS ammeter 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. The Contractor shall redistribute single-phase loads where there is greater than a 20% difference between readings in any two phases. The Contractor shall also be required to notify the Contracting Officer of current readings taken before and after installation, and any phase loaded above 80% of the rating of its overcurrent protective device.
- d. Neutral Isolation Tests. For all new installations, the neutral in the service entrance switch shall be tested for isolation from ground with an ohmmeter capable of reading greater than 20,000 ohms.
- e. Earth Resistance Test. The Contractor shall comply with the grounding electrode system testing requirements of paragraph 16A.5h.
- f. Operating Test. After the interior wiring system installation is completed, and at such time as the Contracting Offer may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this Specification. The test shall be performed in the presence of the COR.

DIVISION 16 - ELECTRICAL
SECTION 16B
600-VOLT POWER CABLE FOR UNDERGROUND INSTALLATION

- 16B.1 SCOPE. This section covers the material requirements for all Contractor-furnished single-conductor 600-volt power cable required for direct earth burial installation. Installation of power cable is covered in Section 16F.
- 16B.2 GENERAL REQUIREMENTS. Cable construction shall include copper single conductor and XLP (thermosetting crosslinked polyethylene) insulation. Cable shall be UL listed as Type USE or RHW or RHH for use in circuits not exceeding 600 volts at conductor temperatures of 90°C for continuous normal operation, 130°C for emergency overload conditions, and 250°C for short circuit conditions. Cables shall be suitable for direct burial and above-grade installation in wet or dry locations.
- 16B.3 APPLICABLE SPECIFICATIONS.
- a. Underwriters Laboratories Standard 854 for Service Entrance Cables.
 - b. Underwriters Laboratories Standard 44 for Thermoset-Insulated Wires and Cables.
 - c. ICEA Publication Number S-95-658, NEMA WC70 for Nonshielded 0-2kV Cables.
 - d. Federal Specification A-A-59544.
- 16B.4 CABLE CONSTRUCTION. Cable characteristics shall include the following materials and construction:
- a. Conductors. Conductors shall be solid or Class B stranded annealed uncoated copper, per UL Standards 854 and 44.
 - b. Separator. A suitable separator over the conductor may be used at the option of the manufacturer.
 - c. Insulation. Each conductor shall be insulated with XLP (crosslinked polyethylene) complying with the physical and electrical requirements of UL Standard 854 for Type USE and UL Standard 44 for Types RHW and RHH and ICEA Publication Number S-95-658. The insulation shall be applied lightly to the conductor and shall be free-stripping.
- 16B.5 IDENTIFICATION. The cable shall be identified by surface marking indicating manufacturer's conductor size and metal, voltage rating, UL Symbol and type designation, and year of manufacture.

- 16B.6 TESTS. Cable shall be tested in accordance with requirements of UL Standard 854 for Type USE, UL Standard 44 for Types RHW and RHH, and ICEA Publication Number S-95-658.
- 16B.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.
- 16B.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.

DIVISION 16 - ELECTRICAL
SECTION 16C
600-VOLT ARMORED POWER CABLE

- 16C.1 DESCRIPTION. This section covers the material requirements for all Contractor furnished 600-volt 3-conductor armored power cable required for direct earth burial installation. Installation of power cable is covered in Section 16F.
- 16C.2 GENERAL REQUIREMENTS. Cable construction shall include three copper conductors with XLP (thermosetting crosslinked polyethylene) insulation, galvanized steel interlocking armor, and PVC jackets under and over armor. Cable shall be UL listed as type MC for use in circuits not exceeding 600 volts phase to phase at conductor temperatures of 90°C in dry locations, or 75°C in wet locations, 130°C for emergency overload conditions, and 250°C for short circuit conditions in wet or dry locations. Cables shall be designed and labeled for direct burial use.
- 16C.3 APPLICABLE SPECIFICATIONS. The following Specifications form a part of this Specification to the extent specified herein:
- a. UL Standard 1569 for Metal-Clad Cables.
 - b. UL Standard 44 for Thermoset-Insulated Wires and Cables.
 - c. ICEA Publication Number S-95-658, NEMA WC70 for Nonshielded 0-2kV Cables.
 - d. IEEE 383 Type Tests of Class 1E Electric Cables and Field Splices and Connections for Nuclear Power Generating Stations.
- 16C.4 CABLE CONSTRUCTION. Cable construction shall include the following materials and construction:
- a. Conductors. Class B stranded annealed uncoated copper per ICEA.
 - b. Separator. A suitable separator over the conductor may be used at the option of the manufacturer.
 - c. Insulation. XLP crosslinked polyethylene meeting the requirements of ICEA and Type XHHW requirements of UL 44. Average thickness of insulation shall be as specified in UL 44 for Type XHHW conductors and in ICEA. Minimum thickness at any point shall be not less than 90% of the specified average thickness.
 - d. Phase Identification. Insulated phase conductors shall be printed with the numeral "1", "2", and "3" on the surface of the insulation.

- e. Assembly. Three phase conductors shall be cabled together with a Class B stranded, uncoated copper grounding conductor and suitable nonhygroscopic fillers to make round. Length of lay shall not exceed 35 times the phase conductor diameter. The grounding conductor shall comply with the requirements of UL Standard 1569. A suitable nonhygroscopic cable tape shall be applied over the assembly.
 - f. Inner PVC Jacket. PVC meeting the requirements of ICEA, Section 7 and the sunlight resistant requirements of UL 1569. Average jacket thickness shall be in accordance with UL 1569. Minimum thickness at any point shall be not less than 70 percent of the specified average thickness.
 - g. Armor. Galvanized steel interlocked armor shall be applied over the inner PVC jacket. Armor shall be in accordance with UL requirements for Type MC cable and Section 6 of ICEA.
 - h. Outer PVC Jacket. PVC meeting the requirements of ICEA, Section 7 and the sunlight resistant requirements of UL 1569. Average jacket thickness shall be in accordance with UL 1569. Minimum thickness at any point shall be not less than 70 percent of specified average thickness.
- 16C.5 TESTS. Conductors and completed cables shall be tested in accordance with UL requirements for Type MC cables having XHHW conductors.
- 16C.6 IDENTIFICATION. Cable shall be identified by surface marking indicating manufacturer's identification, conductor size and metal, voltage rating, UL symbol and type designation, year of manufacture, and "direct burial" designation.
- 16C.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.
- 16C.8 PACKAGING. All cable shall be provided on wooden or steel reels, and ends of all cable shall be sealed to prevent entry of moisture. All reels shall identify type, length, and year of manufacture of cable packaged on such reels. All such identification shall be clearly provided by the manufacturer.
- 16C.9 SUBMITTALS. For the specific cable that the Contractor proposes to use, the Contractor shall submit the manufacturer's complete cable specifications, including compliance with all cable requirements, codes, and standards referenced herein, and a drawing showing cable construction details. Submit these items, and receive the Contracting Officer's approval before installing any cable specified herein. See Paragraph 1A.4 above.

DIVISION 16 - ELECTRICAL
SECTION 16E
CONTROL CABLE

16E.1 SCOPE. This section covers the material requirements for all Contractor furnished exterior standard and gopher-resistant filled control (telephone) cable to be installed as shown on the Drawings. Installation of control cables is covered in Section 16F.

16E.2 GENERAL REQUIREMENTS.

- a. Definition. The term "control cable" used throughout these Specifications and on the project drawings is a general FAA term for cable used to transmit voice and control functions. The required cable is termed "telephone" or "telephone exchange" cable by the cable manufacturing industry.
- b. Quality. All control (telephone) cables shall be the standard products of a single major cable manufacturer and shall be designed and manufactured according to the highest industry standards. All cables shall be free of any imperfection which could affect serviceability and design life.

16E.3 APPLICABLE SPECIFICATIONS.

- a. United States Department of Agriculture, Rural Utilities Service (RUS), Specification REA Bulletin 1753F-205 (PE-39) for "Filled Telephone Cable" latest edition, including all addendums and attachments thereto, forms a part of these Specifications and is applicable in its entirety.
- b. Certain requirements, specified herein, supplement the requirements of Specification REA Bulletin 1753F-205 (PE-39), and shall receive special attention by the cable manufacturer and Contractor.
- c. Cable conforming to Specification REA Bulletin 1753F-208 (PE-89) is an acceptable substitute for PE-39 cable. For purposes of brevity, only the standard cable construction for PE-39 cable is specified herein.

16E.4 STANDARD CABLE CONSTRUCTION. Cable characteristics shall include the following materials and construction.

- a. Conductors. #19 AWG solid annealed copper.
- b. Conductor Insulation. Solid polypropylene or polyethylene color coded in accordance with telephone industry "standard" coding.
- c. Twisted Pairs. Individual conductors twisted into pairs with varying lays to minimize crosstalk.

- d. Forming of Cable Core. Cables having 25 pairs or less are assembled into a single cylindrical group. Cables having more than 25 pairs are assembled in units, each individually identified by color coded unit binders.
- e. Filling Compound. Water resistant non-hardening compound to fill and seal all interstices between the conductor pairs.
- f. Core Covering. Non-hygroscopic dielectric tape.
- g. Flooding Compound. Water resistant and bonding compound to fill all voids between the core wrap and shield and between the shield and jacket.
- h. Shield. Corrugated electrically continuous and longitudinally applied 0.008 inch coated aluminum or 0.005 inch copper.
- i. Jacket. High molecular weight polyethylene or high-molecular weight ethylene copolymer.

16E.5 GOPHER-RESISTANT CABLE CONSTRUCTION.

- a. General. If gopher-resistant cable is required by drawings or special Specifications, cable construction shall comply with all construction requirements for standard cable in Subsection 16E.4 above (including conformance with RUS Specification REA Bulletin 1753F-205 (PE-39) except for Item h, "Shield", which shall comply with the following:
- b. Gopher-Resistant Shield. Corrugated electrically continuous and longitudinally applied overlapping metal shield consisting of one of the following materials:
 - (1) 0.010 inch copper.
 - (2) 0.006 inch copper/stainless steel/copper bimetallic alloy.
 - (3) 0.007 inch Alloy 194 for 6 pr #19 cable.
 - (4) 0.006 inch Alloy 194 for cables larger than 6 pr #19.
 - (5) 0.008 inch coated aluminum with 0.006 inch coated steel.

16E.6 CABLE IDENTIFICATION. In accordance with Specification REA Bulletin 1753F-205 (PE-39), all cable shall have jacket printed at periodic intervals with the name of the manufacturer, manufacturer's standard designation, year of manufacture, number of pairs, conductor gauge, sequential length marks, and notation signifying compliance with the specification (if not clearly referenced in the manufacturer's submittals). In addition, the gopher-resistant shield shall be clearly identified.

16E.7 DATE OF MANUFACTURE. Year of manufacture of all cable shall be no earlier than one calendar year immediately preceding contract award date.

16E.8 PACKAGING. In accordance with Specification REA Bulletin 1753F-205 (PE-39), all cable shall be stored and shipped on reels affording the required protection. Thermal wrapping shall be provided and ends of all cables shall be capped against exposure to moisture. All reels shall be labeled by the manufacturer and shall bear the manufacturer's name, year of manufacture, REA cable designation, description of cable, actual shipping length, and identification referenced to tests of record as required herein.

16E.9 TESTS.

- a. All project cable furnished shall satisfy all test requirements of Specification REA Bulletin 1753F-205 (PE-39). Records of all such tests shall be retained by the manufacturer, and shall be promptly made available to the Federal Aviation Administration upon request. All tests shall be specifically and clearly referenced to all reels of cable furnished.
- b. Basic cable design, for all project cable furnished, shall have proven acceptable to RUS through "qualification testing" according to their specification.
- c. Electrical tests, according to their specification, shall be performed on 100 percent of all project cable furnished.
- d. Quality assurance (capability) tests, according to their specification, shall be performed on such periodic production basis so as to represent quality of all project cable furnished.

16E.10 SUBMITTALS. Prior to procuring any cable specified herein, the Contractor shall submit the following documents for the specific cable that the Contractor proposes to use, to the Contracting Officer, and receive written approval therefrom (see Paragraph 1A.4 above):

- a. Manufacturer's complete cable specifications, including manufacturer's statement of compliance with REA Specification PE-39 or Pe-89.
- b. Drawing showing cable construction details.

DIVISION 16 - ELECTRICAL
SECTION 16F
CABLE INSTALLATION

16F.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section. Included in this section are installation, splicing, and testing of power and control cables.

16F.2 GENERAL REQUIREMENTS.

- a. Service Interruptions. Existing sources of power and control are indicated on the drawings. For circuits actively in use, the Contractor shall coordinate temporary interruptions of service with users and suppliers, the COR, and the airport management.
- b. Precautions. The Contractor shall take all reasonable precautions to protect existing underground equipment and utilities such as fuel tanks, water lines, and buried control and power cables. All known FAA power and control cables leading to and from any operating facility will be marked in the field by the COR for the information of the Contractor before starting work in the general vicinity. The Contractor shall contact utility companies and the airport sponsor for the location of existing utility lines and airport sponsor cables. Thereafter, through the entire construction period, buried equipment and utilities shall be protected from damage. The Contractor shall immediately repair, with equal material, by skilled workmen, any underground cables damaged by contract workers, equipment, or work. Prior approval from the Contracting Officer shall be obtained for the materials, workers, time of day or night, methods of repairs, and for any temporary or permanent repairs the Contractor proposes to make. Upon completion, any repair work shall be inspected and approved by the COR with the concurrence of the affected utility company or airport sponsor.
- c. Cable Protection.
 - (1) All cable ends which will be exposed to weather, water, ground, or corrosive environment prior to termination, shall be sealed against these elements while awaiting termination or splicing. This requirement also applies to all cable ends in manholes or handholes. The sealing material shall be properly sized, easily removable heat shrinkable end caps, or electrical tape, with an application of brushed-on electrical coating.

- (2) Cables shall not be bent at radii less than radii recommended by the manufacturer, or 10 times cable diameter (12 times diameter for armored cable), whichever is greater. Any cables damaged in any way by sharp bending shall be replaced.
- (3) Special care should be taken when working with filled cables, especially when the temperature is below 35°F. This type of cable becomes more difficult to bend and work as the temperature decreases, and there is a possibility of cable damage at temperatures near 0°F.

d. 600-Volt Wire and Cable Color Coding.

- (1) All single conductor 600 volt wire and cable for 120/240 volt power circuits shall be color coded black for line 1, red for line 2, and white for the neutral.
- (2) For conductor sizes smaller than #8 AWG, conductor insulation shall be color coded. For sizes #8 AWG and larger, and for armored power cable, colored tape shall be used to identify the conductors if insulation is not color identified.
- (3) Conductors shall be color-coded in junction boxes, square duct, terminal boxes, or any other place accessible to view. In no case shall green be used for other than grounding, nor white for other than the system grounded (neutral) conductor.

e. Cable Lengths.

- (1) Wherever possible, cable shall be run in one piece, without splices, from connection to connection. The number of splices shall be minimized. If the job plans do not include a schedule for laying each reel of cable, the Contractor shall provide such a plan for approval to the Contracting Officer prior to installing any of the cable. The plan shall be predicated on the use of the longest practicable lengths of cable to minimize splicing requirements.
 - (a) When cable cutting is required, cable ends shall be effectively sealed against moisture immediately after cutting. The method of sealing shall be approved by the COR. Bands of a radius less than eight times the diameter for rubber-covered or plastic-covered cable, or twelve times the diameter for metallic armored cable shall not be made. Cable that has been kinked shall not be installed.

- (b) When unreeling, an observer shall be stationed at the reel to report any cable irregularities. Unless specifically stated in the plans, non-armored cable shall be used in duct and armored cable used for direct-earth burial. Non-armored coaxial and series lighting cable may be direct earth buried when not otherwise specified. Grounding conductors, where required, shall be #6 AWG bare copper wire, minimum.
- f. Workmanship. All work shall be done by experienced personnel regularly engaged in this type of work. All cable splices shall be performed only by experienced and qualified cable splicers. Before any cable splices are made, the Contracting Officer may request a sample splice be made for approval.

16F.3 DIRECT-EARTH BURIAL CABLE INSTALLATION.

- a. Installation Method. Direct-earth burial cables shall be installed either by the trench and backfill method or by the cable plowing method in accordance with all the requirements specified herein.
- b. General Requirements.
 - (1) Underground cables shall be installed in straight lines between terminating locations or points of directional change.
 - (2) Unless otherwise specified, cables shall be installed a minimum of 24 inches and 36 inches below finished grade on airport property and off airport lands, respectively. When cable is routed under railroad tracks, it shall be in rigid-steel conduit or concrete encased duct with the top of the duct not less than 42 inches below the base of the rail.
 - (3) The Contractor shall prepare a schedule for installing each reel of underground cable and shall submit it to the COR for approval before installing any cable. The plan shall be predicated on use of the longest practical lengths of cable, in order to minimize splicing.
 - (4) A cable loop of at least 3 feet shall be left on each and of every cable run, on at least one side of every splice, and at all points where cable is brought above ground. A 3-foot minimum surplus cable length shall be left on both sides of splices in handholes and light bases. The slack loop shall be installed with the same minimum depth requirements as the cable run. Where cable is brought above ground, enough additional slack cable shall be left to make the required connections.
- c. Trench and Backfill Installation Method.
 - (1) Comply with all trenching, backfilling, compaction, and restoration requirements in Division 2.
 - (2) Where turf is well established and sod can be removed, it shall be carefully stripped and properly stored. The Contractor shall excavate all trenches for direct earth burial cable as follows:
 - (a) At the depth specified in Paragraph 16F.3.b(2) above.
 - (b) To a width of not less than 6 inches for a single or multiple runs of power, or control and signal cable.

- (c) To a width and depth which will provide horizontal or vertical separation of power cables as specified in Paragraph 16F.3.f from other power cables of different voltage ratings, or from any power cable and any control or signal cable.
 - (d) Unless otherwise specified, all cables in the same location and running in the same general direction shall be installed in the same trench. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, trenches shall be opened only for the time required to install and inspect cables. The trench shall be closed in the same working day.
- (3) Where rock is encountered, it shall be removed to a depth of 3 inches below the required cable depth, and shall be replaced with a bedding material of earth or same containing no mineral aggregate particles that would be retained on a 1/4 inch sieve. When a ledge is encountered, the COR shall be consulted regarding alternatives such as re-routing, transition to overhead lines, or installation in rigid steel conduit.
 - (4) The Contractor shall unreel the cable adjacent to or over the trench and manually place it in the trench. Do not pull the cable into the trench or drag it along the trench.
 - (5) Where more than one cable is installed in the same trench, maintain separation as hereinafter specified. Multiple cables shall be installed in the same relative positions throughout the cable trench. Cables shall not be stacked, crossed or intertwined in any manner.
 - (6) After underground cable has been installed, the trench shall be backfilled. The first layer of backfill shall be 3 inches deep, loose measurement, and shall be either earth or natural sand containing no material aggregate particles that would be retained on a 1/4-inch sieve. This layer shall not be compacted. The second layer shall be 9 inches deep, loose measurement, and shall contain no particles that would remain on a 1-inch sieve. The remainder of the backfill shall be excavated or imported material and shall not contain stone aggregate larger than 4 inches maximum diameter. The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent undisturbed soil and to the satisfaction of the COR.

- (7) Trenches shall not be excessively wet and shall not contain pools of water during backfilling operations. Trenches shall be completely backfilled and tamped level with the adjacent surface. If necessary to obtain the desired compaction, backfill material shall be moistened or aerated. When sod is to be placed over a trench, backfill shall be stopped at a depth equal to the thickness of the sod to be used. Any excess excavated material shall be removed in accordance with instructions from the COR.
- d. Restoration. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the trenching, storing of dirt, cable laying, pad construction, and other work shall be restored to the original condition. Restoration shall include any necessary grading, fertilizing, liming, seeding, sodding, sprigging, or mulching as required to restore the disturbed area to match the adjacent area. Where trenching cuts through paved area, the surface shall be properly backfilled and resurfaced with paving similar to the original paving. Resurfaced areas shall be level with original paving, free from cracks and capable of withstanding full traffic loads without settling or cracking. The Contractor shall be held responsible for maintaining all disturbed and restored surfaces until final acceptance.
- e. Cable Plowing Method.
- (1) Vibratory cable plowing equipment, adequate for installation of the types of cables to be installed and for the depth required, may be used, provided that soil conditions are suitable, equipment is in good working order, and proper installation procedures are utilized.
 - (2) While cable is being plowed into place, one person in addition to the operator of the plowing vehicle shall be present to assure that the cables do not kink or bind tightly while entering the plow.
 - (3) If, during plowing operations, it appears that the soil contains sharp objects, rocks over 2 inches in diameter, or any other hazard to the cable, plowing shall be discontinued, and the COR notified. The COR shall determine whether plowing will be allowed to continue, or whether another cable placement method shall be used.
 - (4) The slice left by the plow shall be closed by tamping or other approved method, after cable placement, to minimize the disturbance of the surface by the slice.

f. Cable Separation - Direct Burial.

- (1) Where new buried power cables cross over or under control or telephone cables, power cables shall be installed in a length of PVC duct extending two feet each side of the crossing. Minimum separation shall be twelve inches.
- (2) Power cables of the same circuit may be laid together in the trench without separation, except as noted below. Series lighting cables may be considered being of the same circuit.
- (3) Power cables, or the same or different circuits of less than 600 volts, may be laid together in the same trench without separation.
- (4) All power cables, 5,000 volts and below, shall be separated from all control, telephone, and coaxial type cables by a minimum of 6 inches.
- (5) Power cables of more than 5,000 volts, shall be separated from all other cables by a minimum of 12 inches.
- (6) Control and signal cables may be installed without separation from each other.

g. Cable Guard Wires. Guard wires shall be provided in accordance with the grounding requirements of Paragraph 16A.5.e above.

16F.4 CABLE INSTALLATION IN UNDERGROUND DUCTS AND CONDUIT.

a. General. All underground ducts shall be:

- (1) Rigid-steel conduit (heavy wall) conforming to UL 6, or
- (2) Rigid non-metallic conduit (duct) conforming to UL 651 and NEMA TC 2.

b. Conduit Burial. Rigid-steel conduits may be direct earth buried. Rigid non-metallic conduits shall be concrete encased.

- c. Duct Size, Material, and Installation. Ducts shall be of the size, material, and type indicated on the Drawings or Specifications. Standard precast spacers shall be used for duct support and alignment. Where no size is indicated on the Drawings or Specifications, the ducts shall not be less than 4 inches inside diameter. All duct lines shall be laid to slope toward handholes, manholes, and duct ends for drainage. Grades shall be at least 3 inches per 100 feet. On runs where it is not practicable to maintain the slope all one way, the duct line shall be sloped from the center in both directions toward manholes, handholes, or duct ends. Pockets or traps where moisture may accumulate shall be avoided.
- d. Access Penetrations. Where a steel conduit penetrates a wall of a manhole or handhole, a grounding bushing shall be provided. These grounding bushings shall be connected to each other and to the earth ground system with #6 AWG bare copper conductors.
- e. Mandrel Requirements. The Contractor shall mandrel each duct he installs and each existing duct in which he installs or replaces cable. An iron-shod mandrel, not more than 1/4-inch smaller than the bore of the duct, shall be pushed through each duct with jointed conduit rods. The mandrel shall have a leather or rubber gasket slightly larger than the duct hole.
- f. Spare Ducts. All spare ducts installed by the Contractor shall be provided with #10 AWG copper-clad steel pull wires or polyolefin pull lines with a minimum tensile strength of 200 pounds. The open ends of the spare ducts shall be sealed with removable tapered plugs of a type recommended by the duct manufacturers. The plug shall be adapted to firmly secure the pull wire.
- g. Duct Protection. All ducts shall be securely fastened in place during construction and progress of the work, and shall be plugged to prevent seepage of grout, water, or dirt. Any duct section having a defective joint shall not be installed. Trenching for ducts shall be in accordance with Paragraph 16F.3 of this Specification.

- h. Ducts Encased in Concrete. Concrete-encased duct shall be installed so that the top of the concrete envelope or conduit is not less than 18 inches below the bottom of paving when installed under runways, taxiways, and other paved areas; and not less than 18 inches below finished grade when installed in unpaved areas.

All concrete encased ducts shall be placed on a layer of concrete not less than 3 inches thick prior to its initial set. Where two or more ducts are encased in concrete, the Contractors shall space them not less than 1-1/2 inches apart (measured from outside wall to outside wall) using spacers applicable to the type of duct. As the duct laying progresses, concrete not less than 3 inches thick shall be placed around the sides and top of the duct bank. End bells or couplings shall be installed flush with the concrete encasement where required. Interlock spacers shall be used every 5 feet to insure a uniform spacing between ducts. All bottom spacers shall be secured to 1-inch by 3-inch boards to prevent sinking and overturning. All joints in adjacent ducts shall be staggered a minimum of 24 inches apart and shall be made completely waterproof prior to concreting.

- i. Ducts Without Concrete Encasement. Underground ducts shall be installed so that the tops of all such ducts are at least 18 inches below finished grade. Underground ducts, except rigid steel conduit, shall not be installed under paved areas, roadways, railroad tracks, or ditches. Trenches for single-duct lines shall be not less than 6 inches nor more than 12 inches wide, and the trench for two or more ducts installed at the same level shall be proportionally wider. Trench bottoms for ducts without concrete encasement shall be made to conform accurately to grade to provide uniform support for the duct along its entire length. A 3-inch layer of bedding material shall be placed around the ducts. The bedding material shall contain no particles that would be retained on a 1-inch sieve. The bedding material shall be tamped until firm. When two or more ducts are installed in the same trench without concrete encasement, they shall be spaced not less than 2 inches apart (outside wall to outside wall) in a horizontal direction or not less than 6 inches apart (outside wall to outside wall) in a vertical direction.
- j. Guard Wires. Ducts, whether encased or not encased, which contain cables that are not routed in ferrous conduit, shall be provided with a guard wire in accordance with the grounding provisions of Paragraph 16A.5.e above.

k. Installation Equipment. Major equipment items, required for installing cable in underground ducts, shall include the following:

- (1) Power winch.
- (2) Cable feed-in tubing guide capable of producing a uniform and rigid 3 and 4-foot and greater radius bend, and having a nominal diameter equal to that of the ducts.
- (3) Single pulleys or sheaves providing a minimum cable bending radius (not overall sheave radius) of 10 times the largest cable diameter. Such sheaves shall be used for minor cable bends within "through cable" manholes and at feed-in manhole rims (if necessary). Sheaves shall have ball or roller bearings.
- (4) Adjustable gang pulleys with three or more pulleys capable of producing up to a 4-foot smooth cable bending radius. Each pulley shall have minimum cable bending radius of 10 times the largest cable diameter.
- (5) Lubrication equipment to pre-lubricate ducts, cables at guide-in tubing, and cables at intermediate pull-through manholes.
- (6) Cable reel support equipment including stands, arbor, and braking mechanism.
- (7) Dynamometer for measuring pulling tensions.
- (8) Communications equipment.
- (9) Pulling ropes or cords having the following characteristics:
 - (a) A working strength at least equal to the maximum allowable cable tensions as specified herein. "Working strength" is normally 10 to 14 percent of published rope "breaking strength."
 - (b) Rope or cord shall be a twisted or braided synthetic fiber unaffected by water and having a low level of elongation under load. Material shall have a texture non-injurious to plastic duct when pulled against bends. Wire rope, if proposed, shall have a smooth and rigidly adhering synthetic material covering.

(c) All pulling ropes or cords shall have swivel devices at cable attachment ends.

- (10) Cable lubricant specifically manufactured for electrical and control (telephone) cables. Do not use soap lubricants or those containing soap which are harmful to polyethylene- sheathed cables.
- (11) Cable pulling devices (secured to ends of cable as specified below).

1. Cable Pulling Devices.

- (1) Pulling devices for securing cable to pulling rope shall be factory-installed pulling eyes, field-installed pulling eyes, or basket weave cable grips. All shall be provided with integral or separate swivels.
- (2) Factory-installed pulling eyes necessitate that each cable pulling segment be cut to length by the cable manufacturer. Greater tensions and longer pulling lengths can be used with factory pulling eyes for straight duct bank segments.
- (3) Field-installed pulling eyes for control cable shall be a 4-crimp series, sized to the cable. Power cable pulling eyes shall be a type secured to conductors and approved by the COR.
- (4) Basket weave cable pulling grips shall be carefully sized to the specific diameters of the cables to be installed. Use grips with a rotating eye feature for power and control (telephone) cables.

m. Duct Cleanout and Pre-Lubrication.

- (1) If any new or existing underground duct or conduit displays any evidence of contamination by soil or other foreign matter, such ducts or conduit shall be cleaned with a stiff bristle brush, swabbed, and flushed clean with water under pressure, before proceeding with cable pulling operations. Even a minor amount of soil or sediment in the bottom area of a duct will greatly increase the coefficient of friction and pulling tension required. With soil contamination, cable lubricant is of little value. Therefore, it is of utmost importance that conduit be cleaned prior to installation of cable.

- (2) It is the Contractor's responsibility to determine whether ducts designated for occupancy should be cleaned. The Contractor shall assume complete responsibility for any difficulties or damage to the cable in placing cable in ducts.
- (3) In addition to cable lubrication as specified elsewhere, all ducts to receive cables under this contract, shall be pre-lubricated using the same lubricant as for cables. Lubrication shall be thoroughly applied with applicators designed for this purpose. Lubrication on cable only, will rub off to a large degree, especially at duct bank offsets at manholes.

n. Setting Up Cable Reels and Apparatus.

- (1) The Contractor shall inspect cable reels for flange protrusions which could damage the cable sheath. Also, the Contractor shall inspect for any obstructions that could interfere with proper unwinding of the cable.
- (2) Careful control shall be exercised in the movement of cable reels. Where it is necessary to roll a reel to a desired location, it shall be rolled in the direction indicated by the arrows painted on the reel flanges. The reel shall not be allowed to tilt. A substantial runway of heavy planks should be employed where uneven ground conditions exist that may cause the reel to tilt. Where it is necessary to move a reel of cable with heavy equipment, a cable reel sling or equivalent should be used.
- (3) In conduit sections containing curves, the cable reel shall be set up at the manhole near the curve unless other conditions do not permit.
- (4) Cable reels shall be set up on the same side of the manhole as the conduit section in which the cable is to be placed. The reel shall be made level and brought into proper alignment with the conduit section so that the cable may be passed from the top of the reel in a long smooth bend at maximum radius into the duct without twisting and making more than a 90-degree bend. This is of utmost importance in handling filled type cable in temperature ranges of 35°F and lower. Under no circumstances shall the cable be pulled from the bottom of a reel.
- (5) It is essential that the cable reel be in proper alignment and level during the placing operation. Incorrect location of the reel will cause unnecessary binding which will result in uneven cable feed.

- (6) Do not permit adjacent turns of cable on the reel to stick together and cause binding as the cable is payed off the reel. Feed the cable by rotating the reel manually.
- (7) Other cable support equipment, such as pulleys, sheaves, and gang-pulley equipment shall be set up rigidly within intermediate manholes to smoothly guide cables to exiting ducts.
- o. Attaching Pulling Grips. All pulling grips shall be stretched onto the cables such that the entire lengths of the grip woven material will exert tension on the cable, thereby distributing stress. If the end of any cable grip (furthest from the cable end) does not grip as tightly as the lead end, secure same to cable with a steel banding. Inspect cable grips frequently, and the first pull of control (telephone) cable in particular (in the first intermediate manhole), to ascertain that this requirement is fulfilled. If any uneven gripping is evident, banding will be required for all remaining cable installation of the applicable cable type and size.
- p. Feeding and Pulling Cable.
 - (1) All cable shall be installed using methods that will prevent excessive and harmful stretching, twisting, and flexing of the cable. Such damaging treatment will mechanically weaken the cable and destroy the electrical properties immediately or in a short time.
 - (2) Cable may be pulled by hand or power winch. Pull rope shall be attached to cables with pulling eye or basket weave pulling grips (all equipped with swivels) for each cable pulled. Do not exceed maximum allowable pulling tension as hereinafter specified. Do not use cable manufacturer's maximum pulling tensions except for cable factory-installed pulling eyes.
 - (3) All splices shall occur in manholes only. Splices shall not be pulled into ducts or manholes.
 - (4) Cable feed-in tubing guide, same size as conduit, of suitable length shall be secured in the manhole between the cable reel and the face of the duct to protect the cable and guide it at the maximum possible smooth radius into the duct as it is payed off the reel.

- (5) A cable lubricator (funnel) shall be placed around the cable just ahead of the cable feed-in guide to facilitate lubrication of the cable. The quantity of lubricant shall conform to the lubricant manufacturer's recommendations.
- (6) Before starting to pull, check the equipment carefully to make sure that it is properly set up in order to minimize the chance of interruption once pulling has started. Tension shall be kept on both the cable reel and the pulling line at the start of the pull. Excessive slack and the twist of the pulling line may cause the connecting links to turn and catch in the duct. As far as possible, the cable shall be pulled in without stopping. A pulling speed of 80 to 100 feet per minute is recommended to minimize friction forces.
- (7) A person experienced with cable handling shall be posted continuously at the cable reel while pulling cable. In addition to braking the reels and observing cable lubrication, he shall carefully inspect cable paying off the reel for cable sheath and other defects. If defects are noticed, the pulling operation shall be stopped immediately and the COR promptly notified of the defect. Kinks and/or irregularities in the cable sheath shall be removed or corrected as directed by the COR.
- (8) Careful attention shall be paid to signals from the installation crew as the cable is being pulled so that pulling may be stopped instantly whenever necessary to avoid damage to the cable.
- (9) If for any reason the pulling operation is halted between manholes, the winch operator shall not release the tension on the winch unless directed to do so. In restarting the pulling operation, the inertia of the cable shall be overcome by gradually increasing the tension in steps a few seconds apart until the cable once again is in motion.
- (10) The leading end of the cable at intermediate manholes shall be guided into the duct and a feeder tube nozzle placed around the cable to prevent the cable from rubbing on the edge of the duct.
- (11) All pulled ends shall be examined for evidence of damage due to the pulling operation. The cable sheath shall not be pulled beyond the cable core. Notify the COR for inspection, and for repair or replacement action that must be taken where cracks or openings are

found in the cable sheath following the pulling operations.

- (12) Cable ends shall be kept sealed at all times using RUS approved cable end caps and electrical tape. After the cable has been placed, the exposed cable in the manholes should be wiped clean of cable lubricant with a cloth before leaving the manhole.
- (13) All individual cable segments shall be pulled in one direction only. Both ends of a cut cable segment shall not be introduced into an intermediate manhole and pulled in two different directions. Also, no cable segments shall be pulled out of any manhole and introduced into the same manhole for a continuation of a cable segment pull. These unacceptable pulling practices, used to avoid splicing, result in abrasion from dragging over ground surfaces and manhole frame, exposure to pedestrian and vehicular traffic, damage to cable layers from twisting and small bending radii when pulling cable loops through manhole frame. Shields of cables so pulled are almost always damaged.
- (14) Sidewall cable pressure from duct bends, feed-in tubes, and pulleys, frequently govern the length of cable that can be pulled. The greater the radii, the less the sidewall pressure. Therefore, the Contractor shall use the maximum radius at every manhole where a 90-degree pull is permitted. Adjustable gang pulleys with three or more pulleys shall be used for horizontal bends in manholes. Individual pulleys within the gang pulley device shall have a cable bending radius of minimum 10 times outside diameter of largest cable to be pulled. Width of pulleys shall be adequate to support the cable group to be pulled. Adjust gang pulleys to produce a smooth 90 degree curvature bend where such changes in direction occur.
- (15) If cables will be spliced in a manhole where duct banks enter and leave 90 degrees apart, separate cable segments shall be introduced into the manhole and pulled in different directions unless pulling is permitted around a horizontal gang pulley within the manhole.
- (16) Where more than one cable will be installed in a single duct, all shall be pulled into the duct concurrently.

- q. Cable Spoil. All cable pulling ends shall be trimmed back to remove cable material always damaged by pulling eyes or basket weave pulling grips. To remove such spoil, cut each cable off a distance from the end equal to three times the length of pulling eye or twice the length of the basket weave pulling grip as a minimum. These amounts shall be cut off for all cables including those to be spliced or terminated by others.
- r. Use of Dynamometer.
- (1) The dynamometer shall be accurately calibrated and secured to properly indicate tension exerted on the cable. The dynamometer reading will usually give the resultant force exerted on the anchoring device, which shall be converted to the horizontal component to give correct value of pulling tension.
 - (2) Dynamometer readings shall be made only in the presence of the COR. If any pulling tension is approaching the maximum allowable, and if in the judgment of the COR, the allowable will be appreciably exceeded for the proposed run, pulling operations shall be immediately stopped, and the cable run spliced in the preceding manhole.
- s. Maximum Cable Pulling Tensions. Maximum allowable cable pulling tensions, as measured by dynamometer, shall not exceed the following values for single cables. For multiple cables, add the tension values for the number of cables being pulled. Use a pulling rope having a working strength [not breaking strength, reference subsection 16F.4k(9)] at least equal to the "maximum allowable pulling tension" values below.

<u>Cable</u>	<u>Maximum Allowable Pulling Tension (lbs)</u>
1-1/C #8	125
1-1/C #6	200
1-1/C #4	325
1/1-C #2	500
1-6 PR #19	125
1-12 PR #19	250
1-25 PR #19	500

- t. Separation of Cables Installed in Conduit or Duct.
- (1) Power cables of the same voltage may be installed in the same duct.
 - (2) Power cables of less than 600 volts may be installed in the same duct.

- (3) Power cables of less than 600 volts shall not be installed in the same duct with control, telephone, or coaxial type cables.
- (4) Power cables of more than 600 volts shall not be installed in the same duct with control, telephone, coaxial, or power cables of less than 600 volts.
- (5) Control, telephone, and coaxial cables may be installed in the same duct.
- (6) Power cables may be installed in the same duct system as control and signal cables, but power cable shall be installed in a different duct separated a minimum of 3 inches (outside wall to outside wall) from ducts that encase control and signal cables. Power cables rated more than 600 volts shall be separated from control and signal cables to the maximum extent possible in the duct system.

u. Cable Installation in Manholes or Handholes.

- (1) Power and control cables shall be installed in separate manholes or handholes unless otherwise specified. If installed in same manhole, install power and control cables on opposite sides. At splice locations, use cable racks at different elevations to separate power and control cables.
- (2) Cable racking surplus shall be pulled back by hand into intermediate manholes. Pull surplus one manhole at a time beginning near both ends of cable segment. Do not use power winch unless permitted by the COR.
- (3) Cables shall be carefully routed around manhole interiors, taking all necessary precautions to prevent sharp bending. Cable racks shall be plastic or galvanized steel with properly sized porcelain insulators for the latter. Fasten all cables to plastic racks with nylon ties and to steel racks by means of the insulators.
- (4) Where a splice occurs, cable shall make one loop around , and the splice located near the center of the loop.
- (5) Where power and control cables are installed in the same manhole, the entire exposed length of all power and control (telephone) cables shall be fireproofed by applying fire and arc proofing tape.

16F.5 CABLE LABELING.

- a. All cables shall be labeled in each manhole and in each terminal cabinet with not less than two labels per cable, one near each duct entrance hole. Labels shall be attached to cables immediately after installation of each cable.
- b. Labels shall be military grade, pre-cut, heat-shrinkable flattened polyolefin and shall readily accept thermal transfer print. The product shall meet the material requirements and physical properties of AMS-DTL-23053/5C (Class 1 and Class 3). Label size shall be consistent with the manufacturer's maximum size for a particular cable size range, have a white background with 1/4-inch high black lettering, or the maximum size letters for labels that cannot accommodate the 1/4-inch height.
- c. Labels shall consist of an abbreviation of the facility served, e.g., "ASR", "VORTAC", "ALS", and abbreviations for all the types of cables installed, e.g. "P" for power, "C" for control, and "R" for radio frequency (coaxial). Where like multiple control cables are routed between the same facilities, further identify such cables throughout the run with a single-digit number following the letter "C". All individual-conductor power circuits shall be bundled under the same label as opposed to separate labels for each conductor.

16F.6 WARNING TAPE. Warning tape shall be placed 12 inches above cables that are installed by direct burial, and ducts both with and without concrete encasement. The tape shall be detectable warning tape, 3 inches wide, and yellow in color with the words "CAUTION BURIED CABLE LINE BELOW" printed on it..

16F.7 CABLE MARKERS. The location of direct earth-burial cables, and ducts both with and without concrete encasement, shall be marked at grade surface with concrete slabs, 2 feet square by 6 inches thick. These markers shall be placed every 200 feet along a cable run, at each change of direction of the cable, and at each cable splice. These markers shall be installed within 24 hours of the final backfill of the cable trench. Markers shall be installed flat in the ground with the top approximately 1 inch above the finished grade. After the concrete marker has set a minimum of 24 hours, the top surface shall be painted with bright orange paint manufactured specifically for uncured exterior concrete. Markers shall not be installed in concrete or asphalt surfaces. Each cable marker shall have the following information impressed upon its top surface:

- a. The word, "CABLE."
- b. Name of facility served, e.g., "ASR," "VORTAC," "ALS."
- c. Abbreviations for all the types of cables installed, e.g., "P" for Power, "C" for Control, and "R" for Radio Frequency (coaxial).
- d. An arrow to indicate the direction or change of direction of the cable run.
- e. Any additional information, as directed by the Contracting Officer.

Manholes and handholes shall be identified by "FAA POWER" or "FAA-CONTROL" markings on the covers. These markings shall be cast into steel covers, or die-stamped into a nominal 1/16 inch minimum thickness copper plate razed or fastened to the cover with a minimum of two 10-32 brass screws.

The Contractor shall obtain approval from the Contracting Officer for the information to be impressed on the cable markers and the method used to make the impressions. Letters shall be 4 inches high, 3 inches wide, and 1/2 inch deep.

16F.8 SPLICING.

a. General Requirements.

- (1) Splices shall be performed only by experienced and qualified cable splicers regularly engaged in this type of work.
- (2) Cable armor and/or shielding shall be bonded together across splices to provide continuous electrical paths.
- (3) Where a cable is cut preparatory to splicing, the work shall proceed without delay. When an unavoidable delay is encountered in completing a splice, the opened cable shall be protected to prevent the entrance of moisture and foreign matter.
- (4) Any splicing material (such as resin) older than the do-not-use-after date on the package, shall be replaced with new material at the Contractor's expense.
- (5) Unless otherwise specified, where multiple runs of single-conductor underground power cables are spliced, each single-conductor cable shall be spliced in a separate envelope.

- (6) Approved stress reduction methods shall be used in splicing all shielded high voltage power cables (5KV and higher voltage).
- b. Underground Power Cable Splices (600 Volts or Less). All low voltage splices shall be encapsulated in pressure resin in clear plastic envelopes, except as otherwise specified in Paragraph 13A.6 above, on drawings, or in special Specifications. All low voltage splices shall be made with compression connectors specified in Paragraph 13A.6 above, except as otherwise specified on drawings and in special Specifications.
- c. Underground Control (Telephone Cable) Splices.
- (1) Kit and Resin. The splices shall consist of a rigid polypropylene mold body with a built-in spacer web to provide cable centering and proper compound coverage. The mold body shall be filled with a flexible polyurethane electrical compound capable of continuous operation at 90°C, with an emergency overload temperature rating of 130°C. Splices must have provisions for inline splicing of shielded or non-shielded plastic or rubber-jacketed control (telephone) cables. The splices shall be rated for direct burial applications. For control cables with outside diameters between 0.25 inches and 3.25 inches, 3M Scotchcast Signal and Control Cable Inline Splicing kits of the 72N series are approved, as they are among kits which meet Specifications.
- (2) Connectors. Control cable splice connectors shall be in-line type, in which two conductors are spliced by laying one conductor in each end of the connector, and crimping the connector with a special tool selected to match the connector type and size. Before crimping, the connector is open on one side of its length. After crimping, the connector is closed all around its length. The connector bodies shall be made with a tin-plated phosphor bronze piece on the inside, to contact the cable conductors, and bonded polyester insulation on the outside, to insulate the connection. The insulation shall be color coded to denote wire size range. The cable splice connectors and tools shall incorporate the insulation displacement termination technique which uses a slotted, tin-plated contact to displace the conductor insulation, thus providing four redundant electrical contact points. Connectors which require pre-stripping the conductor shall not be used. AMP, Inc. (Harrisburg, PA) Picabond connectors sized for conductor size, and matching AMP tooling, are among products meeting the above Specifications, and are approved.

d. Submittals. See Paragraph 1A.4 above. If the Contractor

- (1) Intends to splice using materials different from those specified in Paragraphs b and c above, or
- (2) Intends to splice a 5KV or higher voltage power cable, then the Contractor shall submit to the Contracting Officer, shop drawings or catalog cuts for all splicing materials, tools, and dies. The Contractor shall splice no cables before he has received the Contracting Officer's approval of these items.

16F.9 CONTROL (TELEPHONE) CABLE TERMINATIONS.

a. Cable Routing and Support.

- (1) Cable jackets shall be removed within terminating enclosures such that no more than 2 inches of jacket material is visible within the enclosures. Ground shielding and armor as specified below.
- (2) Exposed cable conductor bundles shall be lock-stitched laced together with nylon lacing twine spaced at approximate 5/8- inch intervals. Each bundle shall contain maximum 25 pairs of conductors which shall be neatly routed and secured to backing panels with nylon clamps.

b. Cable Pair Terminations.

- (1) Terminated pairs shall have the same sequence on each terminal strip. (For terminal block Specifications, see Paragraph 16A.19, above.) The color code termination sequence on the terminal strips shall be in accordance with the following schedule. The white mates shall start at the top or left-hand side of the terminal block with color continuing down or across the block according to the following schedule:

MATE COLORS

PRIMARY WIRE COLORS

WHITE	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
RED	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
BLACK	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
YELLOW	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE
VIOLET	BLUE
"	ORANGE
"	GREEN
"	BROWN
"	SLATE

- (2) When cables do not have the preceding color code, like pairs shall be terminated in the same sequence at both ends of the cable.

16F.10 CABLE ARMOR AND SHIELD GROUNDING.

a. Grounding Locations.

- (1) Control cable armor and/or shielding shall be grounded at both ends of each cable run. Ground unused pairs of control cable at both ends.
- (2) Power cable armor shall be grounded at both ends of each cable run.
- (3) Shielding and armor of control and power cables shall not be grounded at splice locations.

b. Grounding Procedures.

- (1) Use #16 AWG stranded copper grounding conductors for grounding shielding and armor. Secure grounding conductors to shielding and armor by using UL-approved grounding connectors specifically designed for this purpose. Neatly tape ends of butted cable to conceal the connections.
- (2) Attach crimp-type lugs of proper size to free ends of grounding conductors, and secure lugs to enclosure interior wall with a machine screw and nut.

DIVISION 16 - ELECTRICAL
SECTION 16G
CABLE TESTING

16G.1 DESCRIPTION OF WORK. The extent of work is indicated on the drawings and by the provisions of this section. Included in this section are testing of power, control, and coaxial cables.

16G.2 GENERAL REQUIREMENTS.

- a. Both before and after installation, all Contractor-furnished and Government-furnished power and control (telephone) cables shall be tested as required herein. Testing after installation shall be accomplished across splices.
- b. All testing shall be accomplished in the presence of the COR. Furnish two signed and dated copies of all test results, clearly tabulated for all segments of cable tested, to the COR.
- c. The Contractor shall use his own test equipment, which shall bear current calibration certification from a certified instrument calibration laboratory.
- d. Any measured values not conforming to specified values shall be cause for rejection of the defective cable installation. After repair or replacement, if so required by the COR, cable shall be retested and additional remedial work performed until satisfactory test results are obtained. All repair and replacement work shall be accomplished at no additional cost to the Government.

16G.3 INSULATED POWER CABLES, 600 V. Insulation-resistance measurements must be made with both ends of the insulated conductors disconnected from source and load terminals, arresters, and large surge protectors. Apply a 500-volt dc voltage to the conductors being tested with an insulation-resistance test instrument and read the insulation directly on the instrument meter scale. Apply the test voltage for at least 1 minute after the meter reading has stabilized, to allow even distribution of the test voltage throughout the insulation. Apply the test voltage between each insulated conductor and all other conductors, and between each insulated conductor and ground. Record the measured resistance. It shall be a minimum of ~~30 megaohms~~. **50 megaohms**.

- 16G.4 INSULATED POWER CABLES, 5kV. Insulation-resistance measurements must be made with the cable's insulated conductors disconnected on both ends. Apply 10kV dc voltage to the conductor being tested with an insulation-resistance test instrument. Where a 10,000 volt dc test instrument is not available, these tests may be performed at 500 volts dc using a 500 volt dc insulation-resistance test instrument. Apply the test voltage for at least 1 minute after the meter reading has stabilized, to allow even distribution of the test voltage throughout the insulation. Read the insulation leakage current directly from the instrument meter scale. Use the instrument calibration chart to determine the insulation resistance from the leakage current previously on the meter scale. Record the insulation resistance shown by the chart. Apply the test voltage between each insulated conductor and all other conductors in multiconductor cables, and between each conductor and ground. If the conductor-to-conductor or conductor-to-ground insulation resistance measurements of any conductor are below the minimum resistance value of 50 megaohms, part the cable at the splices and measure the insulation resistance of each cable section to isolate the current leakage path.
- 16G.5 APPROACH LIGHTING SYSTEM SERIES LOOP CABLE, 5kV. Apply a 10kV dc voltage to the cable being tested with an insulation-resistance test instrument, connected between one end of the cable and the substation ground. Where a 10,000 volt dc test instrument is not available, the test may be performed at 500 volts dc using a volt dc insulation-resistance test instrument. Apply the test voltage for at least 1 minute after the meter reading has stabilized, to allow even distribution of the test voltage throughout the insulation. Record the insulation resistance shown by the chart. If the cable fails to meet the 50 megaohm standard, sectionalize the loop to determine if the cable or isolation transformers have defective insulation.
- 16G.6 CONTROL CABLE TESTING. For continuity, shorts, crosses, and grounds testing, make these tests with both ends of each conductor disconnected from terminal strip jumper wires, surge protectors, and equipment. The tests should be as follows:
- a. Continuity Tests. Make continuity tests with an ohmmeter at the near end of the cable. Temporarily short each conductor to its paired conductor, common connector, or to a shield or armor, at the far end of the cable. Record the meter readings. Remove the temporary short at the far end of the cable after each conductor or conductor pair is tested for continuity.

- b. Shorts, Crosses, and Grounds Tests. Make the tests with an ohmmeter connected at either end of a cable. Test between all paired or unpaired conductors within a shielded or unshielded conductor group. Test between each conductor and its nearer designated grounding conductor, pair shield, group shield, cable shield, or armor.

For insulation-resistance measurements, apply a ~~500-volt~~ **cable rated** dc test voltage to the conductors being tested with an insulation-resistance test instrument, and read the insulation resistance directly on the instrument meter scale. Apply the test voltage for at least 1 minute after the meter has stabilized. Apply the test voltage between paired conductors, between conductors of a conductor group, and between conductors of an ungrouped cable. Apply the test voltage between each conductor and its designated common grounded conductor, pair-shield, group shield, and overall cable shield or armor. The resistance shall be a minimum of 50 megohms.

16G.7 COAXIAL CABLE TESTING. Test new solid-dielectric coaxial cable for shorts, continuity, and dielectric resistance after installation as follows:

- a. Short-Circuit Test. Test the coaxial cable for a short circuit before the continuity test and dielectric-resistance measurements are made. Test a spliced cable for a short circuit before putting it into service. Disconnect both ends of the cable. Test before a connector is attached to both ends. The connectors are to be attached after the continuity test and dielectric-resistance measurements are completed. After the connectors are attached to the ends of the cable, repeat the short test to ensure that neither connector is shorted internally after attachment to the cable. The connectors are to remain on the ends of the cable for all performance tests thereafter. The test shall be made by connecting the high range of an ohmmeter between the center and outer conductors of the cable, and between the outer conductor and armor of armored cables. The meter needle may deflect toward the zero end of the ohms scale, then move slowly toward the infinite ohms end of the scale. This is caused by the ohmmeter battery voltage stress field being distributed throughout the cable dielectric.
- b. Continuity Test. Test the cable for continuity of its inner and outer conductors. If the test reveals an open conductor, the short-circuit test will have to be repeated after correcting the conductor break. Disconnect both ends of the cable. Unground the outer conductor if covered by a plastic outer jacket. Test before the cable connectors are attached to the ends.

- c. Dielectric Resistance Measurement. Test before the cable connectors are attached, then repeat the test after the connectors are attached. Apply the test voltage between the inner and outer conductor of the cable with an insulation-resistance test instrument. The test voltage should be 500 volts dc, and the minimum resistance shall be 50 megohms.

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**

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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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.

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

FAA-STD-019F Content Arrangement (continued)		
<p>5 DETAILED REQUIREMENTS</p>		<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
<p>6 NOTES</p>		<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

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>	

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.

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.

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.

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.									

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:

- 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

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

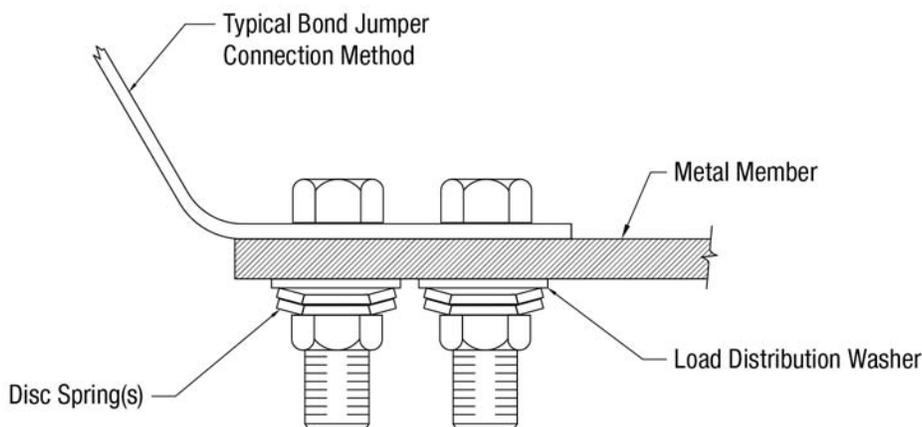
Self-drilling and self-tapping metal screws are permitted to make a physical connection between metal back panels within equipment cabinet/enclosures when access to the opposite side of the bond is not available using other bonding methods.

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.

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:						
<p>1. Other manufacturers of disc spring washers of equal or better performance are permissible. Use bolt assembly manufacturer's recommended torque values.</p> <p>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:</p> $B_{\text{Bolt Clamp Load}} < W_{\text{Number of Washers}} \times F_{\text{Washer Flat Load}}$ <p>For example, a 1/4-in. stainless steel bolted connection requires minimum 1,510 lbs clamp load, therefore, 3 disc washers will be needed.</p>						



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.

- 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.

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.

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.

- 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

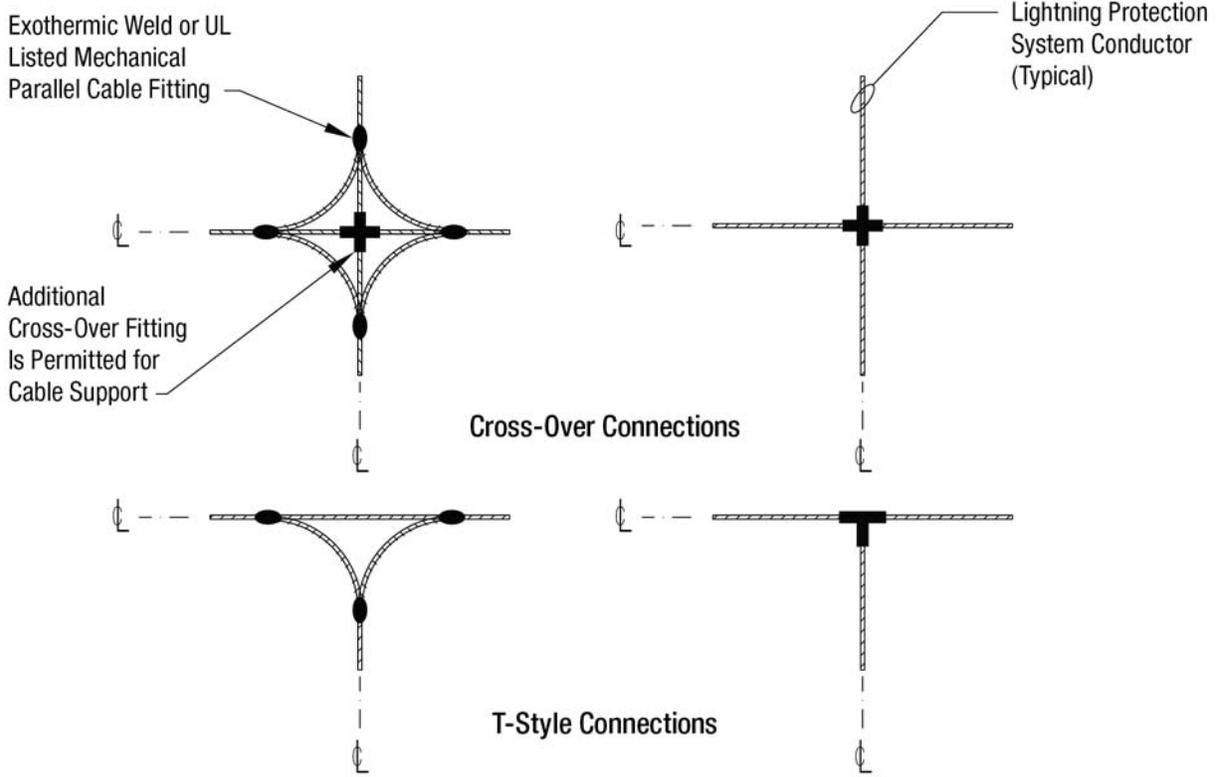
Down conductors shall follow the most direct downward path to earth. Main and bonding conductors shall maintain a downward or horizontal course, and are permitted to rise at no greater than a 1 to 4 slope.

- 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.

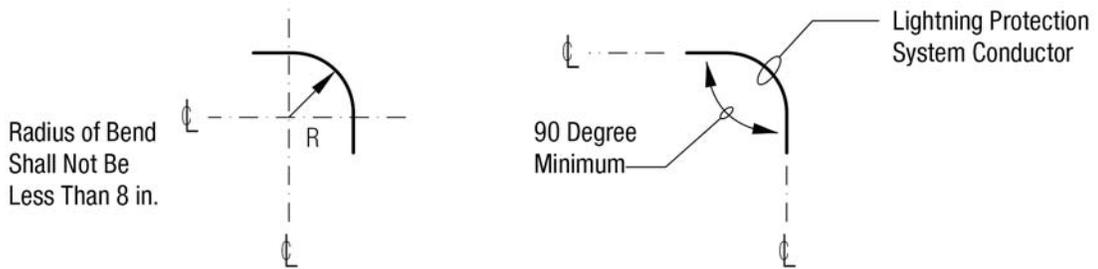
- d. Main Conductors. Main conductors shall be permitted to pass through elements of the building structure, e.g., parapets, eaves, walkways, walls, where necessary to maintain horizontal or downward course. Provide a 2-in., Schedule 80 rigid PVC conduit sleeve, or UL listed through-connector fitting 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.

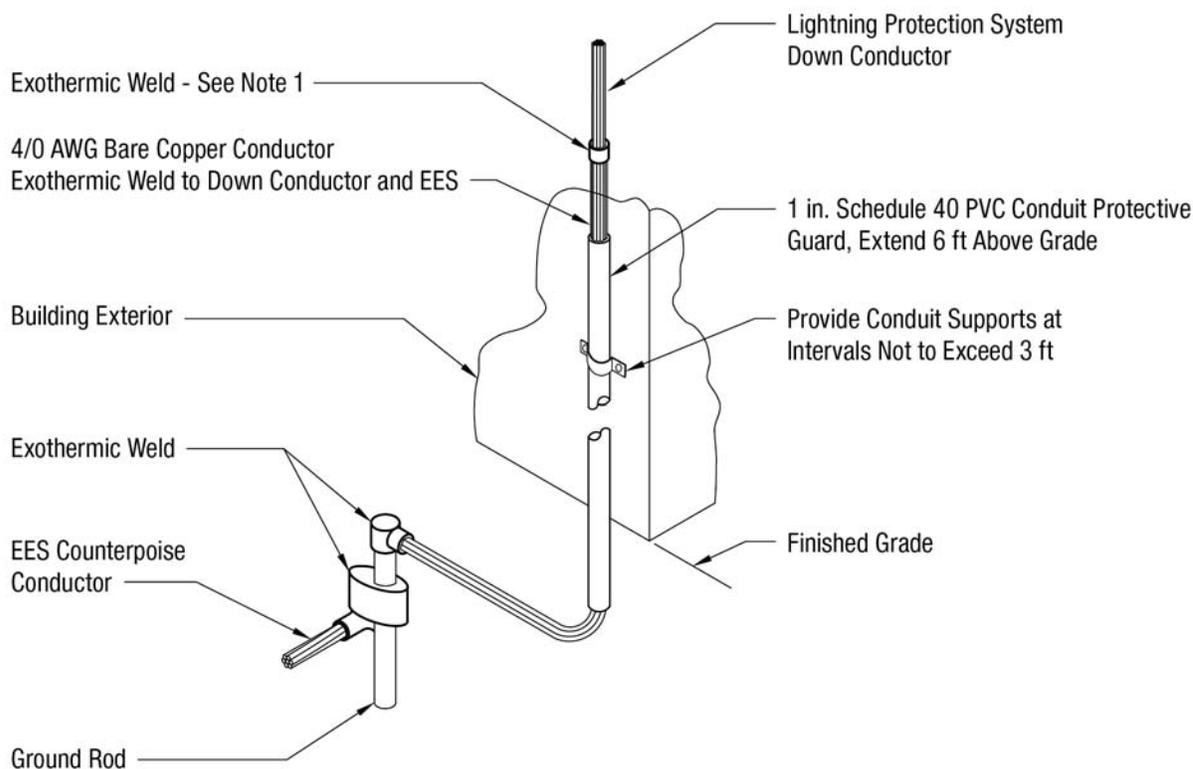


CABLE-TO-CABLE HORIZONTAL AND VERTICAL CONDUCTOR CONNECTIONS



CONDUCTOR BENDING REQUIREMENTS

Figure 2. Lightning Protection System Main Conductor Connections – Illustrative Example



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

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.

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.

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.

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.

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.

- 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

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.

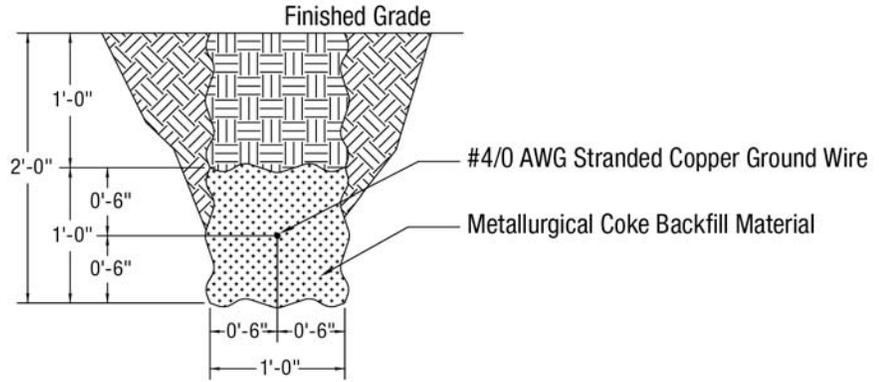


Figure 5. Grounding Trench Detail

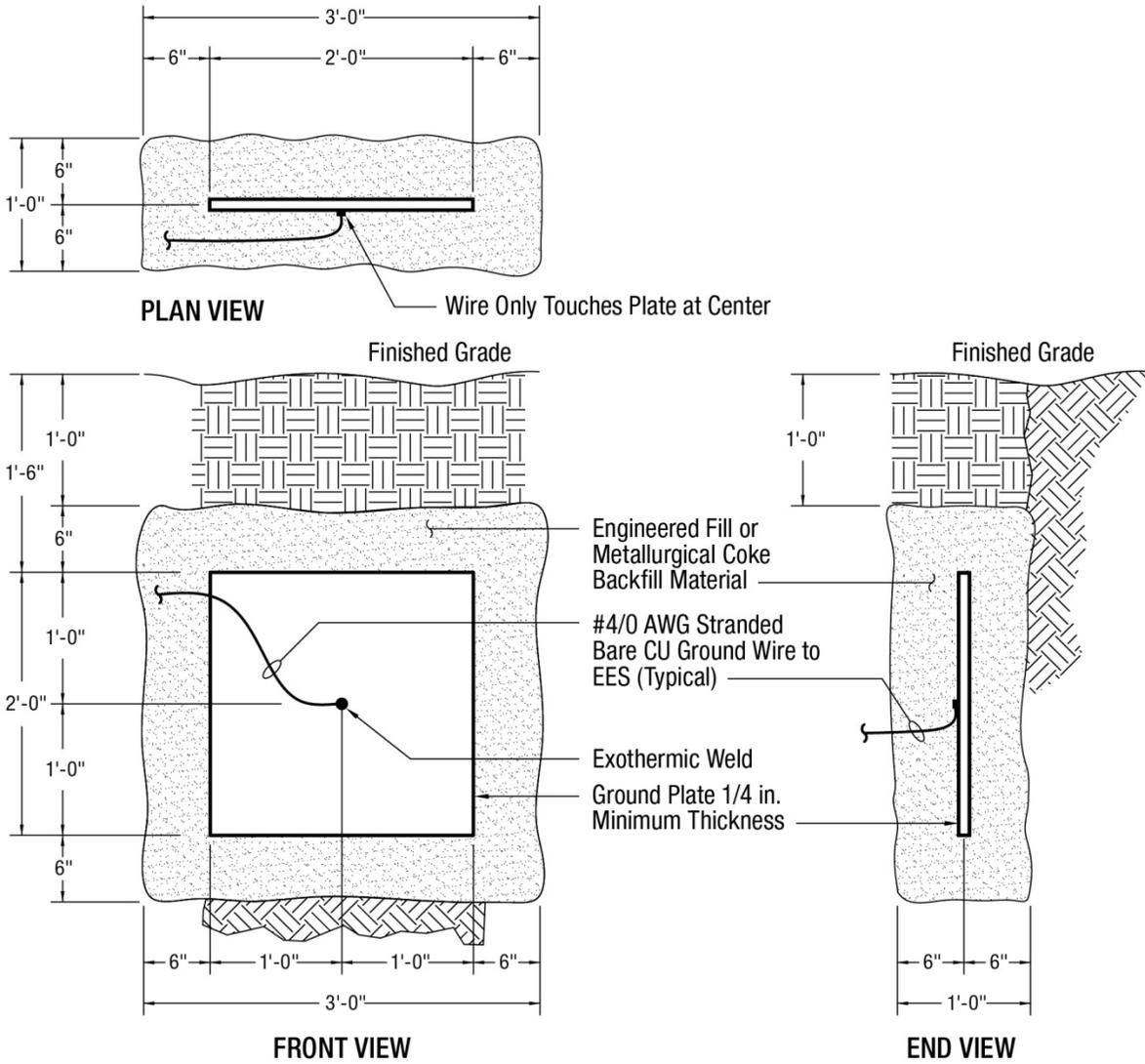


Figure 6. Ground Dissipation Plate Detail

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

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:

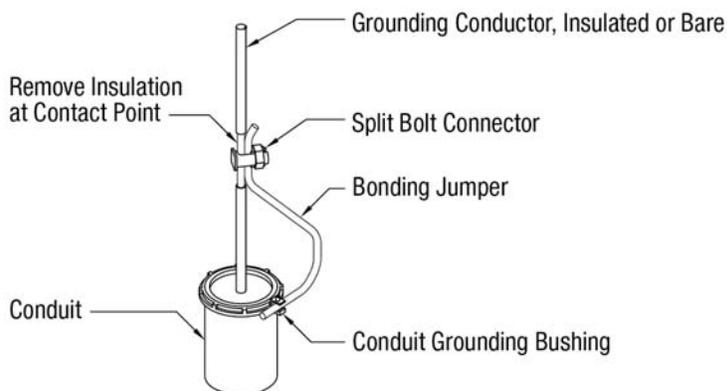
- a. IMC and RMC Conduits. A grounding bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation (see Figure 7).
- b. EMT Conduits. The connectors shall have an insulated throat, smooth bell shaped end, or a grounding bushing.
- c. Communication Conduit Pathways. 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.*

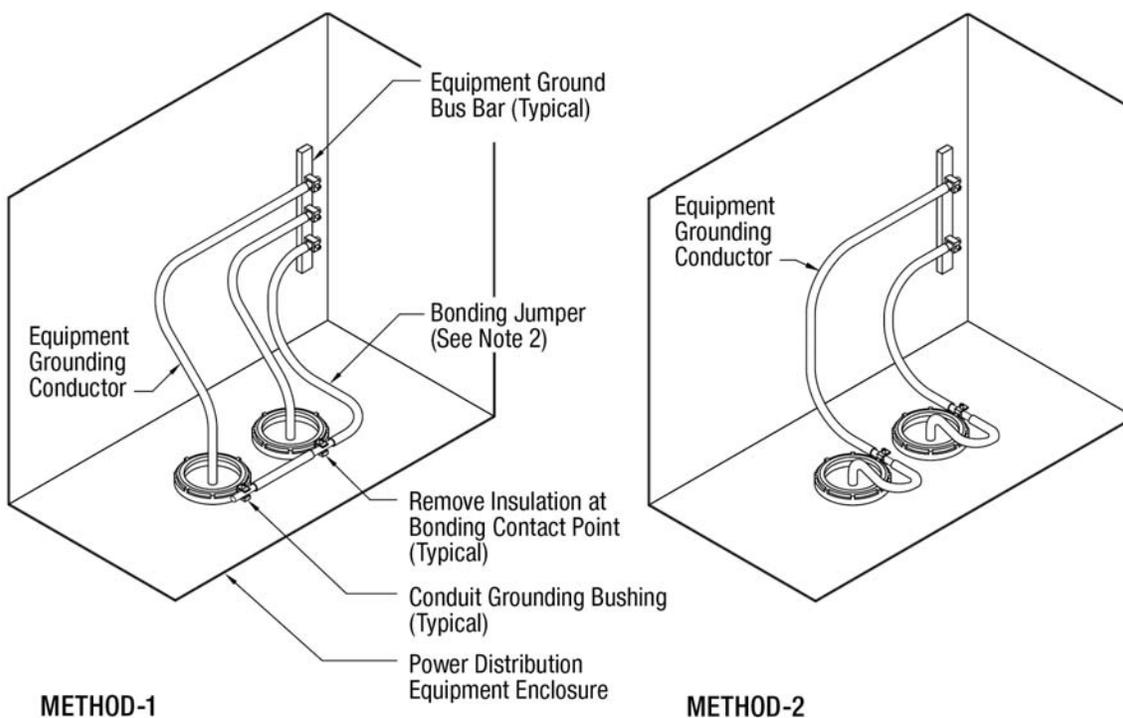
4.5.4.1 Non-Current-Carrying Metal Equipment Enclosures

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.



ILLUSTRATIVE EXAMPLE: CONDUIT RACEWAY



METHOD-1

METHOD-2

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

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.*

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.

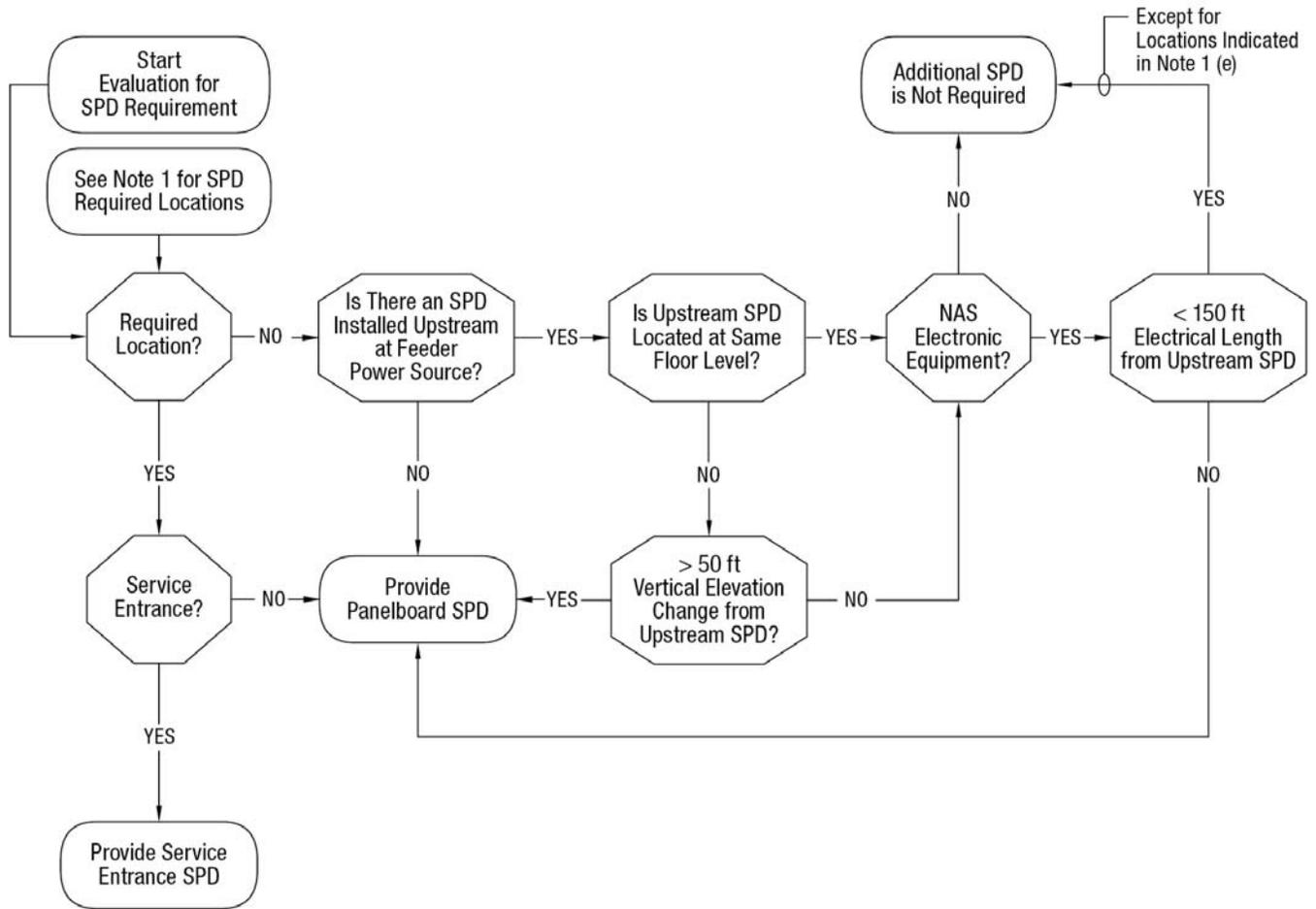
Where feeder and branch panelboards are located close together and their panelboards do not serve exterior circuits, use the SPD location decision tree diagram, Figure 8, to determine if an SPD is required for branch panelboards. SPDs for panelboards that provide service to exterior circuits shall meet requirements of paragraphs 5.7.2.1.1, 5.7.2.1.2, and 5.7.2.1.3 for facility entrance SPDs.

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.



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

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.

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.

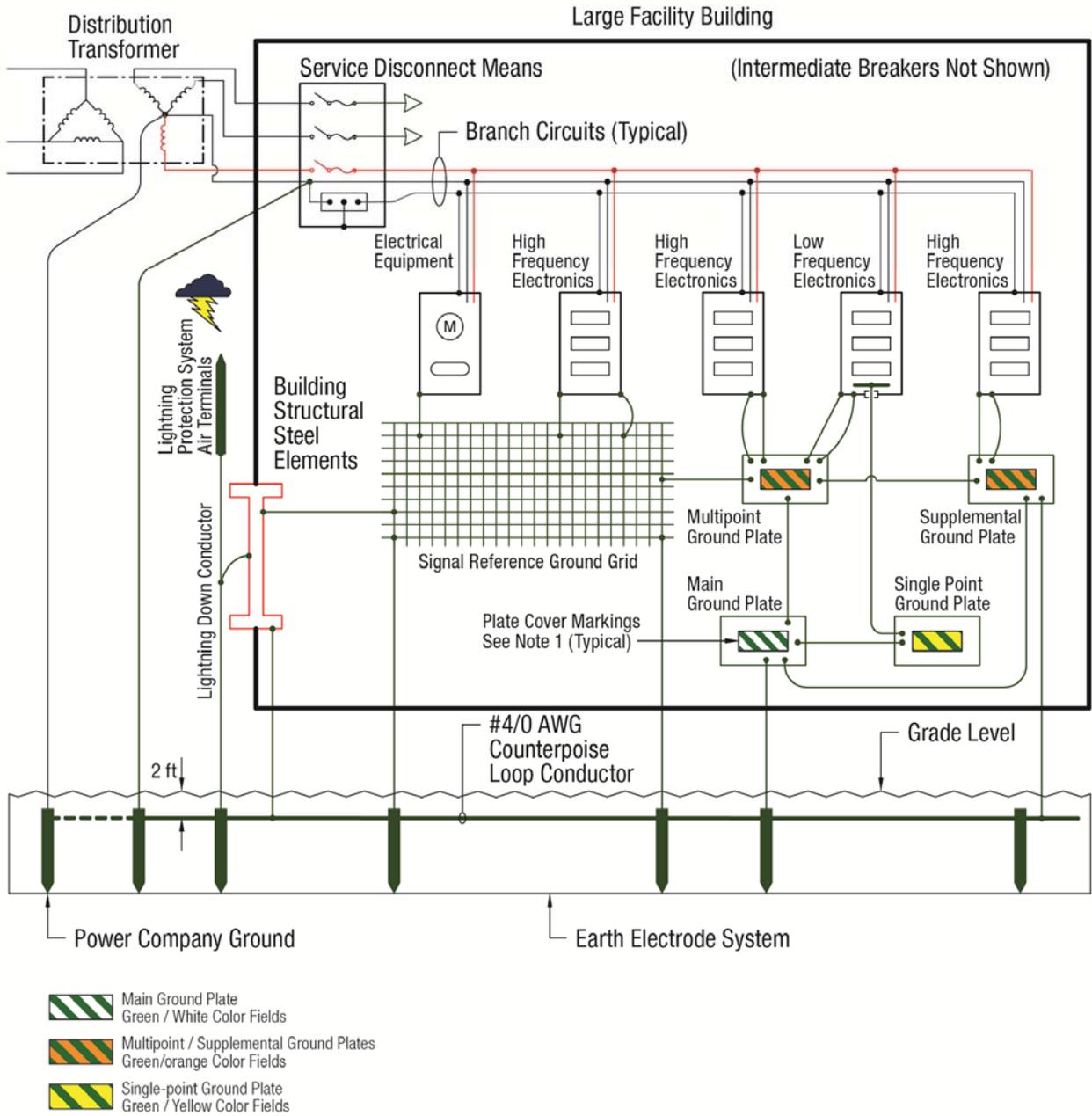


Figure 9. Typical Facility Grounding System

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.

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.

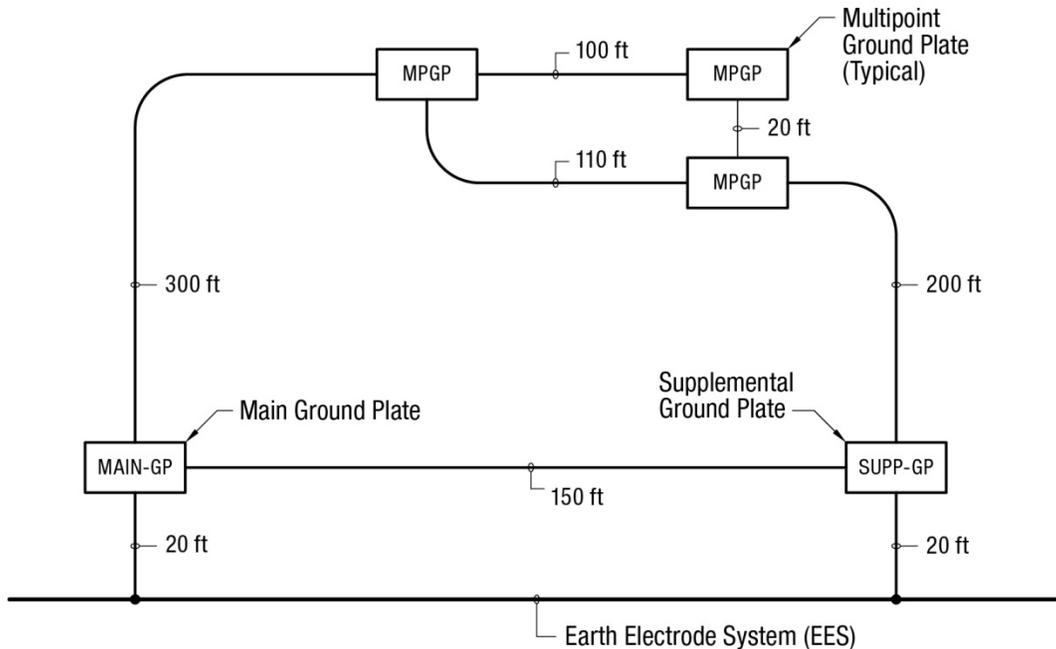
See Table 4 for the multipoint ground plate installation requirements. Ground buses shall be copper material. Ground bus width and thickness shall be selected from Table 3, and shall be as long as required.

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.

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

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.

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: a. <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. b. <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: a. <u>Main-GP.</u> Provide label caption, “MAIN GROUND PLATE” and cover markings with clear background and green slashed marking tags around the caption. b. <u>Supp-GP.</u> Provide label caption, “SUPPLEMENTAL GROUND PLATE” and cover markings with clear background and green slashed marking tags around the caption. c. <u>MPGP.</u> Provide label caption, “MULTIPOINT GROUND PLATE” and cover markings with green background and bright orange slashed marking tags around the caption. d. <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.				

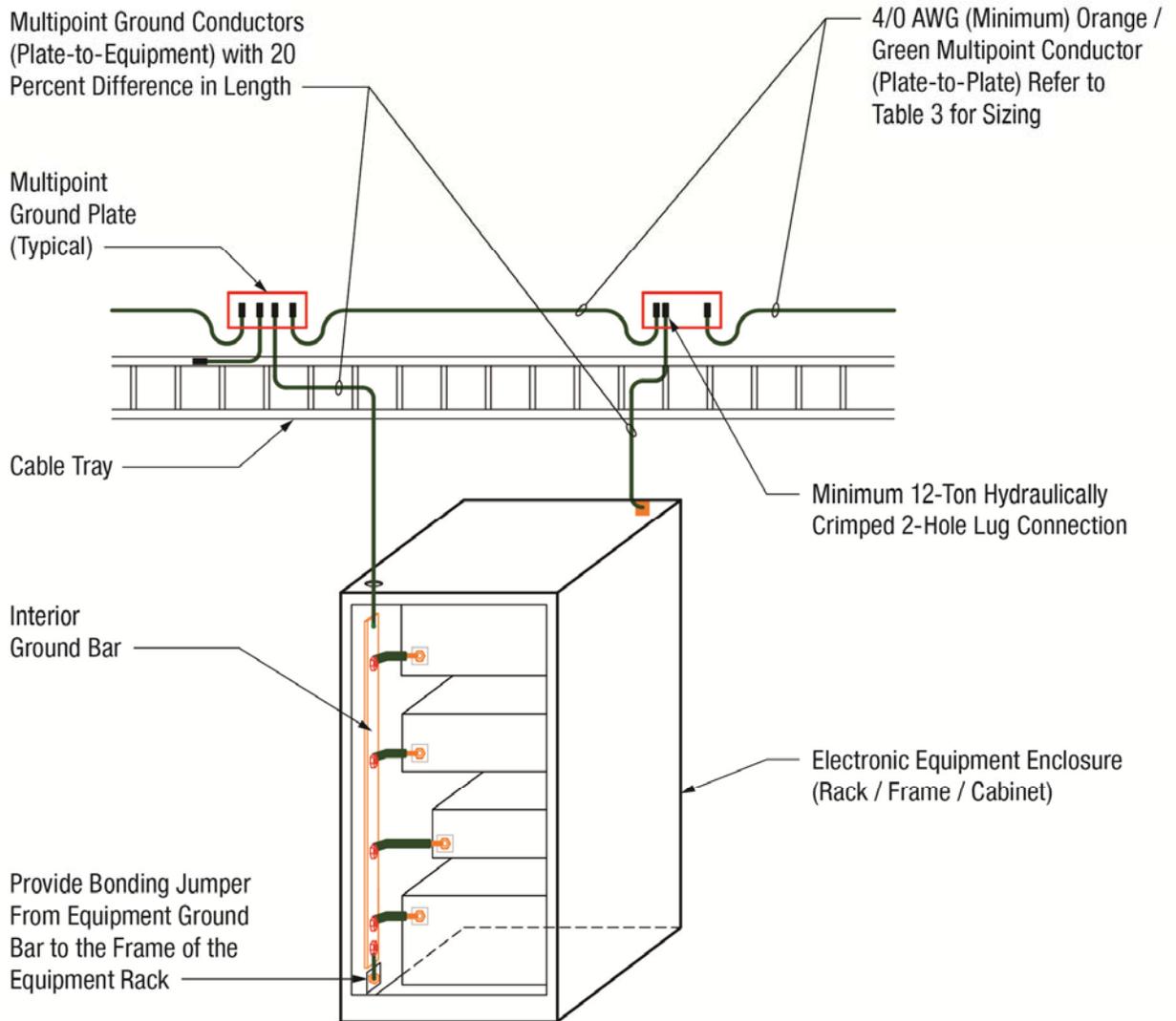
4.7.3.1.4 MPG Conductors - Plate and Bus to Equipment

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.



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

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
<u>Notes:</u>	
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.

- 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.

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.

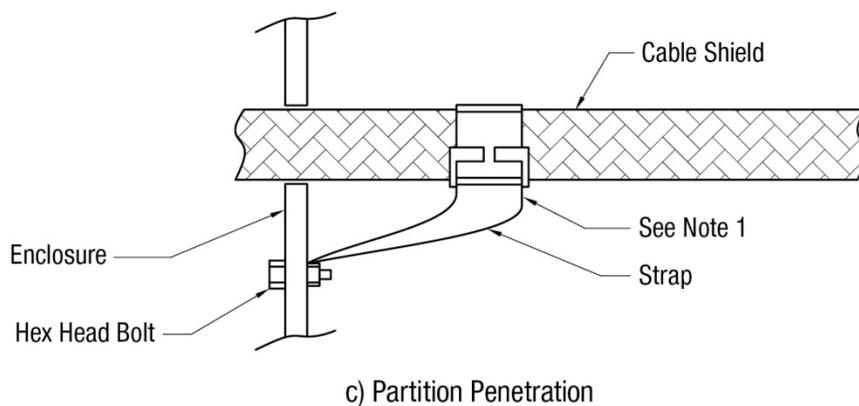
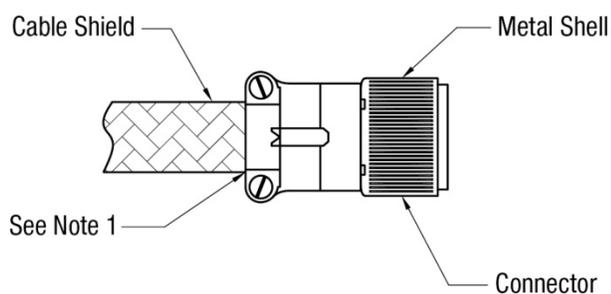
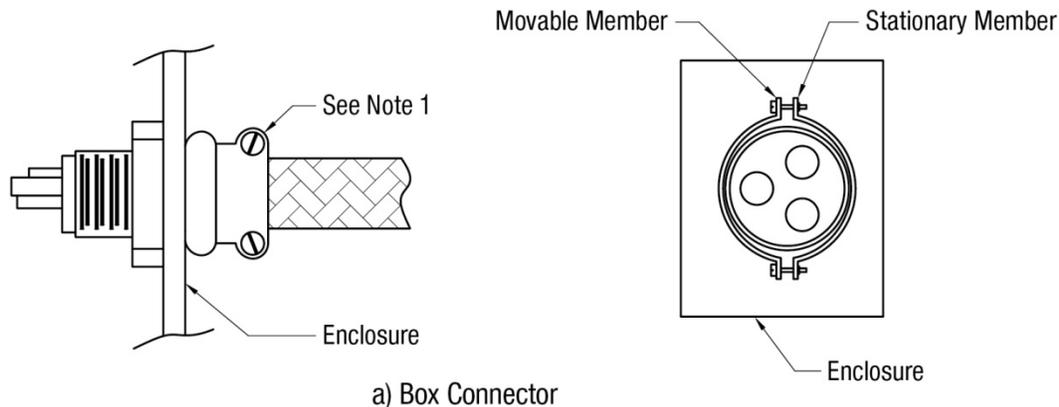
- b. Shield Termination Lengths. Shield terminations shall consist of minimum length pigtails between the shield and the connection to the bonding halo or ferrule ring and between the halo or ferrule ring and the shield pin on the connector. The unshielded length of a signal line shall not exceed 1 in. 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.

- 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.



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

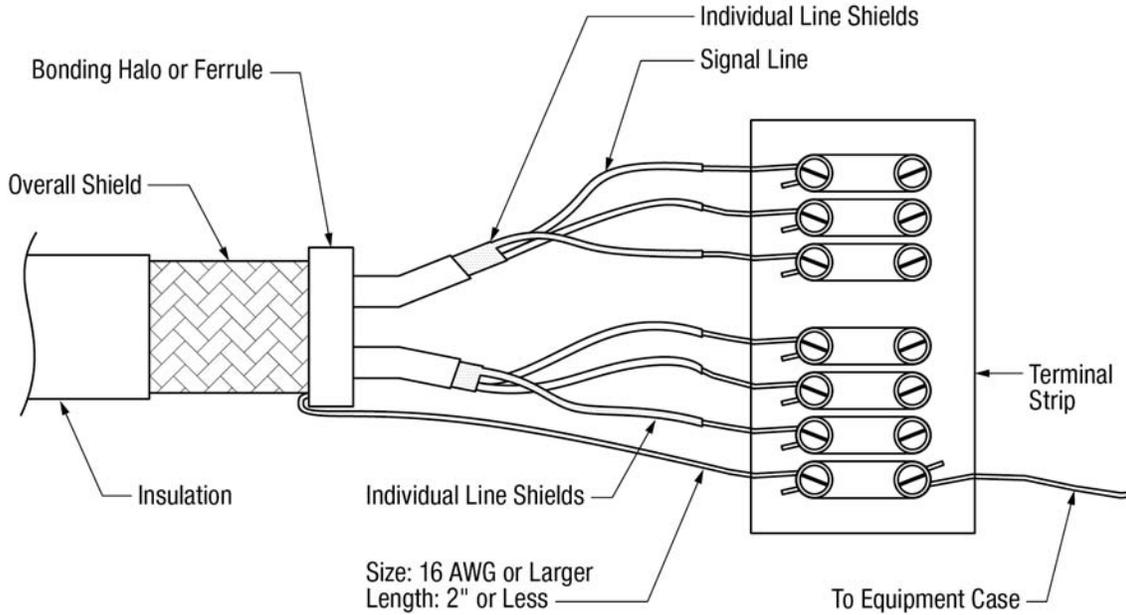


Figure 13. Grounding of Overall Cable Shield to Terminal Strip

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.

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.

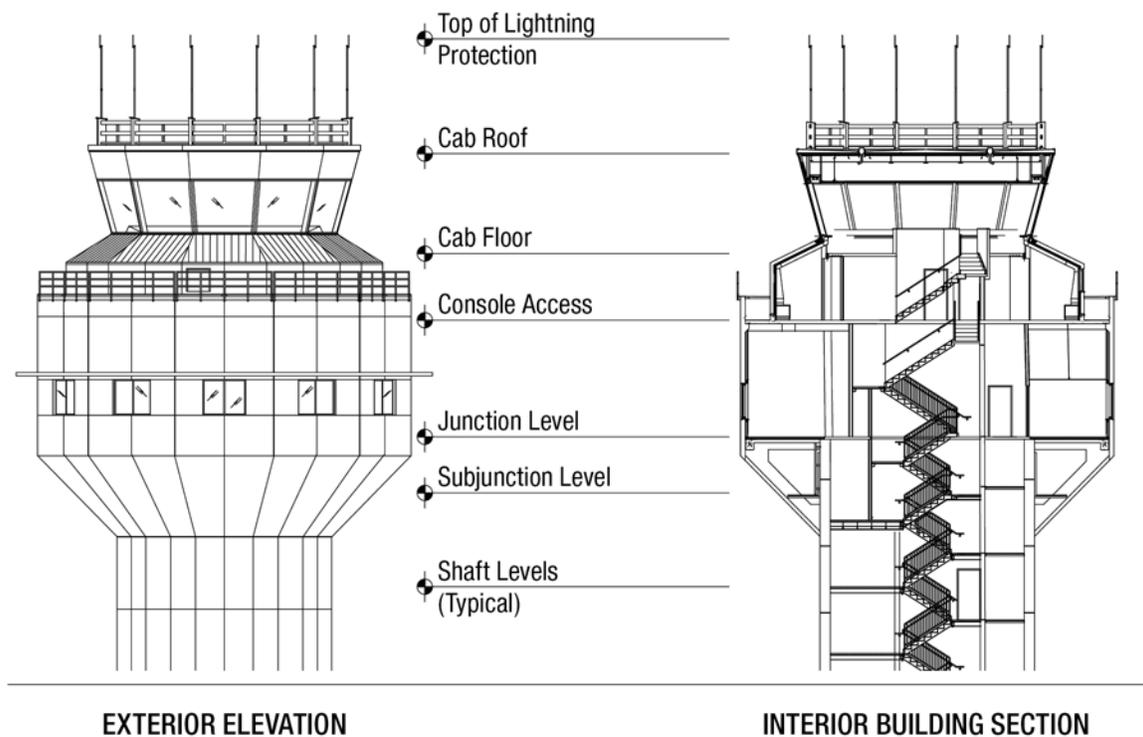


Figure 14. Airport Traffic Control Tower – Typical Floor Levels

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

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

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

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.

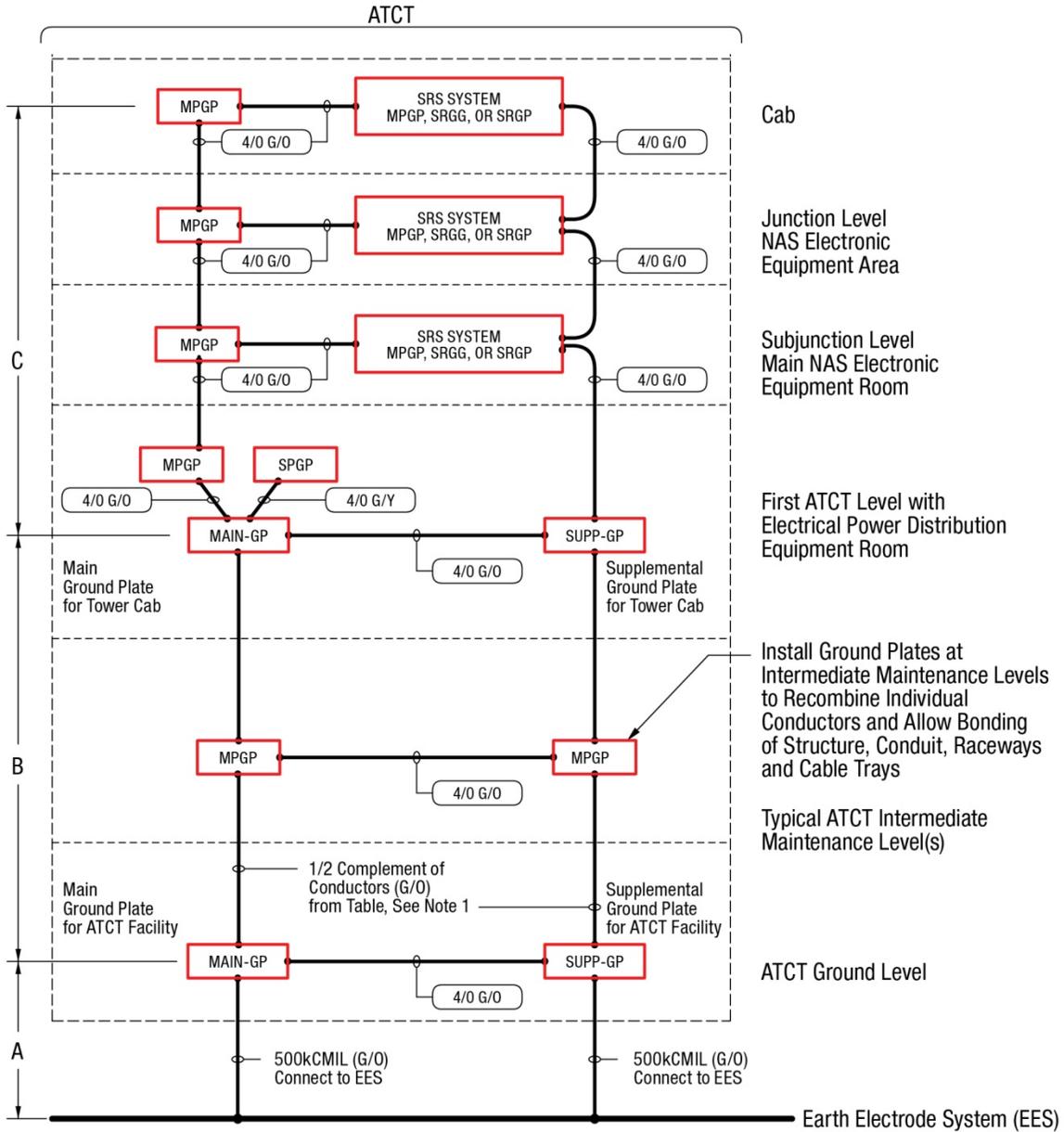
Recombine risers to an MPG plate at each maintenance level of the ATCT shaft. These conductors shall be mechanically bonded to the main ground plate and the base plate. Connect base plate(s) exothermically to the EES with the same number and size of conductors used for the riser conductors in accordance 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
<u>Note:</u>						
1. Refer to Figure 15 and Figure 16 for conceptual MPG configurations.						



SYMBOLS:

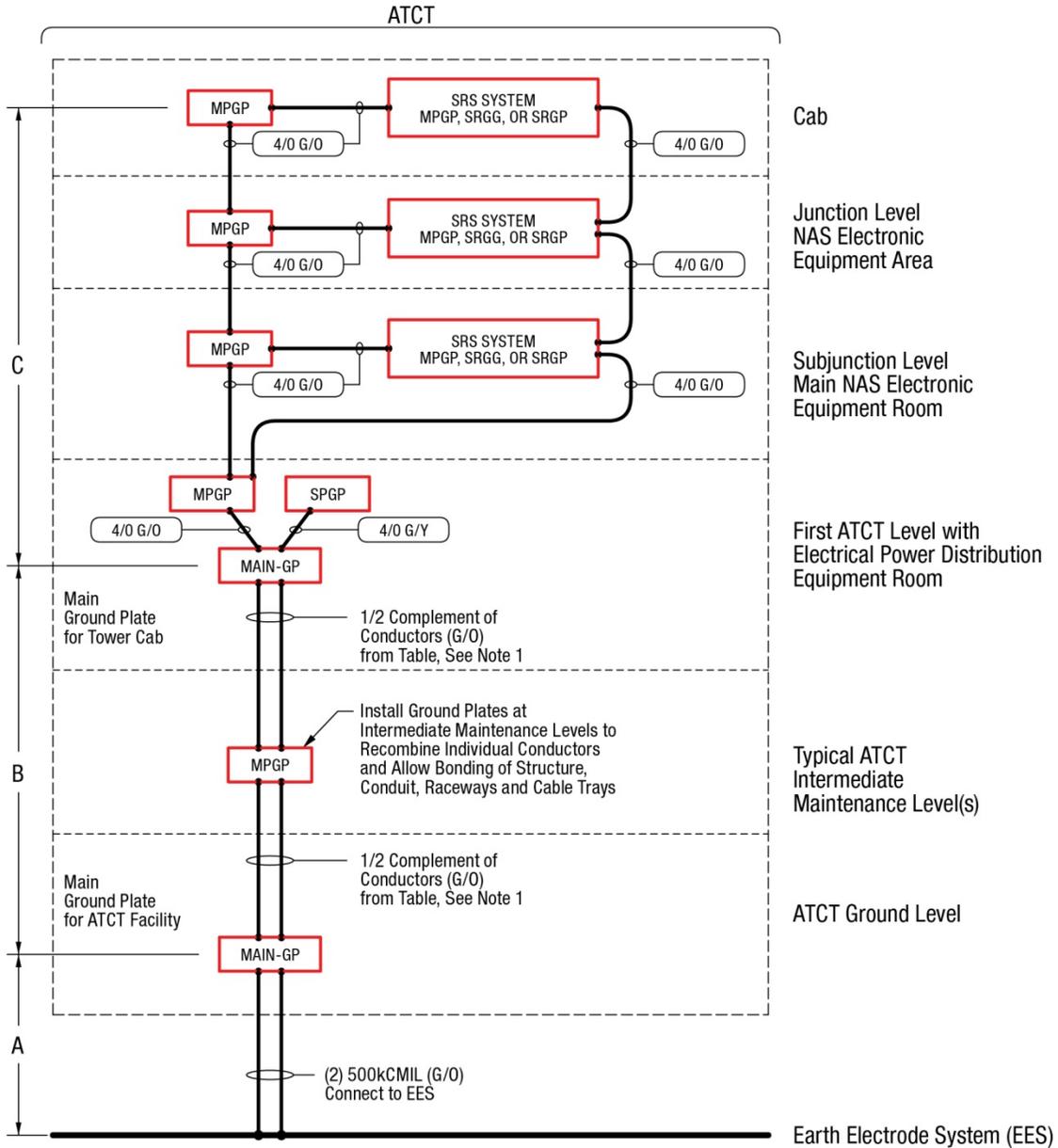
- MPGP Ground Plate, Subscript Denotes:
- MAIN-GP : Main Ground Plate
- SUPP-GP : Supplemental Ground Plate
- MPGP : Multipoint Ground Plate
- SPGP : Single Point Ground Plate

- 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)



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)

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

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.

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.

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.

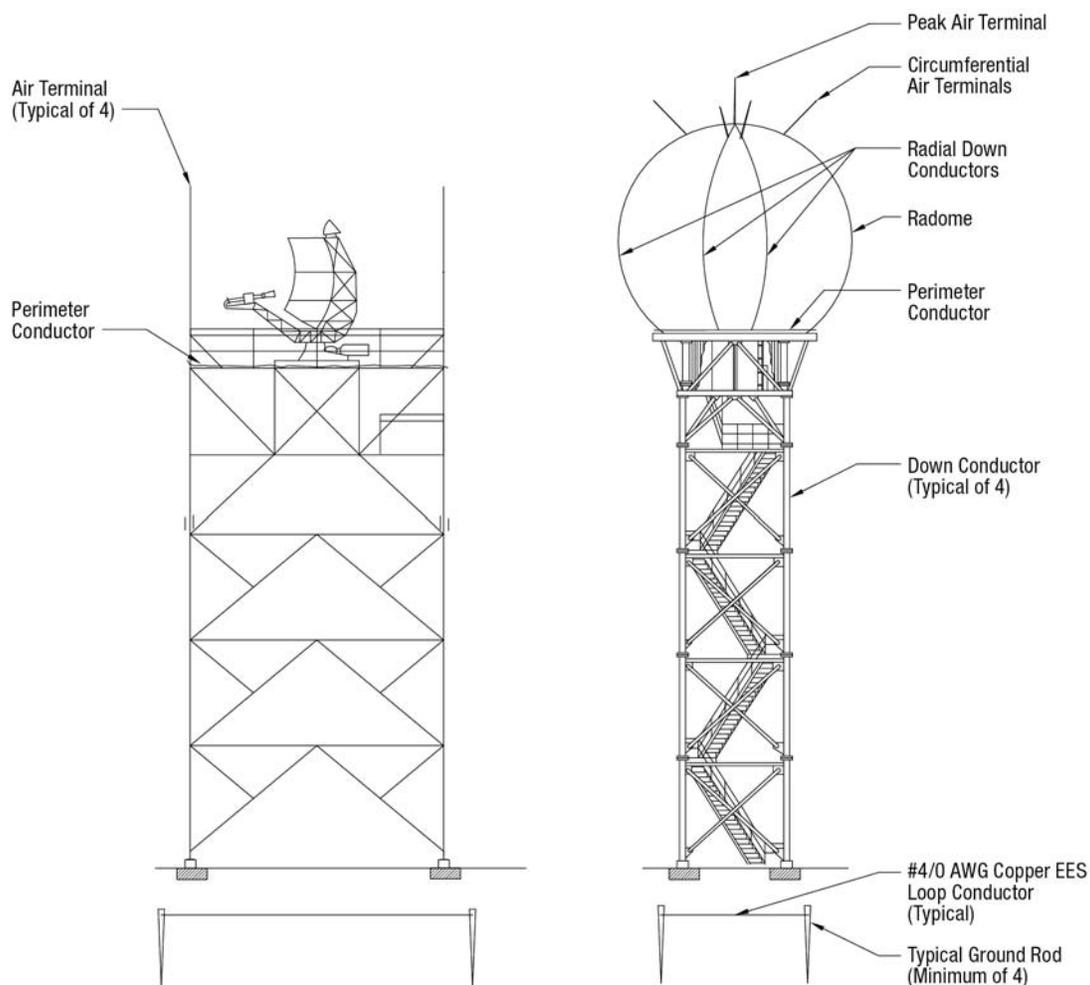
Lightning protection systems for standalone radomes shall be designed and installed in consultation with the OPR of the radar system and the OPR of this document. Paragraph 5.3.2.5 shall be used as guidance in developing lightning protection systems for these radomes.

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.



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

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.

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).

- 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.

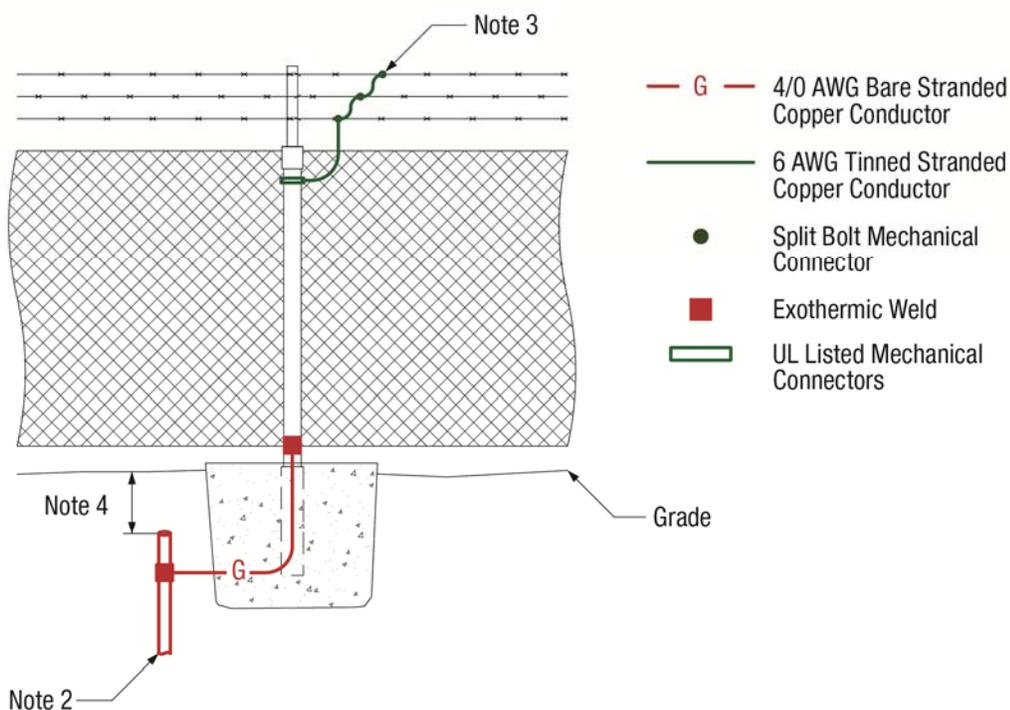
5.3.8.2 Fences Crossed by Overhead Power Lines

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.



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

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.

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

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.

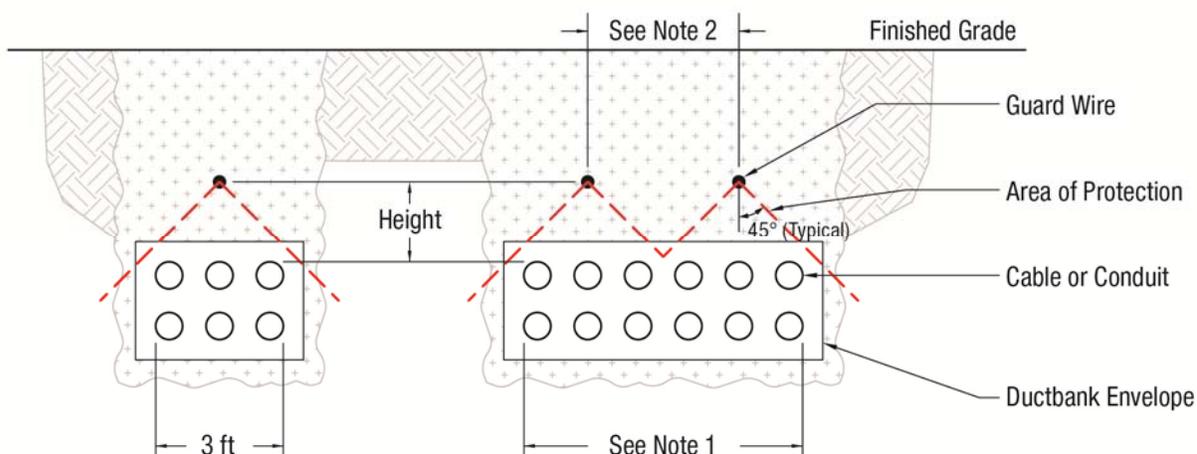
5.4.3.3.2 Guard Wires

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.



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

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).

- 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.

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.

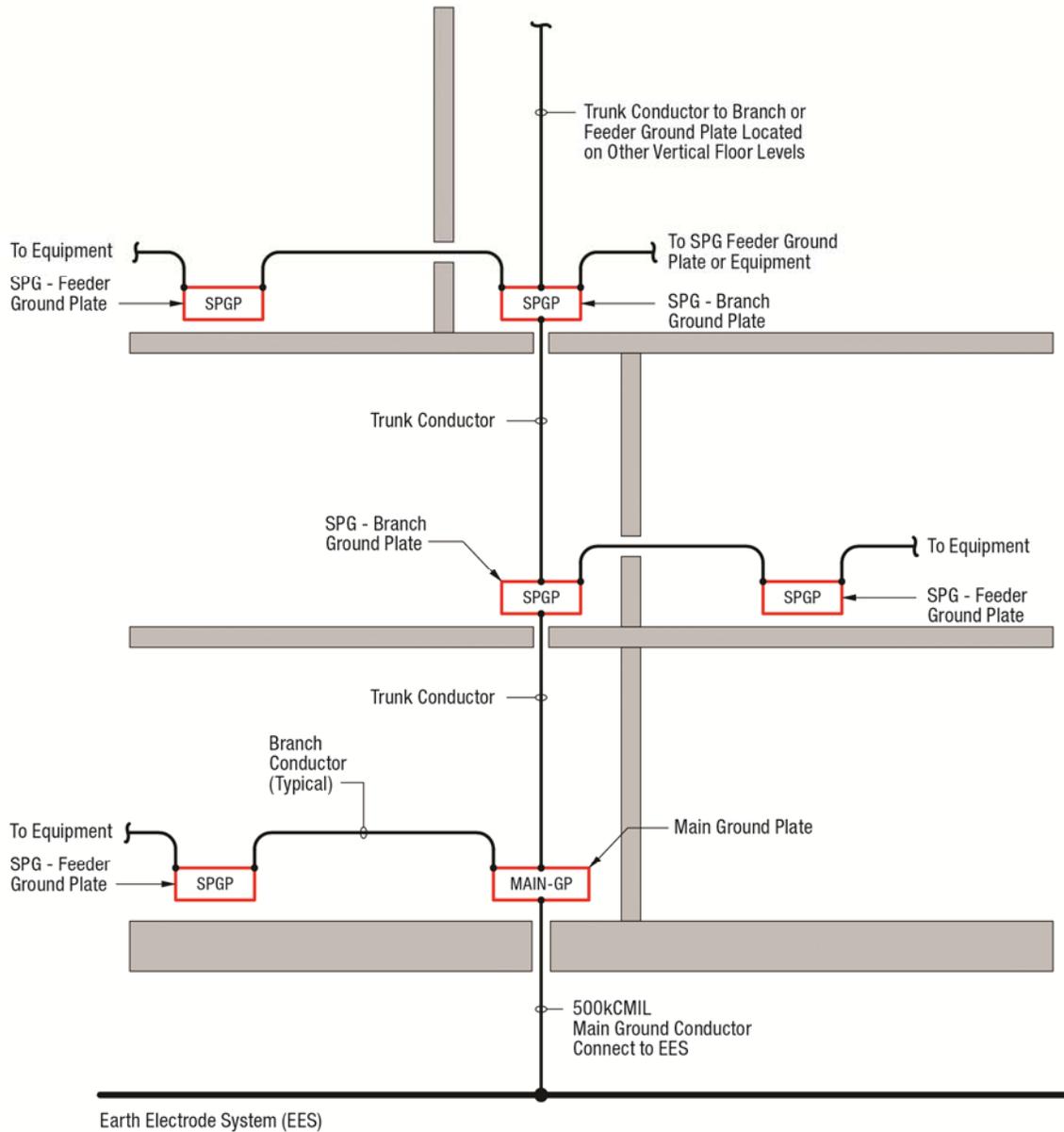


Figure 20. Single-Point Ground System Installation – Illustrative Example

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

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.

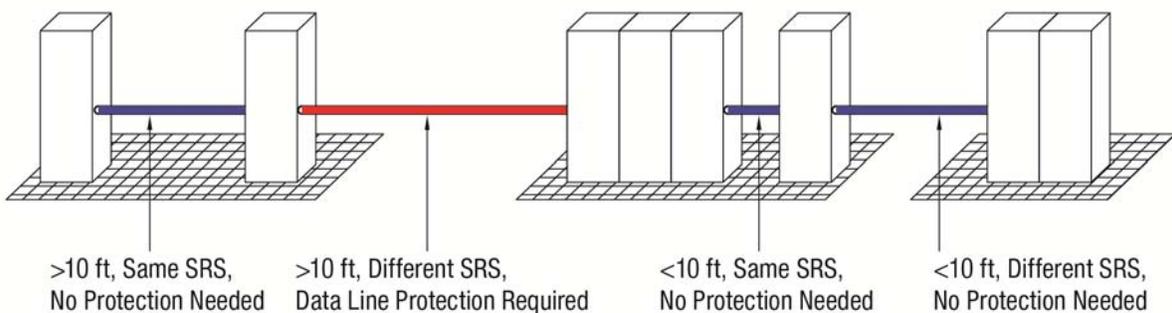


Figure 21. Lines and Cables Requiring Protection

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,

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 x 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 μ s 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 μ s waveform and V_1 is the clamping voltage measured at 1 kA for an 8/20 μ s 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 8. Electronic Equipment Power Entrance SPD - Slope Resistance (R_{slope})

Location	Slope Resistance Value
Electronic equipment power entrance	60 mΩ 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 μs current impulse waveform are shown in Table 9. 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 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 μs 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

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

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.

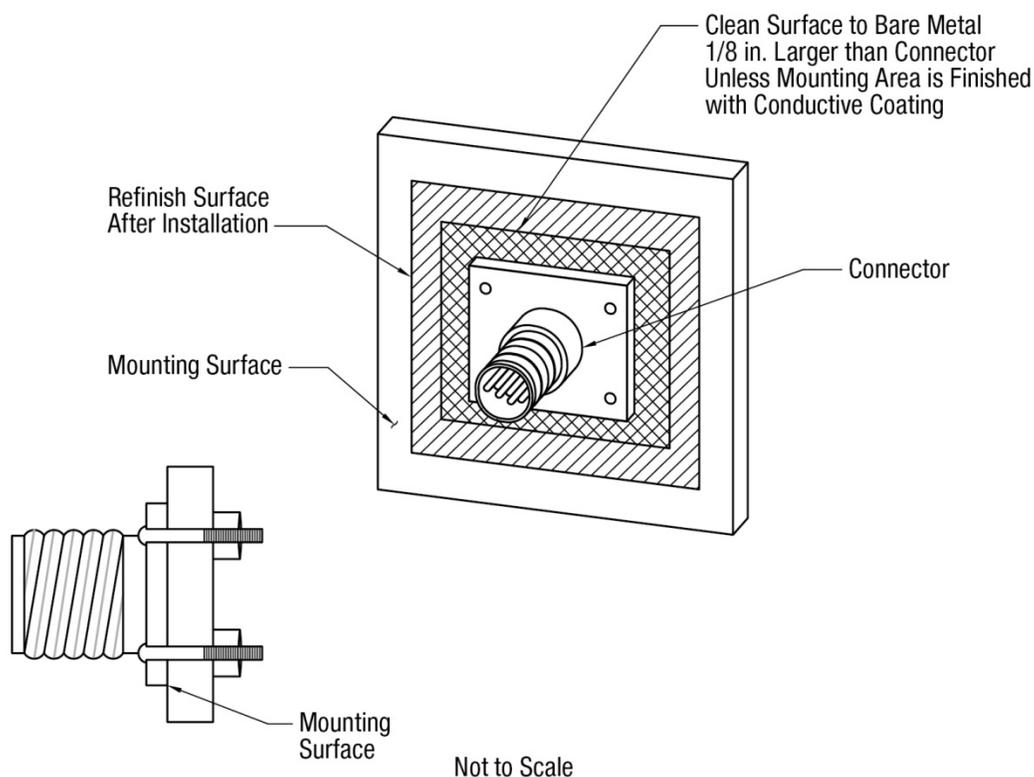
5.6.5.5.2 Electronic Equipment

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.



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

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 m Ω total and not more than 2.5 m Ω 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 M Ω or greater with external power, signal, and control lines disconnected from the electronic equipment.

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 M Ω or greater with the equipment power switch in the “on” position and the equipment disconnected from its power source.

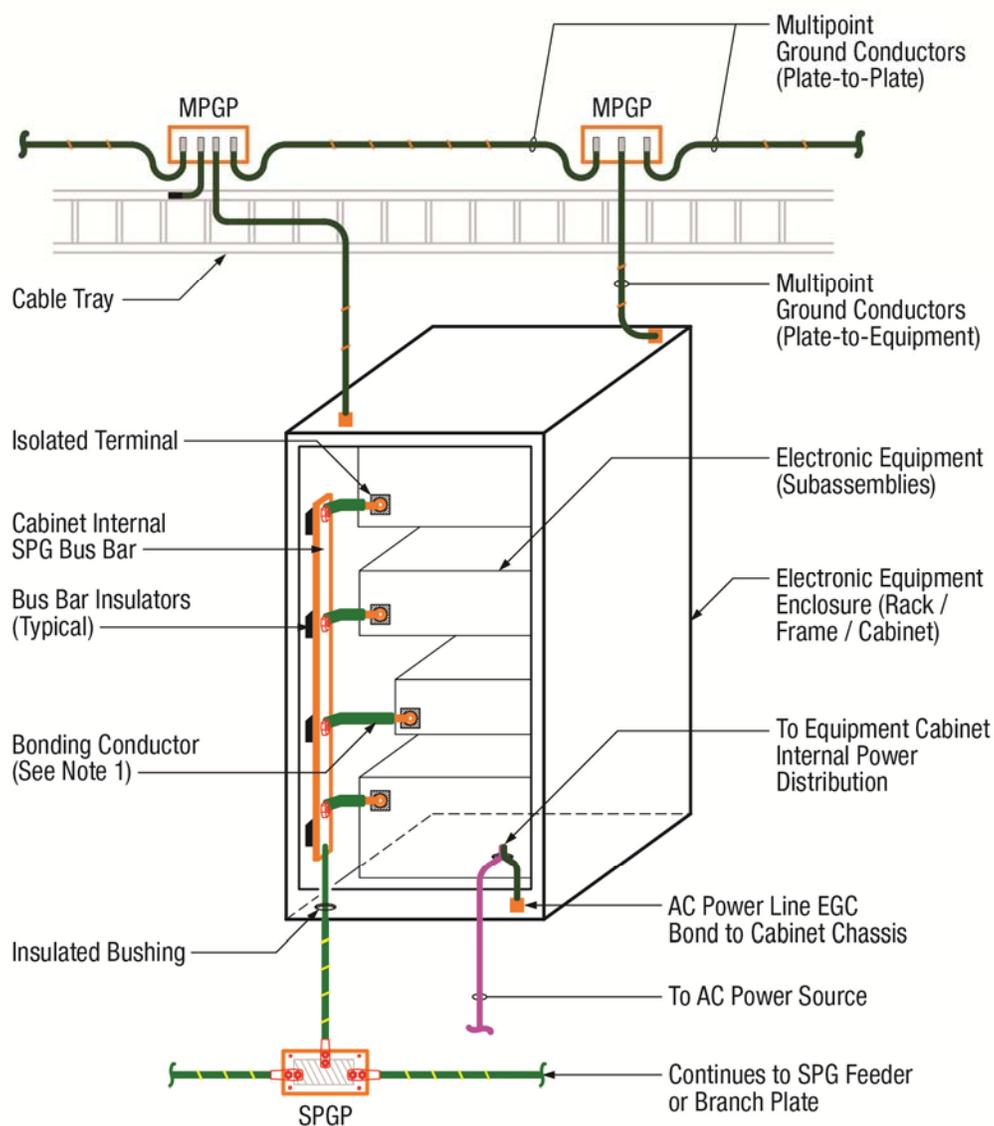
5.6.6.3.4 Equipment Single-Point Ground Terminals

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 M Ω 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 m Ω , 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.



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

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.

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

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 M Ω 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 x 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 μ s 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 μ s waveform defines a transient reaching peak

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.

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:

$$R_{slope} = (V_{10} - V_1)/9000$$

Where V_{10} is the clamping voltage measured at 10 kA for an 8/20 μ s waveform and V_1 is the clamping voltage measured at 1 kA for an 8/20 μ s 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 μ s current impulse waveform are shown in Table 13. 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 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	400 L-N, L-G	Maximum
	120/240	700 L-L	
	277/480	700 L-L, L-G	Maximum
	380 Delta	1200 L-L, L-G	Maximum
Feeder and Branch Panelboards	480 Delta	1200 L-L, L-G	Maximum
	120/208	475 L-N, L-G	+/- 45 V
	120/240	775 L-L	
	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	

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.

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.

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_{tt}) 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.

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.

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.

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.

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.

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.

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_{tt}) 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

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

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.

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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