U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Standards for Specifying Construction of Airfields

Date: DRAFT

Initiated By: AAS-100

AC No: 150/5370-10J

Change:

1 Purpose.

The guide specifications contained in this Advisory Circular (AC) relate to materials and methods used for construction on airports. These guide specifications need to be edited for use on individual projects. Items covered in this AC include general provisions, earthwork, flexible base courses, rigid base courses, flexible surface courses, rigid pavement, fencing, drainage, turf, and lighting installation.

2 Cancellation.

This AC cancels AC 150/5370-10H, *Standard Specifications for Construction of Airports*, dated December 21, 2018.

3 Application.

The Federal Aviation Administration (FAA) recommends the guidelines and specifications in this AC for materials and methods used in airfield development for construction and rehabilitation projects on airports.

This AC does not constitute a regulation, is not mandatory, and is not legally binding in its own right. The AC will not be relied upon as a separate basis by the FAA for affirmative enforcement action or other administrative penalty. Conformity with this AC is voluntary, and nonconformity will not affect rights and obligations under existing statutes and regulations, except for the projects described in items 2, 3, and 4 below:

1. The standard specifications contained in this AC are practices the FAA recommends for the construction of pavements and airport development serving aircraft greater than 30,000 lbs (13,600 kg).
2. This AC contains methods and procedures for compliance with 14 Code of Federal Regulations (CFR) Part 139 that are acceptable to the Administrator.

3. The use of this AC is mandatory for all projects serving aircraft greater than 30,000 lbs (13,600 kg). See Grant Assurance No. 34, *Policies, Standards, and Specifications*.
4. The use of this AC is mandatory for all projects serving aircraft greater than 30,000 lbs (13,600 kg) funded with the Passenger Facility Charge (PFC) program. See PFC Assurance #9, *Standards and Specifications*.
5. For building construction, the General Contract Provisions are applicable. Additionally, applicable laws and local building codes are acceptable as construction standards.

4 Developing Project Specifications.

The guide specifications in this AC must be edited to develop construction specifications for individual federally funded projects.

1. For individual projects, pertinent portions of the standards must be copied into the contract documents.
2. For airfield pavement projects at non-primary airports, serving aircraft less than 60,000 lbs (27216 kg), state highway specifications may be used in states where the state has requested, and received, FAA approval to use state highway specifications.
3. Refer to FAA Order 5300.1, *Modifications to Agency Airport Design, Construction, and Equipment Standards*, for approval criteria related to Owner requests to deviate from an FAA standard on federally funded projects.
4. When preparing construction contracts for federally funded projects or for grant obligated airports, use current contract provisions and mandatory provisions (wage, labor, Disadvantaged Business Enterprise (DBE), etc.).
5. DBE and Equal Employment Opportunity (EEO), etc. information can be found at the FAA website: https://www.faa.gov/airports/aip/procurement/.
6. Additional contract clauses may be required to comply with local and state laws relating to advertising, awarding, and administering construction contracts.

5 Changes, Additions, and Deletions to the FAA Standard Specifications.

1. Engineer Notes (shown between lines of asterisks) contained in the AC provide directions to the Engineer. These notes explain the options available to the Engineer when preparing project documents, and the appropriate changes and additions that must be made. **Do not include Engineer Notes in the final project documents.**
2. Where numbers, words, phrases, or sentences are enclosed in brackets **[__]**, a choice or modification must be made. Where blank spaces **[__]** occur in sentences, the appropriate data must be inserted.
3. Where entire paragraphs are not applicable, delete text and insert “Not used” after the paragraph number. Do not renumber specification paragraphs. For projects subject to the application criteria of paragraph 3, a MOS is necessary for any deviation from standard specifications for material and construction methods. The

FAA will consider a MOS to accommodate unusual local conditions on a specific project for airfield pavement construction. **Note:** Adding a new section and/or item will trigger the need for a MOS.

4. When a new section or item is added, it must use a unique number that does not correlate with standard FAA Items; e.g., use SC-XXX not P-XXX.

6 Principal Changes.

This AC contains the following principal changes:

1. Extensive technical and editorial edits have been made throughout the document based upon input from users and comments received during the review periods.
2. Added table names to all tables.
3. Updated references to ACs, industry standards, and ASTM International Standards (ASTMSs).
4. Updated Section 10, Definition of Terms.
5. Revised Section 50-01 to clarify the conditions of reasonably close conformity.
6. Added new Item C-101, Operational Safety for Airfield Construction.
7. Removed the requirement for smoothness testing on subgrade, subbase and base layers. Smoothness testing still required for stabilized material immediately beneath wearing course (Parts 3 and 4).
8. Added option in Parts 3 and 4 to test density and moisture with non-nuclear devices (Items P-152, P-155, P-157, P-158, P-204, P-209, P-210, P-211, P-212, P-215, P-217, P-219, P-220).
9. Added requirement to check grade to Item P-152.
10. Deleted Item P-156 (incorporated into Item P-157).
11. Renamed Item P-154 to P-204 and relocated it to Part 4, Aggregate Subbase and Base Courses.
12. Renamed Item P-207 to Full Depth Reclamation (FDR) Base Course.
13. Deleted Item P-153 Sand-Clay Base Course.
14. Added Item P-215 Rubblized Concrete Pavement Base Course, based upon EB 66.
15. Added option to Items P-304 and P-307 for microcracking when placed under flexible pavement.
16. Item P-307 is now Stabilized Drainable Base Course and includes the option to stabilize with either cement or asphalt. Incorporated EB 102 into P-307. Mix design for cement stablized drainable base requires minimum amount of cement and strength is not tested.
17. In Item P-401:

- Clarified requirement to use Item P-401 when the aircraft gross weight is 30,000 lbs (13,600 kg) or greater or tire pressures are greater than 175 psi.
- Removed Marshall mix design.
- Added requirement to test coarse aggregate angularity with uncompacted voids.
- Added requirement to test fine aggregate angularity with uncompacted voids.
- Added tailoring option for fuel resistant asphalt binder.
- Replaced binder grade bump table in note to engineer with link to Airfield Asphalt Binder Selection Tool.
- Clarified when a new job mix formula (JMF) is required and when an existing JMF needs to be validated.
- Added requirement for prepaving meeting prior to control strip placement.
- Added QC test of asphalt binder.
- Clarified basis of adjustments to payment.

18. Deleted Item P-403.
19. Deleted Item P-404 (incorporated into Item P-401).
20. In Item P-501:

- Removed requirement for ASTM C1260 testing.
- Aggregate reactivity testing follows ASTM C1567, except limits 0.08% at 28 days (30 days from casting).
- Removed requirement for minimum cement content.
- Revised design strength to be 90-day strength, acceptance strength based upon 14-day correlation, but still includes the option to develop a correlation between compressive strength and flexural strength for acceptance and payment.
- Added requirement to develop correlation between compressive and flexural.
- Added requirement for pre-paving meeting prior to placement of control strip.
- Clarified that D cracking is only a concern in freeze-thaw areas based upon climatic zones.
- Clarified when a new mix design is required and what changes require either a new trial batch or a new mix design.
- Clarified strengths required to open to construction traffic and aircraft traffic.

    - Added QC tests for water cement ratio and flexural strength.
    - Added requirement to store and condition cores.
    - Clarified adjustments to payment.

21. Changed the order of Parts 8 and 9. Part 8 is now Miscellaneous and Part 9 is now Surface Treatments.
22. In Item P-603, added option for virgin asphalt tack coat and for trackless tack coats.
23. Renamed Items P-608 and P-608R to P-628 and P-628R to keep all items organized by increasing number.
24. For airfield signage bases, light bases, navigational aid foundations, drainage structures, and other miscellaneous airfield concrete other than airfield pavements, Item P-610, Item P-501, or concrete meeting state Department of Transportation (DOT) specifications for structures may be used provided aggregates meet reactivity requirements of Items P-610 or P-501.
25. Standardized friction testing for all surface treatments to require friction after application to be at or above the maintenance planning level.
26. Clarified when surface treatments may be used. No restrictions on use of P-623, P-628 and P-628R. All others, P-629, P-629S, P-630, P-632, and P-635, may be used on pavements serving aircraft < 60,000 lbs. Friction testing is required any time a surface treatment is used on a runway or high-speed taxiway.
27. Added new Item P-635 Polymer Concrete Micro-Overlay (PCMO).
28. Combined Items P-623 and P-626 into one specification, P-623.
29. Combined Items P-630 and P-631 into one specification, P-630.
30. Added Appendix from Fuel Resistant Test to all Fuel Resistant specifications.
31. Changed the order of Parts 10 and 11. Part 10 is now Drainage. Part 11 is now Fencing.
32. Renamed Items F-162, F-163, and F-164 to Items F-862, F-863, and F-864 to keep all items organized by increasing number.
33. Combined Items F-160 and F-161 into one specification, F-860.

7 Units.

Throughout this AC, English units are used followed with “soft” (rounded) metric units. The English units govern. One unit of measure should be selected and shown in the final project documents.

8 Where to Find this AC.

Find a list of all ACs at https://www.faa.gov/regulations_policies/advisory_circulars/. Find Federal Aviation Regulations at https://www.faa.gov/regulations_policies/faa_regulations/.

9 Feedback on this AC.

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback form at the end of this AC.

John R. Dermody
Director of Airport Safety and Standards

Table of Contents

List of Tables

Part 1 – General Contract Provisions

Section 10 Definition of Terms

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Sections within Part 1 may be edited to match with local procurement requirements. However, on federally funded projects the procurement must be in accordance with 2 CFR part 200. See FAA Order 5100.38D, Change 1, *Airport Improvement Program Handbook.*

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When using the following terms, these specifications, in the contract, or in any documents or other instruments pertaining to construction where these specifications govern, Table 10 defines the Federal Aviation Administration's intent and meaning.

Table 10: Term Definitions

Term	Definition
Access Road	The right-of-way, roadway, and all improvements constructed connecting the airport to a public roadway.
Advertisement	A public announcement, as required by local law, inviting bids for work to be performed and materials to be furnished.
Air Operations Area (AOA)	Any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An AOA includes 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.
Airport Improvement Program (AIP)	A grant-in-aid program, administered by the Federal Aviation Administration (FAA).
American Association of State Highway and Transportation (AASHTO)	The American Association of State Highway and Transportation Officials (AASHTO).
Apron	An area where aircraft are parked, unloaded or loaded, fueled, and/or serviced.
ASTM International	American Society for Testing and Materials (ASTM).
Award	The Owner's notice to the successful bidder accepting the submitted bid.

Term	Definition
Bidder	Any individual, partnership, firm, or corporation, acting directly or through a duly authorized representative, who submits a proposal for the work contemplated.
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.
Certificate of Analysis (COA)	The COA is the manufacturer's report of all applicable testing of the materials meeting the specification requirements.
Certificate of Compliance (COC)	The manufacturer's certification stating materials or assemblies furnished fully comply with the requirements of the contract. The manufacturer's authorized representative must sign the certificate.
Change Order	A written order to the Contractor covering changes in the plans, specifications, or proposal quantities and establishing the basis of payment and Contract Time adjustment, if any, for work within the scope of the contract and necessary to complete the project.
Construction Safety Drawings (CSD)	Project drawings that graphically depict work zone limits and operational safety measures per phase.
Construction Management Program (CMP)	Owner's plan for the staff and procedures that will be used to assure that the completed work meets the standards for quality acceptance in the project specifications.
Construction Safety and Phasing Plan (CSPP)	The plan for safety and phasing of a construction project developed by the airport operator, or the airport operator's consultant and approved by the airport operator.
Contract	A written agreement between the Owner and the Contractor establishing the obligations of the parties including, but not limited to performance of work, furnishing of labor, equipment and materials, and the basis of payment.
Contract Item (Pay Item)	A specific unit of work for which a price is provided in the contract.
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 must be completed by that date.

Term	Definition
Contractor	The individual, partnership, firm, or corporation primarily liable for the acceptable performance of the work contracted and payment of all legal debts pertaining to the work, who acts directly or through lawful agents or employees to complete the contract work.
Contractor's Quality Control (QC) Facilities	The Contractor's QC facilities according to the Contractor Quality Control Program (CQCP).
Contractor's Quality Control Program (CQCP)	Details the methods and procedures taken to ensure 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.
Control Strip	A demonstration by the Contractor that the materials, equipment, and construction processes result in a product meeting the specification requirements.
Drainage System	The system of pipes, ditches, and structures that collect and conduct surface or subsurface waters from the airport area.
Engineer	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for engineering of the contract work and acting directly or through an authorized representative.
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.
Extra Work	An item of work not provided for in the awarded contract or previously added by Change Order or supplemental agreement but found by the Owner's Engineer or Resident Project Representative (RPR) to be necessary to complete the work within the intended scope of the contract.
Federal Aviation Administration (FAA)	When used to designate a person, "FAA" denotes the Administrator or their duly authorized representative.
Federal Specifications	The federal specifications and standards, commercial item descriptions, and supplements, amendments, and indices prepared and issued by the General Services Administration (GSA).
Intention of Terms	Whenever, in these specifications or on the plans, the words "directed," "required," "permitted," "ordered," "designated," "prescribed," or words of like import are used, it is understood that the direction, requirement,

Term	Definition
	permission, order, designation, or prescription of the Engineer and/or RPR is intended; and similarly, the words “approved,” “acceptable,” “satisfactory,” or words of like import, mean approved by, or acceptable to, or satisfactory to the Engineer and/or RPR, subject in each case to the final determination of the Owner. Any reference to a specific requirement of a numbered paragraph of the contract specifications or a cited standard is interpreted to include all general requirements of the entire section, specification item, or cited standard that may be pertinent to such specific reference.
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.
Materials	Any substance specified for use in the construction of the contract work.
Major Contract Items	A major contract item is any item listed in the proposal, the total cost of which is equal to or greater than 20% of the total amount of the award contract.
Modification of Standards (MOS)	An FAA-approved deviation from a standard specification applicable to material and construction methods. See FAA Order 5300.1.
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 NTP states the date the Contract Time begins.
Owner	The Owner for this project is **[__]**. ** **Insert Owner’s name here.** **
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.
Pavement Structure	The combined surface course, base course(s), and subbase course(s), if any, considered as a single unit.

Term	Definition
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.
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 according to the terms of the contract.
Plans	The official drawings or exact reproductions showing the location, character, dimensions, and details of the airport, the work to be done and what is considered as a part of the contract, supplementary to the specifications. Plans may also be referred to as 'contract drawings.'
Project	The agreed scope of work for accomplishing specific airport development with respect to a particular airport.
Proposal	The written offer of the bidder (when submitted on the approved proposal form) to perform the contemplated work and furnish the necessary materials according to the provisions of the plans and specifications.
Proposal Guaranty	The security furnished with a proposal is to guarantee that the bidder enters the contract if their own proposal is accepted by the Owner.
Quality Assurance (QA)	All planned actions by the Owner necessary to assure that all work complies with the specifications and that all materials and work will perform satisfactorily. Actions include checks and reviews; oversight, including specification compliance review, document control, material verification sampling and testing at project and production sites, oversight of on-site equipment, calibration of test equipment, and acceptance or rejection of material based on verification and QC testing; documentation of Quality Assurance activities.
Quality Assurance Inspector	An authorized representative of the Engineer and/or 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.
Quality Acceptance Laboratory	The official testing laboratories of the Owner, or such other laboratories as may be designated by the Engineer or RPR. May also be referred to as Engineer's, Owner's, or QA Laboratory.

Term	Definition
Quality Control (QC)	The Contractor's responsibility to control material(s) and construction processes to complete construction according to project specifications.
Resident Project Representative (RPR)	The individual, partnership, firm, or corporation duly authorized by the Owner to be responsible for all necessary quality assurance activities inspections, observations, tests, and/or observations of tests of the materials or contract work performed by the Contractor or through an authorized representative.
Runway	The area on the airport prepared for the landing and takeoff of aircraft.
Runway Safety Area (RSA)	A defined surface surrounding the runway that is prepared or suitable for reducing the risk of damage to aircraft. See the Operational Safety Drawings (OSD) for the RSA limits, where applicable.
Safety Plan Compliance Document (SPCD)	A project submittal detailing how the Contractor proposes to comply with the operational safety measures of Item C-101, as derived from the project CSPP.
Specifications	A part of the contract containing the written directions and requirements for completing the contract work. Standards for specifying materials or testing cited in the contract specifications by reference must have the same force and effect as if included in the contract physically.
Sponsor	A Sponsor is defined in 49 USC § 47102(24) as a public agency that submits an application to the FAA for a federally funded airport grant; or a private Owner of a public-use airport that submits an application to the FAA for a federally funded airport grant for the airport.
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 manufactured features of the airport that may be encountered in the work and not otherwise classified herein.
Subgrade	The soil that forms the pavement foundation.
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 supervises and directs the construction.

Term	Definition
Supplemental Agreement	A written agreement between the Contractor and the Owner that establishes the basis of payment and Contract Time adjustment, if any, for the work affected by the supplemental agreement.
Surety	The corporation, partnership, or individual, other than the Contractor, executing payment or performance bonds that are furnished to the Owner by the Contractor.
Taxilane	A taxiway designed for low-speed movement of aircraft between aircraft parking areas and terminal areas.
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.
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 Operational Safety Drawings for the limits of the TSA, where applicable.
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.
`[ Additional Terms as needed based upon the contract type ]`	`[ None ]` ** **The Engineer may add and define additional terms, if necessary.** **On projects that utilize a Construction Manager (CM), a Construction Manager at Risk (CMAR), or a Construction Manager/General Contractor (CMGC), add definitions of these roles on the project.** **The CM generally acts as an agent of the Owner and is not legally or financially responsible for completion of the work; a CMAR and CMGC are legally and financially obligated to complete the work.** **

END OF SECTION 10

Section 20 Proposal Requirements and Conditions

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The information provided in this section is often duplicated within the Instruction-to-Bidders and Invitation-for-Bidders. To limit redundant requirements and potential discrepancies, modifications may be made to this section to include a reference that these requirements may be found in the procurement section of the project bid documents.

The language provided in this section represents model language acceptable to the Federal Aviation Administration (FAA). The Owner may make edits to the model language reflecting established written local and state procurement versions provided such requirements do not conflict with the requirements of 2 Code of Federal Regulations (CFR) Part 200 or 49 United States Code (USC) Chapter 471.

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20-01 Advertisement (Notice to Bidders).

[__]

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Insert the project advertisement documents here or indicate their location.

The published advertisement states the time and place for submitting sealed proposals; provides a description of the proposed work; gives instructions to Bidders about obtaining proposal forms, plans, and specifications; indicates the proposal guaranty required; and the Owner’s right to reject any and all bids.

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20-02 Bidder Qualifications.

Bidders must submit evidence of competency and financial responsibility to perform the work to the Owner at bid opening. Evidence of competency, unless otherwise specified, consists of statements covering the Bidder’s experience on similar work, and lists of the equipment and key personnel available for the work.

Each Bidder must furnish the Owner satisfactory evidence of their financial responsibility. Evidence of financial responsibility, unless otherwise specified, consists 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. A Public Accountant must verify such statements or reports. At the time of submitting such financial statements or reports, the Bidder must further certify whether their financial responsibility is approximately the same as stated or reported by the Public

Accountant. If the bidder's financial responsibility changed, the bidder must qualify the Public Accountant's statement or report to reflect the bidder's true financial condition at the time of such qualified statement or submit the report to the Owner.

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Edit this paragraph as necessary to state what is acceptable to the Owner as evidence of financial responsibility, such as prequalification to bid from a State DOT.

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20-03 Proposal Forms Contents.

The Owner's proposal forms state the location and description of the proposed construction; the place, date, and time of opening of the proposals; and the estimated quantities of the various work items and materials to be furnished for which unit bid prices are requested. The proposal form states the time by which work must be completed, and the amount of the proposal guaranty that must accompany the proposal. The Owner only accepts those proposals properly executed on physical or electronic forms the Owner provided. Paragraph 20-09, *Irregular Proposal,* provides Bidder actions that may cause the Owner to deem a proposal irregular.

[Mobilization is limited to [10] percent of the total project cost.]

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Delete if Item C-105 Mobilization is not included in the project.

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[A prebid conference is required on this project to discuss, as a minimum, the following items: Disadvantaged Business Enterprise (DBE) requirements; material requirements; submittals; Quality Control/Quality Acceptance (QC/QA) requirements; the Construction Safety and Phasing Plan (CSPP) including airport access and staging areas; unique airfield paving construction requirements; time allowed for construction, and [list other major items to be discussed.]]

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If the Owner requires a prebid conference, state the time, date, and place in the proposal. Conduct a prebid conference for all projects with pavement construction costs exceeding $500,000. At a minimum, include the following items for discussion: material requirements; submittals; QC/QA requirements; Item C-101 Operational Safety Elements, airfield security, role of the CSPP, any unique airfield construction requirements, including

airport access and staging areas; and unique airfield paving construction requirements.

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20-04 Proposal Forms Issuance.

The Owner 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:

1. Failure to comply with any of the Owner's prequalification regulations, if such regulations are cited, or otherwise included, in the proposal as a bidding requirement.
2. 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.
3. Documented record of Contractor default under previous contracts with the Owner.
4. Documented record of unsatisfactory work on previous contracts with the Owner.

20-05 Estimated Proposal Quantities.

The proposal gives an estimate of quantities of work to be done and materials to be furnished under these specifications. It is the result of calculations and believed to be correct. It is given only as a basis for comparison of proposals and the award of the contract. Payment to the Contractor is only made for the actual quantities of work performed or materials furnished according to 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*.

20-06 Examination of Plans, Specifications, and Site.

The Bidder is expected to carefully examine the proposed worksite, the proposal, plans, specifications, and contract forms. Bidders must satisfy themselves to the character, quality, and quantities of work to be performed, materials to be furnished, and requirements of the proposed contract. The submission of a proposal is evidence that the Bidder made such examination.

[Boring logs and other records of subsurface investigations and tests are available for inspection by Bidders. It is understood and agreed that such subsurface information, whether included in the plans, specifications, or otherwise made available to the Bidder, was obtained and is only intended for the Owner's design and estimating purposes. Such information is available for the convenience of all Bidders. It is further understood and agreed that each Bidder is solely responsible for all assumptions, deductions, or conclusions which the Bidder may make or obtain from `their own examination of the boring logs and other records of subsurface investigations and tests furnished by the Owner. ]`

20-07 Proposal Preparation.

The Bidder must submit their proposal on the forms furnished by the Owner. Unless explicitly stated otherwise, all blank spaces in the proposal forms must be completed correctly for each and every item which a quantity is given. The Bidder must, where indicated, correctly complete all blank spaces for each and every item the Bidder gives a quantity. In case of a conflict between words and numerals, the words, unless obviously incorrect, govern.

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

20-08 Responsive Bid and Responsible Bidder.

A responsive bid conforms to all significant terms and conditions contained in the Owner's invitation for bid. It is the Owner's responsibility to decide if they are willing to accept any exceptions to the solicitation taken by a Bidder. A responsible Bidder can 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, past performance record, and financial and technical resources.

20-09 Irregular Proposal.

A proposal is considered irregular for the following reasons:

1. If the proposal is on a form other than that furnished by the Owner, or if the Owner's form is altered, or if any part of the proposal form is detached.
2. If there are unauthorized additions, conditional or alternate pay items, or irregularities of any kind that make the proposal incomplete, indefinite, or otherwise ambiguous.
3. 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.
4. If the proposal contains obviously unbalanced unit prices. Unbalanced unit prices are when some of the line items have a price significantly lower or significantly higher than expected.

5. If the proposal is not accompanied by the proposal guaranty specified by the Owner.
6. If the applicable Disadvantaged Business Owners (DBE) information is incomplete.

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

20-10 Bid Guarantee.

Each separate proposal must be accompanied by a bid bond, certified check, or other specified acceptable collateral, in the amount specified in the proposal form. Such bond, check, or collateral, must be made payable to the Owner.

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See FAA Order 5100-38 and 2 CFR Part 200 for bonding requirements.

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20-11 Proposal Delivery.

[Place each proposal in a plainly marked, sealed envelope with the project number, airport location, and the name and business address of the Bidder on the outside. When sent by mail, preferably registered, enclose the sealed proposal, marked as indicated above, in an additional envelope. Proposals are not considered unless received at the place specified in the advertisement or as modified by Addendum before the time specified for opening all bids. Proposals received after the bid opening time are returned to the Bidder, unopened. **]**

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Bid delivery requirements, including electronic delivery, to comply with local/state regulations may be substituted for this language.

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20-12 Withdrawal or Revision of Proposals.

A Bidder may withdraw or revise (by withdrawal of one proposal and submission of another) a proposal provided that the Bidder’s request for withdrawal is received by the Owner **[** in writing | by fax | by email **]** before the time specified for opening bids. The Owner must receive revised proposals at the place specified in the advertisement before the time specified for opening all bids.

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Edit to reflect local procurement requirements for proposal withdrawals.

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20-13 Public Opening of Proposals.

Open and read proposals publicly, at the time and place specified in the advertisement. Invite Bidders, their authorized agents, and other interested persons to attend. Proposals withdrawn (by written request) or received after the time specified for opening bids must be returned to the Bidder unopened.

20-14 Bidder Disqualification.

A Bidder is considered disqualified for any of the following reasons:

1. Submitting more than one proposal from the same partnership, firm, or corporation under the same or different name.
2. Evidence of collusion among Bidders. Bidders participating in such collusion are disqualified as Bidders for any future work of the Owner until any such participating Bidder has been reinstated by the Owner as a qualified Bidder.
3. If the Bidder is in default for any reason specified in paragraph 20-04, *Proposal Forms Issuance,* of this section.

20-15 Discrepancies and Omissions.

A Bidder who discovers discrepancies or omissions with the project bid documents must immediately notify the Owner's Engineer. A Bidder that has doubts as to the true meaning of a project requirement may submit to the Owner's Engineer a written request for interpretation no later than **[__]** days prior to bid opening.

The Owner issues any interpretation of the project bid documents by the Owner's Engineer by written addendum. The Owner does not consider any instructions, clarifications, or interpretations of the bidding documents in any manner other than written addendum.

END OF SECTION 20

Section 30 Award and Execution of Contract

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The information provided in this section is often duplicated within the Instruction-to-Bidders and Invitation-for-Bidders. To limit redundant requirements and potential discrepancies, modifications may be made to this section to include a reference that these requirements may be found in the procurement section of the project manual.

The language provided in this section represents model language acceptable to the Federal Aviation Administration (FAA). The Owner may make edits to the model language reflecting established written local and state procurement versions, provided such requirements do not conflict with the requirements of 2 Code of Federal Regulations (CFR) Part 200 or 49 United States Code (USC) Chapter 471.

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30-01 Consideration of Proposals.

After proposals are publicly opened and read, the Owner compares proposals on 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, governs.

Until the contract award is made, the Owner reserves the right to reject a Bidder’s proposal for any of the following reasons:

1. If the proposal is irregular, as specified in Section 20, paragraph 20-09, *Irregular Proposal*.
2. If the Bidder is disqualified for any of the reasons specified Section 20, paragraph 20-14, *Bidder Disqualification*.

In addition, until contract award, the Owner reserves the right to reject any or all proposals, waive technicalities, if such waiver is in the Owner’s best interest and 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 must promote the Owner’s best interests.

30-02 Contract Award.

A contract award, if it is to be awarded, is made within **[__]** calendar days of the date specified for publicly opening proposals, unless otherwise specified.

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It is recommended to make the contract award within 30 days, but the award may not exceed the maximum time allowed by the contracting authority.

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If the Owner elects to proceed with a contract award, the Owner awards the responsible Bidder whose bid, conforming with all the material terms and conditions of the bid documents, is the lowest in price.

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If the Owner includes bid alternates (additive or deductive), the bid documents must clearly state the order of evaluation the Owner applies during bid evaluation. Practices that establish the basis of award on the base bid, plus any arbitrary combination of bid alternates, may jeopardize federal participation.

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30-03 Award Cancellation.

The Owner 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 Owner, according to paragraph 30-07.

30-04 Return of Proposal Guaranty.

The Owner immediately returns all proposal guaranties, except those of the two lowest Bidders, after the Owner has made a comparison of bids, as specified in the paragraph 30-01, *Consideration of Proposals*. The Owner retains the proposal guaranties of the two lowest Bidders until such time an award is made, at which time, the Owner returns the unsuccessful Bidder's proposal guaranty. The successful Bidder's proposal guaranty is returned as soon as the Owner receives the contract bonds, as specified in paragraph 30-05, *Contract Bond Requirements.*

30-05 Contract Bond Requirements.

At the time of contract execution, the successful Bidder must furnish the Owner a surety bond or fully executed bonds by the Bidder and the surety, guaranteeing the performance of the work and the payment of all legal debts, incurred by reason of the Contractor's performance of the work. The Owner must accept the surety and the form of the bond or bonds. Unless otherwise specified in this subsection, the surety bond or bonds, must equal the full amount of the contract.

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2 CFR 200.326 provides that for contracts exceeding the Simplified Acquisition Threshold, the Owner should use local bonding policy and requirements provided the FAA determined that the federal interest is adequately protected.

If the FAA did not make such determination, the Owner must require separate performance and payment bonds in the full amount of the awarded contract. For federally funded airport contracts awarded in an amount of $250,000 or less, the Owner should specify bonding according to local requirements.

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30-06 Execution of Contract.

The successful Bidder must sign (execute) the necessary agreements for entering the contract and return the signed contract to the Owner, along with the fully executed surety bond or bonds, specified in paragraph 30-05, *Contract Bond Requirements,* of this section, within **[** `15` **]** calendar days from the date mailed or otherwise delivered to the successful Bidder.

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Find required federal contract provisions at the FAA's website: www.faa.gov/airports/aip/procurement/federal_contract_provisions/.

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30-07 Contract Approval.

Upon receipt of the executed contract and contract bond or bonds by the successful Bidder, the Owner must complete the contract execution according to local laws or ordinances and return the fully executed contract to the Contractor. Delivery of the fully executed contract to the Contractor constitutes the Owner's approval to be bound by the successful Bidder's proposal and the contract terms.

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 is just cause for award cancellation and forfeiture of the proposal guaranty, not as a penalty, but as liquidated damages (LD) to the Owner.

END OF SECTION 30

Section 40 Scope of Work

40-01 Contract Intent.

The contract's intent is to provide for the construction and completion, in every detail, of the work described. It is further intended that the Contractor furnishes all labor, materials, equipment, tools, transportation, and supplies required to complete the work according to the plans, specifications, and contract terms.

40-02 Alteration of Work and Quantities.

The Owner reserves the right to make changes in quantities and work as necessary or desirable to complete, in a satisfactory manner, the original intended work. Unless otherwise specified in the Contract, the Owner's Engineer or Resident Project Representative (RPR) is authorized to make, in writing, such in-scope alterations in the work and variation of quantities necessary to complete the work, provided the alterations do not represent a significant change in the character of the work.

A significant change in character of work means: any change 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 do not invalidate the contract or release the surety. The Contractor agrees to accept payment for such work alterations and quantity variances according to Section 90, paragraph 90-03, *Compensation for Altered Quantities*.

If the value of altered work or quantity variance meet the criteria for significant change in character of work, cover such altered work and quantity variance by a supplemental agreement. Supplemental agreements also require consent of the Contractor's surety, separate performance, and payment bonds. If the Owner and Contractor cannot agree on a unit adjustment for any contract item requiring a supplemental agreement, the Owner reserves the right to terminate the contract with respect to the item and make other arrangements for its completion.

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Find applicable federal contract provisions for procurement and contracting under federally funded airport grant projects on the following website: https://www.faa.gov/airports/aip/procurement/federal_contract_provisions

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40-03 Omitted Items.

The Owner, Owner's Engineer, or RPR may provide written notice to the Contractor to omit from the work any contract item not meeting the definition of major contract item. Omit major contract items by a supplemental agreement. Omission of such contract items does not invalidate any other contract provision or requirement.

If a contract item is omitted or otherwise ordered to not be performed, the Contractor is 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 must be according to Section 90, paragraph 90-04, *Payment for Omitted Items*.

40-04 Extra Work.

If acceptable completion of the contract requires the Contractor to perform an item of work not provided in the awarded contract, as previously modified by Change Order or supplemental agreement, the Owner may issue a Change Order to cover the necessary extra work. Change Orders for extra work must contain agreed unit prices for performing the Change Order work, according to the requirements specified in the order, and any adjustment to the Contract Time that, in the RPR's opinion, is necessary for completion of the extra work.

When the RPR determines it to be in the Owner's best interest, the RPR may order the Contractor to proceed with extra work as provided in Section 90, paragraph 90-05, *Payment for Extra Work*. Cover extra work necessary for acceptable completion of the project, but not within the general scope of the work covered by the original contract, by a supplemental agreement as defined in Section 10.

If extra work is essential to maintaining the project critical path, the RPR may order the Contractor to commence the extra work under a Time and Material (T&M) contract method. Once sufficient detail is available establishing the effort level necessary for the extra work, the Owner must initiate a Change Order or supplemental agreement to cover the extra work. The Owner must reject any claim for payment of extra work not covered by written agreement (Change Order or supplemental agreement).

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Unless the FAA specifically requests, the Owner does not have to obtain prior FAA approval for contract changes except for the Buy American Review, if required. However, if an Owner proceeds with contract changes without FAA approval, it is at the Owner's risk.

****

40-05 Maintenance of Traffic.

It is the contract's explicit intention that the safety of the aircraft is the most important consideration. The Contractor must conduct its operations in a manner conforming to the operations safety requirements in Item C-101 and the Operational Safety Drawings (OSDs) as based upon the project Construction Safety and Phasing Plan (CSPP) .

40-05.1 It is understood and agreed that the Contractor provides for the free and unobstructed movement of aircraft in the Air Operations Areas (AOAs) of the airport with respect to their own operations and operations of all subcontractors, as specified in Section 80, paragraph 80-04, *Limitations Operations*. It is further understood and agreed that the Contractor provides for the uninterrupted operation of visual and electronic signals (including power supplies) 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*.

40-05.2 When the contract requires the maintenance of an existing road, street, or highway during the Contractor's performance of work otherwise provided for in the contract, plans, and specifications, the Contractor must keep the road, street, or highway open to all traffic and provide maintenance to accommodate traffic. At their expense, the Contractor is responsible for the repair to equal, or better than, preconstruction conditions of any damage the Contractor's equipment and personnel causes.

`[ Unless otherwise specified herein, the Contractor is not required to furnish snow removal for such existing road, street, or highway. ]`

40-06 Removal of Existing Structures.

The Contractor must remove all existing structures encountered within the established lines, grades, or grading sections, unless such existing structures are otherwise specified to be relocated, adjusted up or down, salvaged, abandoned in place, reused in the work, or remain in place. The cost of removing such existing structures is not measured or paid for directly, but is included in the various contract items.

If the Contractor encounters an existing structure (above or below ground) in the work for which the disposition is not indicated on the plans, the contractor must notify the RPR prior to disturbing such structure. The RPR will determine the disposition of existing structures not shown on the project plans.

Except as provided in Section 40, paragraph 40-07, *Rights in, and Use of, Materials Found in the Work*, it is intended all existing materials or structures that may be encountered (within the lines, grades, or grading sections established for completion of the work) and are used in the work, as otherwise provided for in the contract, and remain the Owner's property when used in the work.

****

In separate technical specifications, provide for the removal of large or complicated pre-existing structures such as box-culverts, underground storage tanks, large underground electrical vaults, large reinforced concrete structures or foundations, or similar existing airport facilities. In the contract proposal, provide contract pay items to cover payment for such work.

****

40-07 Rights in, and Use of, Materials Found in the Work.

If the Contractor encounters any material such as (but not restricted to) sand, stone, gravel, slag, or concrete slabs within the established lines, grades, or grading sections, intended by the terms of the contract to be embankment, the Contractor may at their own option either:

1. Use such material in another contract item, provided the RPR approves such use and is in conformance with the contract specifications applicable to such use; or,
2. Remove such material from the site, upon the RPRs written approval; or
3. Use such material for the Contractor's own temporary construction onsite; or,
4. Use such material as intended by the contract terms.

If the Contractor wishes to exercise option 1, 2, or 3, the Contractor must request the RPR's approval in advance. If the RPR approves the Contractor's request to exercise option 1, 2, or 3, the Contractor is paid for the excavation or removal of such material at the applicable contract price. The Contractor must replace, at their expense, such removed or excavated material with an agreed equal volume of material 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 is not charged for use of such material used in the work or removed from the site.

If the RPR approves the Contractor's exercise of option a., the Contractor is paid, at the applicable contract price, for furnishing and installing such material according to the contract requirement in which the material is used. It is understood and agreed that the Contractor cannot claim for delays by reason of their own exercise of option 1, 2, or 3.

The Contractor must not excavate, remove, or otherwise disturb any material, structure, or part of a structure 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.

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The Engineer can modify this section if the Owner does not have rights to the material.

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40-08 Final Cleanup.

Upon completion of the work, and before making acceptance and final payment, the Contractor removes all machinery, equipment, surplus and discarded materials, rubbish, temporary structures, and stumps or portions of trees from the site. The Contractor cuts all brush and woods within the limits indicated and leaves the site in a neat and presentable condition. Material cleared from the site and deposited on adjacent property is not considered satisfactorily disposed of unless the Contractor obtained written permission of the property Owner.

END OF SECTION 40

Section 50 Control of Work

50-01 Authority of the RPR.

The RPR has final authority regarding the interpretation of project plan and specification requirements. The RPR will determine acceptability of the quality of materials furnished, method(s) of performance of work, and the manner and rate of performance of the work. The RPR does not have the authority to accept work that does not conform to specification requirements. Before accepting any non-conforming work, the RPR must determine if the work is in reasonably close conformity following procedures outlined in paragraph 50-02.

50-02 Conformity with Plans and Specifications.

50-02.1 The RPR determines if the materials, work, and finished product conform to the requirements of the plans and specifications. If the finished product meets all acceptance criteria, it will be accepted by the RPR and paid in accordance with the specifications.

50-02.2 If the materials, work and/or finished product are not acceptable, the RPR will determine if they are within reasonably close conformity with the lines, grades, grading sections, cross-sections, dimensions, material requirements, and testing requirements specified in the contract, plans, or specifications.

50-02.2.1 The term “reasonably close conformity” does not waive the Contractor’s responsibility to complete the work according to the contract, plans, and specifications.

50-02.2.2 The term “reasonably close conformity” is not to be construed as waiving the RPR’s responsibility to require compliance with the contract’s requirements, plans, and specifications during the Contractor’s execution of the work.

50-02.3 The RPR determines reasonably close conformance only after performing an appropriate engineering analysis to determine if the materials, work, or finished product will provide equal or better performance. The RPR will accept the materials, work, or finished product if it is determined to be within reasonably close conformance. The engineering analysis must be documented in the project records.

50-02.4 If the RPR determines that the materials, work, or finished product are not in reasonably close conformance but the finished product has a level of safety, economy, durability and/or workmanship acceptable to the Owner, the RPR has the authority, after consultation with the Owner and the FAA, to accept the work at a reduced price.

50-02.5 The RPR documents the determination and recommend adjustments in the contract price for the affected portion of the work that accounts for the decreased performance expected. The RPR will incorporate their determination and recommendation in a contract Change Order or supplemental agreement and submit to the Owner for approval.

50-02.6 If the RPR finds the furnished materials, work performed, or the finished product are not in conformity with the plans and specifications and result in an unacceptable finished product, the affected work or materials must be removed and replaced, or otherwise corrected by, at the Contractor's expense, according to the RPR's written orders.

50-02.7 The RPR is not responsible for the Contractor's means, methods, techniques, sequences, procedures of construction, or safety precaution incidents.

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For contracts funded by federal grants, the Owner is required to keep the FAA advised of the RPR's determinations as to acceptance of work not in reasonably close conformity to the contract, plans, and specifications.

Unless specifically requested by the FAA, the Owner does not have to obtain prior FAA approval for contract changes except for the Buy American Review, if required. However, if an Owner proceeds with contract changes without FAA approval, it is at the Owner's risk.

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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 a conflict occurs between the electronic files and hard copy plans, hard copy plans 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 complete work. In case of discrepancy, calculated dimensions govern over scaled dimensions; contract technical specifications govern over contract general provisions, plans, cited standards for materials or testing, and cited ACs; contract general provisions govern over plan. If any paragraphs contained in the Special Provisions conflict with General Provisions or Technical Specifications, the Special Provisions 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 must immediately ask the RPR for an interpretation and decision. Such decision is final. The Contractor must 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, the Contractor must immediately notify the Owner or the designated representative in writing requesting their written interpretation and decision.

50-04 Special Provisions List. [ ]

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The Engineer must list the Special Provisions in order of precedence.

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50-05 Contractor Cooperation.

Supply the Contractor with [five] hard copies or an electronic PDF of the plans and specifications. The Contractor must have one hard copy of the plans and specifications, each available on the construction site at all times. The Owner will supply the Contractor with [two] full size and [five] half size hardcopies [and | or] an electronic PDF of the plans and specifications.

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

50-06 Cooperation Among Contractors.

The Owner 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 must conduct the work without interfering or hindering the completion progress of work performed by other Contractors. Contractors working on the same project must cooperate with each other, as directed.

Each Contractor involved assumes all liability, financial or otherwise, in connection with their own contract. Each Contractor must protect and hold harmless the Owner from 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 must arrange and dispose of materials without interfering with the operations of the other Contractors within the limits of the same project. The Contractor must join their work with that of the others in an acceptable manner and perform it in proper sequence to that of the others.

50-07 Construction Layout and Stakes.

The [Engineer | RPR] establishes necessary horizontal and vertical control. A State Licensed Land Surveyor must establish survey control and/or reestablishment of survey control. The Contractor is responsible for preserving the integrity of horizontal and vertical controls the [Engineer | RPR] established. 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 are deducted as liquidated damage against the Contractor. Prior to the start of construction, the Contractor checks all control points for horizontal and vertical accuracy and certifies in writing to the RPR that the Contractor concurs with Survey Control established for the project. The

Contractor provides the RPR all lines, grades, and measurements from control points necessary for the proper execution and control of the work on this project. The Contractor is responsible for establishing all layout required for the construction of the project.

The Contractor must provide copies of survey notes for each construction area 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. Provide surveys to the RPR prior to commencing work items that cover or disturb the survey staking. The Contractor must provide survey(s) and notes to the RPR, prior to commencing, in the following format(s): **[__]**.) Laser, GPS, String line, or other automatic control must be checked with temporary control, as necessary. In case of an error on the Contractor's part, their surveyor, employees, or subcontractors, resulting in established grades, alignment, or grade tolerances not concurring 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 Owner.

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The Engineer specifies the desired format and accuracy for electronic delivery of survey(s) in addition to hard copy(ies). This should be applicable to all survey(s) throughout these specifications.

With FAA approval, additional survey criteria may be added.

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

50-08 Authority and Duties of QA Inspectors.

QA Inspectors are authorized to inspect all work and all material furnished. Such QA inspections may extend to all or any part of the work and to the preparation, fabrication, or manufacture of the materials. 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 the nonconforming work or materials in question until such issues can be referred to the RPR for a decision.

50-09 Inspection of Work by RPR.

All materials and each part or detail of the work are subject to inspection. The RPR is permitted access to all parts of the work. The Contractor furnishes such information and assistance, as required, to make a complete and detailed inspection. If the RPR requests, the Contractor, at any time before acceptance of the work, must remove or uncover such portions of the finished work, as directed. After examination, the Contractor must restore the portions of the work to the standard required by the specifications. If the work exposed or examined proves acceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed, is paid for as extra work. However, if the work so exposed or examined proves unacceptable, the uncovering, or removing, and the replacing of the covering or making good of the parts removed is at the Contractor's expense.

Provide the RPR advance written notice of the work the Contractor plans to perform each week and each day. Any work done or materials used without written notice or allowing the RPR an opportunity for inspection, may be ordered removed and replaced at the Contractor's expense. If the contract work includes relocation, adjustment, or any other modification to existing facilities, not the property of the (contract) Owner, authorized representatives of the Owners of such facilities have the right to inspect such work. Such inspections do not make any facility Owner a party to the contract, and in no way interferes with the rights of the parties to this contract.

50-10 Removal of Unacceptable and Unauthorized Work.

Work not conforming to the requirements of the contract, plans, and specifications is considered unacceptable, unless the RPR determines it as acceptable as provided in paragraph 50-02, *Conformity with Plans and Specifications*. Unacceptable work, whether the result of poor workmanship, defective materials, damage due to carelessness, or any other cause found to exist prior to the final work acceptance must be removed and replaced.

Removals must be made to the lines and grades as established by the RPR. Work done contrary to the RPR's instructions, work done beyond the lines shown on the plans, or as the RPR established, except as specified, or any extra work done without authority, is considered unauthorized and is not paid for under the contract provisions. Any work the RPR orders the Contract to remove or replace is at the Contractor's expense. Upon the Contractor's failure to comply with any of the RPRs orders made under this section's provisions, the RPR has authority to cause unacceptable work to be remedied, or removed and replaced; and unauthorized work to be removed and to recover the resulting costs as liquidated damages against the Contractor.

50-11 Load Restrictions.

The Contractor must comply with all legal load restrictions for hauling materials on airport or public roads beyond the limits of the work. A special permit does not relieve the Contractor of liability for damage that may result from moving material or equipment.

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

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The Engineer must check to see if the on-site project access roads and haul routes will support the construction equipment. Pay particular attention when sections of existing airfield pavements will be used as haul routes to ensure that existing pavements are not overloaded.

If questionable, the Engineer should add appropriate provisions to preserve or rehabilitate any access roads or haul routes to the bid documents. Various measures such as videotape or photographs may be required to document existing conditions prior to the start of construction. Construction traffic should be kept off airport pavements to the extent possible.

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50-12 Maintenance During Construction.

The Contractor must maintain the work during construction until the work is accepted. Maintenance must be continuous and effectively prosecuted, every day, with adequate equipment and forces so that the work is 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 must maintain the previous course or subgrade during all construction operations. Include all costs of maintenance work during construction and before the project is accepted, in the unit prices bid on the various contract items. The Contractor is not paid any additional amount for such work.

50-13 Failure to Maintain the Work.

If the Contractor fails to maintain the work, at any time, as provided in paragraph 50-12, *Maintenance During Construction*, the RPR must immediately notify the Contractor of such noncompliance. Such notification must specify a reasonable time in which the Contractor is required to remedy unsatisfactory maintenance condition. The time specified gives due consideration to the existing exigency. If the Contractor fails to respond to the RPR’s notification, the Owner may suspend any work necessary for the Owner to correct such unsatisfactory maintenance condition. Any maintenance cost incurred by the Owner is recovered as 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 benefits the Owner, the Contractor may request that the RPR make a final inspection of that unit. If, upon inspection, the RPR finds the unit has been satisfactorily completed in compliance with the contract, the RPR may accept it as being complete, and the Contractor may be relieved of further responsibility for that unit. Partial acceptance and beneficial occupancy by the Owner does 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 RPR, and Owner will perform an inspection. If all construction provided for and contemplated by the contract is found to be complete according to the contract, plans, and specifications, such inspection constitutes the final inspection. The RPR must notify the Contractor in writing the 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 notifies the Contractor. The Contractor must correct the unsatisfactory work. Upon correction of the work, another inspection is made constituting the final inspection, provided the work is satisfactorily completed. In such event, the RPR makes the final acceptance and notifies 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 must notify the RPR 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 RPR is not afforded proper opportunity by the Contractor for keeping strict account of actual cost as required, the Contractor agrees to waive any claim for such additional compensation. Such notice by the Contractor, and the fact that the RPR kept account of the cost of the work, must not in any way be construed as proving or substantiating the validity of the claim. Within ten calendar days of work completion, on which the claim for additional compensation is based, the Contractor must submit a written claim to the RPR, who presents it to the Owner for consideration according to local laws or ordinances. Nothing in this subsection is to be construed as a waiver of the Contractor’s right to dispute final payment based on the differences in measurements or computations.

[50-17 Value Engineering Cost Proposal.

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FAA concurrence from the Regional Office (RO) or Airport District Office (ADO) must be obtained when this paragraph is included.

This paragraph may not be applied on construction management at-risk (CMAR) and Design-build project delivery methods after a gross maximum price (GMP) is established.

Use of this paragraph in project specifications is at the option of the Owner/Engineer.

This paragraph must not be incorporated into project specifications if State or local laws prohibit its

use, or if the project does not lend itself to value engineering.

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The provisions of this paragraph apply only to contracts awarded to the lowest Bidder pursuant to competitive bidding.

On projects with original contract amounts more than $100,000, the Contractor may submit proposals in writing to the RPR, for modifying the plans, specifications, or other requirements of the contract for the sole purpose of reducing construction costs. The value engineering cost proposal must not impair, in any manner, the essential functions or characteristics of the project, including but not limited to service life, economy of operation, ease of maintenance, desired appearance, design, and safety standards. This provision does not apply unless the proposal submitted is specifically identified by the Contractor as being presented for consideration as a value engineering proposal.

Not eligible for value engineering cost proposals are changes in the basic design of a pavement type, runway and taxiway lighting, visual aids, hydraulic capacity of drainage facilities, or changes in grade or alignment that reduce the geometric standards of the project.

At a minimum, the Contractor must submit the following information with each proposal:

1. A description of both existing contract requirements for performing the work and the proposed changes, with a discussion of the comparative advantages and disadvantages of each.
2. An itemization of the contract requirements that must change if the proposal is adopted.
3. A detailed estimate of the cost of performing the work under the existing contract and under the proposed changes.
4. A statement of the time by which a Change Order adopting the proposal is issued.
5. A statement of the effect adoption of the proposal has on the time for completion of the contract.

6. The contract work items affected by the proposed changes, including any quantity variation attributable to them.

The Contractor may withdraw, in whole or in part, any value engineering cost proposal the RPR does not accept, within the period specified in the proposal. The provisions of this subsection must not be construed requiring the RPR to consider any value engineering cost proposal submitted.

The Contractor continues to perform the work according to the requirements of the contract until a Change Order incorporating the value engineering cost proposal is issued. If a Change Order is not issued by the date upon which the Contractor’s value engineering cost proposal specifies that a decision is made, or such other date as the Contractor may subsequently have requested in writing, such value engineering cost proposal is deemed rejected.

The RPR is the sole judge of the acceptability of a value engineering cost proposal, and of the estimated net savings from the adoption of all or any part of such proposal. In determining the estimated net savings, the RPR may disregard the contract bid prices if, in the RPR’s judgment, such prices do not represent a fair measure of the value of the work performed or deleted.

The Owner may require the Contractor to share in the Owner’s costs of investigating a value engineering cost proposal the Contractor submits, as a condition of considering such proposal. Where such a condition is imposed, the Contractor must acknowledge acceptance of it in writing. Such acceptance constitutes full authority for the Owner to deduct the cost of investigating a value engineering cost proposal from amounts payable to the Contractor under the contract.

If the Contractor’s value engineering cost proposal is accepted, in whole or in part, such acceptance is by a contract Change Order that specifically states it is executed pursuant to this paragraph. Such a Change Order must incorporate the changes in the plans and specifications necessary to permit the value engineering cost proposal, or part of it, as being accepted and must include any conditions on which the RPR based their approval. The Change Order must also set forth the estimated net savings attributable to the value engineering cost proposal. Determine net savings as the difference in costs between the original contract costs for the involved work items and the costs occurring due to the proposed change. The Change Order establishes the net savings agreed upon and provides for adjustment in the contract price that divides the net savings equally between the Contractor and Owner.

The Contractor’s 50% share of the net savings constitutes full compensation to the Contractor for the value engineering cost proposal and the performance of the work. Acceptance of the value engineering cost proposal and performance of the work must not extend the contract’s completion unless specifically provided for in the contract Change Order. **]**

END OF SECTION 50

Section 60 Control of Materials

60-01 Source of Supply and Quality Requirements.

The materials used in the work must conform to the requirements of the contract, plans, and specifications. Unless otherwise specified, such materials manufactured or processed must be new (as compared to used or reprocessed). To expedite the inspection and testing of materials, the Contractor must furnish documentation to the RPR as to the origin, composition, and manufacture of all materials to be used in the work. The Contractor must furnish documentation promptly after execution of the contract but, in all cases, prior to delivery of such materials.

At the RPR's option, materials may be approved at the supply source before delivery. If, after trial, supply sources for previously approved materials do not produce specified products, the Contractor must furnish materials from other sources. The Contractor must 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*, in effect on the advertisement date.

60-02 Samples, Tests, and Cited Specifications.

All materials used in the work must be inspected, tested, and RPR-approved before incorporation in the work unless otherwise designated. If the Contractor performs any work using untested materials without approval or the RPR's written permission, the work performed is at the Contractor's risk. When directed by the RPR, the Contractor must replace at their expense, work that includes unacceptable, unauthorized materials. Unless otherwise designated, QA tests are made by, and at the expense of the Owner, according to the cited standard methods of ASTM, AASHTO, federal specifications, Commercial Item Descriptions, and all other cited methods, current on the date of advertisement for bids.

The testing organizations performing on-site QA field tests must have copies of all referenced standards on the construction site for use by all technicians and other personnel. Unless otherwise designated, a qualified RPR representative takes QA samples. All materials used are subject to inspection, test, or rejection at any time prior to or during incorporation into the work. After the RPR has reviewed and approved tests, copies of all QA tests will be provided to the Contractor's representative upon request. Provide a copy of all Contractor QC test data to the RPR daily, along with printed reports, in an approved format, on a weekly basis. Prior to final payment, the Contractor must submit a final QC report to the RPR showing all QC test data reports, plus an analysis of all results showing ranges, averages, and corrective action taken on all failing tests.

[The Contractor must employ a QC testing organization to perform all Contractor required QC tests according to Item C-100 CQCP. **]**

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The Engineer may wish to include a requirement that the Contractor furnishes all test data in electronic format. The Engineer must provide detailed specifications to determine the acceptable format to use.

Delete bracketed text when Item C-100 is not included in the specifications.

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60-03 Certification of Compliance/Certificate of Analysis (COC/COA).

The RPR 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 manufacturer must sign the certificate. A COA must accompany each lot of such materials or assemblies delivered to the work in which the lot is clearly identified. The COA is the manufacturer’s COC and includes all applicable test results. Materials or assemblies used based on the COCs may be sampled and tested at any time and if found not to be in conformity with contract requirements is subject to rejection whether in place or not. The RPR must approve the form and distribution of the COA.

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

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

The RPR is the sole judge as to whether the proposed, “or equal”, is suitable for use in the work. The RPR reserves the right to refuse permission for use of materials or assemblies based on the COC.

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When it is impractical to make a clear and accurate description of a technical requirement, the Owner may specify a requirement by, “Brand Name or Approved Equal”, provided the performance features and salient requirements establishing equivalency are explicitly and clearly stated. To avoid unfair influence, provide known vendors/suppliers who can meet the stated requirements.

****

60-04 Plant Inspection.

The RPR, or authorized representative, may inspect, at its source, any specified material or assembly to be used in the work. The RPR may inspect manufacturing plants from time to time to determine compliance with specified manufacturing methods or materials used in the work, and to obtain samples required for acceptance of the material or assembly.

If the RPR conducts plant inspections, the following conditions must exist:

1. The RPR must have the cooperation and assistance of the Contractor and the producer the Contractor contracted for the materials.
2. The RPR must have full entry at all reasonable times to such parts of the plant that concern the manufacture or production of the materials being furnished.
3. If the RPR requires, the Contractor must arrange for adequate office or working space needed for conducting plant inspections. Place the office or working space in a convenient location with respect to the plant. It is understood and agreed that the Owner has the right to retest, any tested and approved material, at the supply source, after delivery to the site. The RPR has the right to reject only material which, when retested, does not meet the requirements of the contract, plans, or specifications.

60-05 Engineer/RPR Field Office.

`[ The Contractor provides dedicated space for the Engineer, RPR, [ other individuals as identified by Owner, ] and inspectors, as a field office for the duration of the project. See Item C-105 for requirements for field office. ]`

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Coordinate requirements for specifying the Engineer's (RPR's) field office and a space for a QA mobile laboratory with the Owner and Engineer since not all airport construction projects need such facilities. If a field office is required for the project, establish a separate line item for payment. Additional office space, with approval of the Owner, may be appropriate based on the project's size and duration. Additional space may be needed for additional services required and retained by the Owner such as independent assurance or QA testing laboratory. Make sure that paragraph 60-05 and Item C-105 and consistent in requirements for field office. Only define the detailed requirements in one location, Item C-105.

****

60-06 Storage of Materials.

Store materials to ensure 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. Locate stored materials to facilitate prompt inspection. The Contractor coordinates materials' storage with the RPR. Stored materials on airport property must not create an obstruction to air navigation or interfere with the free and unobstructed movement of aircraft. Locate material stockpiles, batch plants, and employee parking as shown on the CSD and unless directed otherwise by the RPR. Refer to Item C-101 for additional criteria on construction safety.

Do not use private property for storage purposes without written permission of the Owner or lessee of such property. The Contractor makes all arrangements and bears all expenses for the storage of materials on private property. Upon request, the Contractor furnishes the RPR a copy of the property Owner's permission. Restore all storage sites on private or airport property to their original condition, by the Contractor at their expense, except as otherwise agreed to (in writing) by the Owner or lessee of the property.

60-07 Unacceptable Materials.

Any material or assembly not conforming to the requirements of the contract, plans, or specifications is considered unacceptable and is rejected. The Contractor must remove any rejected material or assembly from the worksite, unless the RPR instructs otherwise. Any material or assembly not conforming to the requirements of the contract, plans or specifications, unless found to be in reasonably close conformity per paragraph 50-02, is considered unacceptable and is rejected. The Contractor must remove any rejected material or assembly from the worksite, unless otherwise instructed by the RPR.

60-08 Owner Furnished Materials.

The Contractor furnishes all materials required to complete the work, except those specified, if any, the Owner furnishes. Make Owner-furnished materials available to the Contractor at the location specified. All costs of handling and transportation from the specified location to the site of work, storage, and installing Owner-furnished materials is included in the unit price bid for the contract item in which such Owner-furnished material is used.

After delivery of any Owner-furnished material to the location specified, the Contractor is responsible for any demurrage, damage, loss, or other deficiencies occurring during the Contractor's handling, storage, or use of such Owner-furnished material. The Owner deducts from any monies due or to become due the Contractor, any cost incurred by the Owner in making good such loss due to the Contractor's handling, storage, or use of Owner-furnished materials.

END OF SECTION 60

Section 70 Legal Regulations and Responsibility to Public

70-01 Laws to Observe.

The Contractor must keep fully informed of all federal and state laws, all local laws, ordinances, regulations, and all orders and decrees of bodies or tribunals having any jurisdiction or authority, affecting those engaged or employed on the work, or affecting the conduct of the work. At all times, the Contractor must observe and comply with all such laws, ordinances, regulations, orders, and decrees; and must protect and indemnify the Owner 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 procures all permits and licenses, pays all charges, fees, and taxes, and gives 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 patent letters or copyright, the Contractor must provide for such use by suitable legal agreement with the Patentee or Owner. The Contractor and the surety must indemnify and hold harmless the Owner, 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 must indemnify the Owner for any costs, expenses, and damages 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 Owner 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 was coordinated with the Owner, such authorized work (by others) must show on the plans and indicated as follows. **[__]**.

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List all authorized work and include the following information as a minimum:

- **Owner (Utility or Other Facility)**
- **Location (See Plan Sheet No.)**

- **Contact Person (Name, Title, Address, and Phone)**

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Except as listed above, the Contractor must 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 RPR's written permission. If the Owner of a public or private utility service, FAA, or NOAA facility, or a utility service of another government agency is authorized to construct, reconstruct, or maintain such utility service or facility during the progress of the work, the Contractor must 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 the RPR orders as extra work, the Contractor makes all necessary repairs to the work 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 is not 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.

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This subsection's intention is to provide for both foreseen and unforeseen work by utility services' Owners and other facilities on the airport. Such Owners have legal rights and obligations under some form of easement with the airport Owner. Make every effort, during the Initial Design Phase, to coordinate the proposed contract work with such Owners so the contract, plans, and specifications provide their rights and obligations.

Where there is conflict between an existing utility service (or facility) and the proposed work, or where the utility Owner or facility must perform work to construct, reconstruct, or maintain the utility or facility, list such work in this subsection and provide in the contract, plans, and specifications. In addition, show all known utility services or facilities, within the limits of the proposed work, on the plans (regardless of whether there is a conflict of work to be performed by the Owner) with enough detailed information to indicate the lack of conflicts.

****

70-05 Federal Participation.

The United States Government agrees to reimburse the Owner for some portion of contract costs. The contract work is subject to the inspection and approval of duly authorized representatives of the FAA Administrator. Do not construe the requirements as making the U.S. 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 must comply with applicable federal, state, and local requirements for health, safety, and sanitary provisions.

70-07 Public Convenience and Safety.

The Contractor must control their operations, and those of their subcontractors and all suppliers, to pose the least inconvenience to the traveling public. Under all circumstances, safety is the most important consideration. The Contractor must maintain the free and unobstructed movement of aircraft and vehicular traffic with respect to their own operations materials being furnished and those of their own subcontractors and all suppliers, according to Section 40, paragraph 40-05, *Maintenance of Traffic,* and must limit such operations for the convenience and safety of the traveling public as specified in Section 80, paragraph 80-04, *Limitations of Operations*.

The Contractor must remove or control debris and rubbish resulting from its work operations at frequent intervals, and upon the RPR's order. If the RPR determines the Contractor's debris in the worksite 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 a debris removal task to a third party, and recover the resulting costs as a liquidated damage against the Contractor.

70-08 Airfield Safety and Security.

The Contractor must comply with operational safety and security requirements in Item C-101 and the OSD.

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The Engineer must add the CSPP's location.

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70-09 Explosives Use.

[The use of explosives is not permitted on this project. | When the use of explosives is necessary for the execution of the work, the Contractor must submit a blasting safety plan. Blasting cannot be done until the blasting safety plan is approved by the RPR. The Contractor is responsible for all damage resulting from the use of explosives.

Store all explosives in a secure manner in compliance with all laws and ordinances, and clearly mark all such storage places. Where no local laws or ordinances apply, provide storage satisfactory to the RPR and, in general, not closer than 1,000 feet (300 m) from the work or from any building, road, or other place of human occupancy.

The Contractor notifies each property Owner and public utility company having structures or facilities in proximity to the work site of their intention to use explosives. Give notice sufficiently in advance to enable `property Owners to take such steps as they may deem necessary to protect their property from injury.`

`Do not use electrical blasting caps within 1,000 feet (300 m) of any source that may induce a current that could result in a discharge of a blasting cap. Such sources include radar facilities, radio frequency (RF) emitters, powerlines, radio receiver/transmitters, and aeronautical communication facilities.` **]**

70-10 Protection and Restoration of Property and Landscape.

The Contractor is responsible for the preservation of all public and private property. The Contractor must protect all land monuments and property markers from disturbance or damage until the Engineer/RPR has witnessed or otherwise referenced their location and must not move such monuments or markers until directed. The Contractor is responsible for all damage, direct or indirect, or injury to the property of any character, public, or private property during the execution of the work resulting from any act, omission, neglect, or misconduct in manner or method of executing the work, or due to defective work or materials. Said responsibility is not released until the project has been completed and accepted. The Contractor must 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 must make good such damage or injury in an acceptable manner.

70-11 Responsibility for Damage Claims.

The Contractor must indemnify and hold harmless the Engineer/RPR and the Owner and 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 “Worker’s Compensation Act,” or any other law, ordinance, order, or decree. Money owed the Contractor by virtue of their own contract considered necessary by the Owner for such purpose may be retained for the use of the Owner or, in case no money is owed, their own surety is held until such suits, actions, or claims for injuries or damages have been settled and suitable evidence to that effect furnished to the Owner, 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.

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, 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 contract's terms or provisions.

70-13 Opening Sections of the Work to Traffic.

The CSD indicates various phases and subphases of work. When it is necessary for the Contractor to complete portions of the contract work for the beneficial occupancy of the Owner prior to completion of the entire contract, inspect the area to verify conformance with applicable FAA standards for active airfield pavements, marking, lighting, signage and FOD. The Owner expects the Contractor to complete project phases on or prior to the date specified within the approved project schedule.

The work phases and sequencing are: **[** `insert Work Phase, time allowed, or required date, where work is shown on plans` **]**.

[__].

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The Engineer must identify phase/description(s) and provide the following minimum information for each phase/description(s):

- **Phase or Description**
- **Required Date or Sequence of Owner's Beneficial Occupancy**
- **Work Shown on Plan Sheet**

The Owner's requirements for "phasing" the work must be coordinated with all users and parties that have an interest in operational capability of the airport. Such coordination must be accomplished at the earliest possible time. See AC 150/5370-12, *Quality Management for Federally Funded Airport Construction Projects*. Such coordination must be accomplished at the earliest possible time, typically at the predesign meeting.

The Engineer should include the Construction Safety Drawings (CSD) in the bid documents. The CSD must include any additional requirements as a result of a Safety Risk Management (SRM) review, if required.

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Upon completion of any portion of the work listed above, the Owner must accept such portion according to Section 50, paragraph 50-14, *Partial Acceptance*. The Contractor may not open any portion of the work until directed by the Owner in writing. If it becomes necessary to open a portion of the work to traffic on a temporary or intermittent basis, such opening is 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 inherent in the work and do 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, permitted by the Owner, must be repaired by the Contractor at their expense.

The Contractor must make their own estimate of the inherent difficulties involved in completing the work under the conditions described and not claim any added compensation by reason of delay or increased cost due to opening a portion of the contract work. Conform to the operational safety requirements contained in Item C-101 and the CSDs. Refer to the CSDs for barricade location and type as well as other temporary visual aids such as marking, lighting, signage, and navigational aids. Refer to the technical specifications and project drawings for requirements applying to permanent improvements. Areas must conform to applicable FAA standards prior to opening sections up to aircraft operations.

70-14 Contractor's Responsibility for Work.

Until the RPR's final written acceptance of the entire completed work, excepting only those portions of the work accepted according to Section 50, paragraph 50-14, *Partial Acceptance*, the Contractor must have the charge and care, and 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 must 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 bear the expense 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 whatsoever, the Contractor is responsible for the work and must take the precautions necessary to prevent damage to the work. The Contractor provides for normal drainage and erects necessary temporary structures, signs, or other facilities at their own expense. During such periods of work suspension, the Contractor must continuously maintain in acceptable growing condition, all living material in newly established planting, seeding, and sodding furnished under the contract, and 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 must cooperate with the Owner of any public or private utility service, FAA, or the National Oceanic Atmospheric Administration (NOAA), or a utility service of another government agency that may be authorized by the Owner to construct, reconstruct, or maintain such utility services or facilities during the progress of the work. In addition, the Contractor must 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, 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.

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The Engineer must list all known services and provide the following minimum information for each service:

- **Utility Service or Facility, or FAA Air Traffic Organization (ATO)/ Technical Operations/System Support Center (SSC)**
- **Contact Person (Name, Title, Address, and Phone)**
- **Owner’s Emergency Contact (Phone)**

The plans must show the approximate location of the utilities or facilities known to exist within the limits of the contract work. The proposed contract plans and specifications must be coordinated with the various Owners as early as possible to avoid overlooking utility conflicts in the design and to obtain the best possible information needed to protect such utility services or facilities from damage resulting from the Contractor’s operations.

Where conflicts are indicated during the coordination, they must be resolved by the airport Owner and the utility owner, according to existing legal agreements, by providing for work in the proposed contract or by the utility owner. In such cases of conflict, regardless of how the conflict is resolved, the airport Owner and utility owner should also be advised of the need to furnish the best information possible as to location of the utility service or facility to ensure protection during the proposed contract work.

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It is understood and agreed that the Owner 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 does 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 will, upon execution of the contract, notify the Owners of all utility services or other facilities of their plan of operations. Notification must 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 is given to the RPR. In addition to the general written notification provided, it is the responsibility of the Contractor to keep such individual Owners advised of changes in their plan of operations that would affect such Owners.

Prior to beginning the work in the general vicinity of an existing utility service or facility, the Contractor must again notify each Owner of their plan of operation. If, in the Contractor’s opinion, the Owner’s assistance is needed to locate the utility service or facility, or the presence of a representative of the Owner is desirable to observe the work, include such advice in the notification. Such notification must 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 must furnish a written summary of the notification to the RPR. The Contractor's failure to give the two days' notice is cause for the Owner to suspend the Contractor's operations in the general vicinity of the utility service or facility.

Where the outside limits of an underground utility service have been located and staked on the ground, the Contractor is 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.

If the Contractor damages or interrupts the operation of a utility service or facility by accident or otherwise, the Contractor must immediately notify the proper authority and the RPR, and take all reasonable measures to prevent further damage or interruption of service. In such events, the Contractor, must cooperate with the utility service or facility owner, and the RPR continuously, until such damage has been repaired and service restored to the satisfaction of the utility or facility owner. The Contractor bears 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 Owner 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 advised that construction limits of the project include existing facilities and buried cable runs that the FAA owns, operates, and maintains. The Contractor, during the execution of the project work, must comply with the following:

1. The Contractor must permit FAA maintenance personnel the right of access to the project worksite for purposes of inspecting and maintaining all existing FAA-owned facilities.

2. The Contractor must provide notice to the FAA's Air Traffic Organization (ATO)/Technical Operations/System Support Center (SSC) Point-of-Contact (POC) through the airport **[** Owner **|** operator **|** manager **|** ___ **]** a minimum of seven calendar days prior to commencement of construction activities to permit sufficient time to locate and mark existing buried cables and to schedule any required facility outages.

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FAA Airports (ARP) will inform the Airport Owner of their requirement to notify the FAA preferably a minimum of 45 days prior to scheduled interruptions and airport projects with the potential to cause

significant impacts to the National Airspace System (NAS). This is handled through the Internet Obstruction Evaluation/Airport Airspace Analysis (IOE/AAA) process and the airspace determination letter.

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3. If execution of the project work requires a facility outage, the Contractor must contact the FAA POC a minimum of 72 hours prior to the time of the required outage.
4. Any damage to FAA cables, access roads, FAA NAVAIDs, or FAA facilities during construction caused by the Contractor’s equipment or personnel whether by negligence or accident requires the Contractor to repair or replace the damaged cables, access road, or FAA facilities to FAA requirements. The Contractor must not bear the cost to repair damage to underground facilities or utilities improperly located by the FAA.

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Any displaced or relocated FAA facility or cables due to construction, requires a signed and executed reimbursable agreement between the Owner and the FAA Tech Ops Division.

Splicing cables may not be an acceptable form of repair for certain projects. If any FAA cables are damaged, the Owner replaces the cables in their entirety.

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5. If the project work requires the cutting or splicing of FAA-owned cables, the FAA POC must 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 onsite to observe the splicing of the cables, as a condition of acceptance. All cable splices are to be accomplished according to FAA ATO specifications and require approval by the FAA POC as a condition of acceptance by the Owner. The Contractor is hereby advised that the FAA restricts location of splices. If a cable splice is required in a location

`not permitted by FAA, the Contractor must furnish and install a sufficient length of new cable that eliminates the need for any splice.` **]**

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The Engineer should include paragraph 70-15.1 when existing FAA-owned facilities and/or cable runs are located within the construction limits.

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70-16 Furnishing Rights-of-Way.

The Owner is 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 is no liability upon the Engineer, RPR, their authorized representatives, or any officials of the Owner, either personally or as an official of the Owner. It is understood that in such matters they act solely as agents and representatives of the Owner.

70-18 No Waiver of Legal Rights.

Upon completion of the work, the Owner must expeditiously make final inspection and notify the Contractor of final acceptance. Such final acceptance, however, does not preclude or stop the Owner from correcting any measurement, estimate, or certificate made before or after completion of the work, nor will 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 Owner of any breach of any part of the contract is not a waiver of any other or subsequent breach. The Contractor, without prejudice to the terms of the contract, is liable to the Owner for latent defects, fraud, or such gross mistakes as may amount to fraud, or as regards the Owner's rights under any warranty or guaranty.

70-19 Environmental Protection.

The Contractor must comply with all federal, state, local laws, and regulations controlling pollution of the environment. The Contractor must 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.

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The Engineer may add project specific requirements.

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70-20 Archaeological and Historical Findings.

Unless otherwise specified in this subsection, the Contractor is advised that 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 (DOI).

If the Contractor encounters, during their operations, any building, part of a building, structure, or object, incongruous with its surroundings, the Contractor immediately ceases operations in that location and notifies the RPR. The RPR immediately investigates the Contractor's finding. The Owner directs the Contractor to either resume operations or to suspend operations, as directed.

If the Owner orders suspension of the Contractor's operations to protect an archaeological or historical finding, or orders the Contractor to perform extra work, such extra work is 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 will include an extension of Contract Time according to Section 80, paragraph 80-07, *Determination and Extension of Contract Time*.

****

The contract language suggested in paragraph 70-20 is intended to remind airport Owners that proper planning prevents construction delays that may occur when encountering objects of archaeological or historical significance. Airport Owners should include in their planning the coordination with state and local planning bodies as may be required by State and local laws pertaining to the National Historic Preservation Act of 1966.

As a general rule, disposition of known archaeological or historic objects situated on the worksite should be covered by a separate contract when such disposition is required as a part of FAA project approval.

****

70-21 Insurance Requirements.

[`Insert local insurance requirements for the project.` **]**

****

Insert local insurance requirements for commercial, general, and umbrella liability; commercial auto and umbrella liability; worker's compensation; property; and/or other types of coverage the project requires.

****

END OF SECTION 70

Section 80 Execution and Progress

80-01 Subcontractors.

The Owner will not recognize any subcontractor on the work. When work is in progress, the Contractor must be represented either in person, by a qualified superintendent, or other designated, qualified representative, duly authorized to receive and execute the RPRs orders. The Contractor must perform, with their organization, an amount of work equal to at least **[__]** percent of the total contract cost. If the Contractor elects to assign their contract, the assignment must be concurred by the surety, presented for the consideration and approval of the Owner, and consummated only after receipt of the Owner's written approval.

****

The Engineer determines the percentage of work to be performed by the Prime Contractor on a project basis (typically at least 25%).

****

The Contractor provides copies of all subcontracts to the RPR **[** `14` **]** days prior to being utilized on the project. At a minimum, the information must include the following:

- Subcontractor's legal company name.
- Subcontractor's legal company address, including County name.
- Principal contact person's name, telephone, and fax number.
- Complete narrative description, and dollar value of the work to be performed by the subcontractor.
- Copies of required insurance certificates according to the specifications.
- Minority/non-minority status.

80-02 Notice to Proceed (NTP).

The Owner's NTP states the date Contract Time commences. The Contractor is expected to commence project operations within **[__]** days of the NTP date. The Contractor must notify the RPR at least **[** `24 hours` **]** in advance of the time contract operations begins. The Contractor must not commence any actual operations prior to the date on the NTP the Owner issues.

****

In general, it is important that the Owner issue the NTP for federally funded airport contracts because any actual construction work, performed prior to execution of a grant agreement (between the Owner and FAA) may be

ineligible for FAA participation in its cost. Check with the FAA for exceptions.

****

80-03 Execution and Progress.

Unless otherwise specified, the Contractor must submit their coordinated construction schedule showing all work activities for the RPR's review and acceptance at least [10 days] prior to starting work. Once the RPR accepts, the Contractor's progress schedule, represents the Contractor's baseline plan to accomplish the project, according to the terms and conditions of the Contract. The RPR will compare actual Contractor progress against the baseline schedule to determine that status of the Contractor's performance. The Contractor must provide sufficient materials, equipment, and labor to guarantee the completion of the project, according to the plans and specifications, within the time set forth in the proposal.

If the Contractor falls significantly behind the submitted schedule, the Contractor, upon the RPR's request, submits a revised schedule for completion of the work within the Contract Time and modifies their operations to provide such additional materials, equipment, and labor necessary to meet the revised schedule. If work execution is discontinued for any reason, the Contractor must notify the RPR at least [24 hours] in advance of resuming operations. The Contractor must not commence any actual construction prior to the date on the NTP the Owner issued.

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

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For projects over $500,000, insert the above bracketed language, edited for project specific scheduling requirements.

****

The Contractor must 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 does not relieve the Contractor of overall responsibility for scheduling, sequencing, and coordinating all work to comply with the requirements of the contract.

****

In general, it is important that the Owner issue the NTP for federally funded contracts because any actual construction work, performed prior to execution of a grant agreement, (between the Owner and FAA) may be ineligible for FAA participation in its cost. Check with the FAA for exceptions.

****

80-04 Limitations on Operations.

The Contractor must control their operations and 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 operations within an AOA of the airport, the work must be coordinated with airport operations (through the RPR) at least **[** `48 hours` **]** prior to commencement of such work. The Contractor must not close an AOA until the RPR authorizes and until the necessary temporary marking, signage, and associated lighting is in place, as provided in Item C-101 and as shown on CSDs.

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 must maintain constant communications as specified; immediately obey all instructions to vacate the AOA; and immediately obey all instructions to resume work in the AOA. Failure to maintain the specified communications or to obey instructions is cause for suspension of the Contractor’s operations in the AOA until satisfactory conditions are provided. The areas of the AOA identified in the CSD, and below, cannot be closed to operating aircraft except on an intermittent basis, as follows.

[__]

****

The Engineer identifies areas of the AOA that cannot be closed to operating aircraft to permit the Contractor’s operations on a continuous basis. As a minimum, the following information is required for each area:

- **AOA**
- **Time periods AOA can be closed**
- **Type of communication(s) required when working in an AOA**
- **Control authority including driver training and/or safety training**

It is intended that the contract provisions limiting the Contractor’s operations be specified for all AOA of the airport, not intended to be closed to permit continuous construction operations. These contract provisions vary widely from airport to airport and require careful coordination (during the early stages of designing the work) with the Owner, FAA, and the airport

users. AC 150/5370-12, *Quality Management for Federally Funded Airport Construction Projects*, contains additional information on this subject.

****

The Contractor is required to plan and coordinate work operations in accordance with Item C-101, Airfield Work Zone Operational Safety, the OSDs, and the approved SPCD.

80-04.1 Operational Safety on Airport During Construction.

All Contractors' operations must be conducted according to the approved project CSPP, the SPCD, and the provisions within the current version of AC 150/5370-2*, Operational Safety on Airports During Construction*. The CSPP included within the contract documents conveys the minimum requirements for operational safety on the airport during construction activities. The Contractor must prepare and submit a SPCD detailing how it proposes to comply with the CSPP requirements.

The Contractor must implement all necessary Safety Plan measures prior to commencement of any work activity. The Contractor must conduct routine checks to ensure compliance with the Safety Plan measures. The Contractor is accountable to the Owner for the conduct of all subcontractors it employs on the project. The Contractor must ensure all subcontractors are aware of the CSPP and SPCD requirements 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 Owner. The necessary coordination actions to review Contractor proposed modifications to an approved CSPP or approved SPCD can require a significant amount of time.

****

The Owner must coordinate any changes to the CSPP with the FAA.

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80-05 Character of Workers, Methods, and Equipment.

At all times, the Contractor must 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 must have sufficient skill and experience to properly perform the work assigned to them. Workers engaged in special work or skilled work must have sufficient experience in such work and in the operation of the equipment required to perform the work satisfactorily.

Any person or subcontractor employed by the Contractor, who violates any operational regulations or operational safety requirements and, in the RPR's opinion, does not perform their work in a proper and skillful manner or is intemperate or disorderly, must at the written request of the RPR, be removed immediately by the Contractor or subcontractor employing such person, and not be employed again in any portion of the work without the RPR's approval. If the Contractor fails to remove such person or persons or fails 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 is met.

All equipment proposed to be used on the work must 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 must 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 must be used unless the RPR authorizes otherwise. If the Contractor desires to use a method or type of equipment other than specified in the contract, the Contractor may request the RPRs authority. The request must be in writing and include a full description of the methods and equipment proposed and the reasons for desiring to make the change. If approval is given, it is on the condition that the Contractor is 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 contractual requirements, the Contractor discontinues the use of the substitute method or equipment and completes the remaining work with the specified methods and equipment. The Contractor removes any deficient work and replaces it with work of specified quality or takes such other corrective action the RPR directs. No change is made in basis of payment for the contract items involved or in Contract Time as a result of authorizing a change in methods or equipment under this paragraph.

80-06 Temporary Work Suspension.

The Owner has the authority to suspend the work wholly, or in part, for such period or periods the Owner 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.

If the Contractor is ordered by the Owner, in writing, to suspend work for some unforeseen cause not 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 is made for anticipated profits. The period of shutdown is computed from the effective date of the written order to suspend work to the effective date of the written order to resume the work. File such claims for such compensation with the RPR within the time period stated in the RPR’s order to resume work. With their claim, the Contractor must submit information substantiating the amount shown on the claim. The RPR forwards the Contractor’s claim to the Owner for consideration according to local laws or ordinances. No provision of this article is to be construed as entitling the Contractor to compensation for delays due to inclement weather or for any other delay provided for in the contract, plans, or specifications.

If it becomes necessary to suspend work for an indefinite period, the Contractor must store all materials so they will not become an obstruction or be damaged in any way. The Contractor must take every precaution to prevent damage or deterioration of the work performed and provide for normal drainage of the work. The Contractor must 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` **|**`the number of working days` **|** `completion date` **]** is as stated in the proposal and contract and must be known as the Contract Time.

If the Contract Time requires extension for reasons beyond the Contractor's control, it must be adjusted as follows.

[`80-07.1 Contract Time Based on Working Days.`

`The RPR bases Contract Time based on working days and calculates it weekly. The RPR furnishes the Contractor a copy of their weekly statement of the number of working days charged against the Contract Time during the week and the number of working days currently specified for completion of the contract (the original Contract Time plus the number of working days, if any, that have been included in approved Change Orders or Supplemental Agreements covering Extra Work).`

`The weekly statement of Contract Time charged is based on the following considerations:`

1. `Time is charged for days on which the Contractor could proceed with scheduled work under construction at the time for at least six hours with the normal work force employed on such items. When normal work force is a double-shift, use twelve hours; and when the normal work force is on a triple-shift, use 18 hours. Conditions beyond the Contractor's control such as strikes, lockouts, unusual delays in transportation, temporary suspension of the scheduled work items under construction, or temporary suspension of the entire work which have been ordered by the Owner for reasons not the fault of the Contractor, will not be charged against the Contract Time.`
2. `(he RPR will not make charges against the Contract Time prior to the NTP's effective.`
3. `The RPR begins charges against the Contract Time on the first working day after the NTP's effective date.`

4. The RPR will not make charges against the Contract Time after the date of final acceptance as defined in Section 50, paragraph 50-15, *Final Acceptance*.

5. The Contractor is allowed one week in which to file a written protest setting forth their own objections to the RPR’s weekly statement. If no objection is filed within such specified time, the weekly statement is considered as acceptable to the Contractor.

The Contract Time (stated in the proposal) is based on the originally estimated quantities as described in the Section 20, paragraph 20-05, *Estimated Proposal Quantities*. If satisfactory completion of the contract requires work performance in greater quantities than those estimated in the proposal, the Contract Time is 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 Contract Time will not consider either the cost of work or the extension of Contract Time NTP’s effective, and including all Saturdays, Sundays, holidays, and non-work days. Exclude 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.

At the time of final payment, the Contract Time is 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 will 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 ceases as of the date of final acceptance. **]**

[80-07.2 Contract Time Based on a Specific Completion Date.

When the Contract Time is a specified completion date, it is the date on which all contract work must be substantially complete.

If the Contractor finds it impossible, for reasons beyond their own control to complete the work within the Contract Time as specified, or as extended according to the provisions of this paragraph, the Contractor may, at any time prior to the expiration of the Contract Time as extended, make a written request to the Owner for an extension of time, setting forth the reasons which the

Contractor believes will justify the granting of their own request. Requests for extension of time, caused by inclement weather, must be supported with National Weather Bureau data showing the actual amount of inclement weather exceeded what could normally be expected during the contract period.

The Contractor's plea that insufficient time was specified is not a valid reason for extension of time. If the supporting documentation justifies that the work was delayed because of conditions beyond the control and without the fault of the Contractor, the Owner may extend the time for completion by a Change Order that adjusts the Contract Time or completion date. The extended time for completion is in full force and effect, the same as though it were the original time for completion.]

[80-07.3 **Contract time based on calendar days.**

Contract Time based on calendar days consists of the number of calendar days stated in the contract counting from the effective date of the Notice to Proceed. 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 are excluded.

At the time of final payment, the contract time will 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 does not consider either cost of work or the extension of contract time included in a Change Order or supplemental agreement. Charges against the contract time will cease as of the date of final acceptance.]

****

Select the appropriate method identifying Contract Time for the contract.

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80-08 Failure to Complete on Time.

For each calendar or working day, as specified in the contract, any work that remains uncompleted after the Contract Time (including all extensions and adjustments, as provided in paragraph 80-07, *Determination and Extension of Contract Time*), the sum specified in the contract and proposal as liquidated damage are deducted from any money due or to become due the Contractor or their surety. Such deducted sums will not be deducted as a penalty considered as liquidation of a reasonable portion of damages including, but not limited to, additional engineering services incurred by the

Owner if the Contractor fails to complete the work in the time provided in the contract.

Table 80-08: Liquidated Damages (LD)

Schedule	Liquidated Damages Cost	Allowed Construction Time

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The Engineer lists the liquidated damage cost and allowed construction time in the proposal form, or other appropriate contract document, to clarify when more than one schedule of work is bid, or in the event all schedules bid cannot be awarded. If liquidated damages are listed elsewhere in the contract, provide the cross-reference link.

The amount of the liquidated damage should not be unreasonable, excessive, or punitive. Liquidated damage must reflect a reasonable estimate of the actual costs which will be incurred by the Owner and airport users and must not be punitive. An excessive value for liquidated damage may not be enforceable.

****

The maximum construction time allowed for Schedules **[__]** is the sum of the time allowed for individual schedules but not more than **[__]** days. Allowing 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, in no way operates as a wavier on the part of the Owner of any of its rights under the contract.

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The Engineer modifies this paragraph for each project.

The Contract Time is an essential part of each contract for construction on airports and should be considered carefully in the preparation of plans and specifications. In selecting the method of specifying the Contract Time (working days, calendar days, or a specified completion date), the primary consideration should be the impact on airport operations should the Contractor be unable to complete the work within the time specified. These considerations should be coordinated with the airport users as indicated in AC 150/5370-12, *Quality Management for Federally Funded Airport Construction Projects.*

The amount of liquidated damage to be specified should be tailored to each contract and based on the cost per day incurred by the Owner should the Contractor overrun the Contract Time. For large airports (where the impact on airport operations may be great), it is not practical for the Owner to

attempt to recover all loss of revenue through liquidated damage. Consequently, the amount of liquidated damage specified must be balanced somewhere between the cost per day incurred for a time overrun and the cost. Bidders would have to add to their bids to cover the contingency of a time overrun.

Contract Time is based on working days when completion is not critical to operation of the airport. As the impact on airport operations increases, the use of calendar days provides more control. Use of a specified completion date should be used only in cases where the construction operations require long-range rescheduling of airport operations. Generally, the amount of liquidated damage would be greater for a calendar day contract than for a working day contract and greatest for a specified completion date contract.

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80-09 Contract Default and Termination.

The Contractor is considered in default of their contract and such default is considered as cause for the Owner to terminate the contract for any of the following reasons, if the Contractor:

1. Fails to begin the work under the contract within the time specified in the NTP, or
2. Fails to perform the work or fails to provide sufficient workers, equipment and/or materials to ensure completion of work according to the terms of the contract, or
3. 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
4. Discontinues the execution of the work, or
5. Fails to resume work which has been discontinued within a reasonable time after notice to do so, or
6. Becomes insolvent or is declared bankrupt, or commits any act of bankruptcy or insolvency, or
7. Allows any final judgment to stand against the Contractor unsatisfied for a period of 10 days, or
8. Makes an assignment for the benefit of creditors, or
9. For any other cause whatsoever, fails to carry on the work in an acceptable manner.

If the Owner considers the Contractor in default of the contract for any reason above, the Owner will immediately give the Contractor written notice, and the Contractor's surety, the reasons for considering the Contractor in default and the Owner's intentions to terminate the contract.

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

All costs and charges incurred by the Owner, together with the cost of completing the work under contract, is 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, the Contractor and the surety are liable and must pay to the Owner the amount of such excess.

80-10 Termination for National Emergencies.

The Owner terminates the contract or portion of the contract, 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 of, is terminated before completion of all work items in the contract, payment is made for the actual number of units or work items completed at the contract price or as mutually agreed for work items partially completed or not started. Claims or loss of anticipated profits are not considered.

Reimbursement for work organization, and other overhead expenses, (when not otherwise included in the contract), and moving equipment and materials to and from the job is 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 not incorporated in the work, will, at the Contractor’s option, be purchased from the Contractor at the actual cost shown by receipted bills and actual cost records at such points of delivery as the RPR designates. Termination of the contract, or a portion of the contract, does not relieve the Contractor of their responsibilities for the completed work or 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 must obtain the RPR’s approval prior to beginning any work in all areas of the airport. Any operating runway, taxiway, or AOA cannot be crossed, entered, or obstructed while it is operational. The Contractor is required to plan and coordinate work operations according to Item C-101, Airfield Work Zone Operational Safety, the OSDs.

END OF SECTION 80

Section 90 Measurement and Payment

90-01 Quantities Measurement.

The RPR measures all work completed under the contract, or their authorized representatives, using `[ United States Customary Units of Measurement | the International System of Units ]`.

The method of measurement and computations used in determination of quantities of material furnished and of work performed under the contract are those methods generally recognized as conforming to good engineering practice. Unless otherwise specified, make longitudinal measurements for area computations horizontally. Deductions are not made for individual fixtures (or leave-outs) having an area of 9 square feet (0.8 square meters) or less. Unless otherwise specified, ensure transverse measurements for area computations are the neat dimensions shown on the plans or were revised by the RPR in writing. Unless otherwise specified, measure all contract items measured by the linear foot such as electrical ducts, conduits, pipe culverts, underdrains, and similar items, parallel to the base or foundation upon which such items are placed.

The term "lump sum" when used as an item of payment means 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 is construed to include all necessary fittings and accessories. When requested by the Contractor and approved by the RPR in writing, weigh the material specified to be measured by the cubic yard (cubic meter). Convert weights to cubic yards (cubic meters) for payment purposes. The RPR determines the factors for conversion from weight measurement to volume measurement. The Contractors must agree to the factors before such method of measurement of pay quantities is used.

Table 90-01: Quantities Measurement

Term	Description
Asphalt Material	Measure asphalt materials by the gallon (liter) or ton (kg). When measured by volume, measure such volumes at 60°F (16°C) or correct to the volume at 60°F (16°C) using ASTM D1250 for asphalts. Use net certified scale weights or weights based on certified volumes in the case of rail shipments, 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 shipping asphalt materials by truck or transport, use net certified weights by volume, subject to correction for loss or foaming, for computing quantities.
Cement	Measure cement by the ton (kg) or hundredweight (km).
Excavation and Embankment Volume	In computing volumes of excavation, use the average end area method unless otherwise specified.

Term	Description
Measurement and Proportion by Weight	The term "ton" means the short ton consisting of 2,000 lbs (907 km) avoirdupois. All materials measured or proportioned by weights must be weighed on accurate, independently certified scales by competent, qualified personnel at RPR designated locations. 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 are not acceptable for material to pass through mixing plants. Trucks used to haul material paid for by weight must be weighed empty, daily, at such times the RPR directs. Each truck must bear a plainly legible identification mark.
Measurement by Volume	Haul materials for measurement by volume in the approved hauling vehicle and measure at the point of delivery. Any size or type of vehicles for this purpose is acceptable for the materials hauled, provided the body is of such shape that the actual contents may be readily and accurately determined. Load all vehicles to at least their water level capacity. All loads must be leveled when the vehicles arrive at the point of delivery.
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., consider such identification to be nominal weights or dimensions. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved are acceptable.
Pay Quantities	When designating the estimated quantities for a specific portion of the work as the pay quantities in the contract, they are the final quantities for which payment for such specific portion of the work are made, unless the dimensions of said portions of the work shown, or unless the RPR revises plans. If revised dimensions result in an increase or decrease in the quantities of such work, the final quantities for payment are revised in the amount represented by the authorized changes in the dimensions.
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 is specified and measured in decimal fraction of inch.
Rental Equipment	Measure rental of equipment by time in hours of actual working time and necessary traveling time of the equipment within the limits of the work. Measure special equipment ordered in connection with extra work as agreed in the Change Order or supplemental agreement authorizing such work, as provided in paragraph 90-05, *Payment for Extra Work*.
Scales	Test scales for accuracy and service before use. Scales for weighing materials, required to be proportioned or measured and paid for by weight, must be furnished, erected, and maintained by the Contractor, or be certified permanently installed commercial scales. Install and maintain platform scales with the platform level and rigid bulkheads at each end. Scales must be accurate within 0.5% of the correct weight throughout the range of use. The Contractor must have the scales checked under the

Term	Description
	RPR’s observation before beginning work and at such other times, as requested. The intervals must be uniform in spacing throughout the graduated or marked length of the beam or dial and must 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 is not permitted. Immediately adjust the scales in the event inspection reveals the scales “overweighing” (indicating more than correct weight). Reduce all materials received after the last previous correct weighting-accuracy test by the percentage of error more than 0.5%. In the event inspection reveals the scales have been under-weighing (indicating less than correct weight), adjust the scales, immediately. No additional payment is made to the Contractor for materials previously weighed and recorded. Arrange beams, dials, platforms, and other scale equipment so the operator and RPR can safely and conveniently view them. Scale installations must have available ten, standard 50-pound (2.3 km) weights for testing the weighing equipment or suitable weights and devices for other approved equipment. Include 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, in the unit contract prices for the various items of the project.
Structure	Measure structures according to neat lines shown on the plans or as altered to fit field conditions.
Timber	Measure timber by the thousand feet board measure (MFBM), actually incorporated, in the structure. Base measurement on nominal widths and thicknesses and the extreme length of each piece.

90-02 Payment Scope.

The Contractor receives and accepts 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, 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 is not 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 must 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,* is 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, *Omitted Items,* the RPR has the right to omit from the work (order nonperformance) any contract item, except major contract items, in the best interest of the Owner. If the RPR omits or orders nonperformance of a contract item or portion of such item from the work, the Contractor must 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 RPR's date order is paid for at the actual cost to the Contractor and becomes the Owner's property. In addition to the reimbursement provided, the Contractor is reimbursed for all actual costs incurred for the purpose of performing the omitted contract item prior to the RPR's order date. Such additional costs incurred by the Contractor must be directly related to the deleted contract item and 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 according to Section 40, paragraph 40-04, *Extra Work*, is paid for at the contract prices or agreed prices specified in the Change Order or supplemental agreement authorizing the extra work.

90-06 Partial Payments.

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

- **[** `Insert retainage option here.` **]**

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The Owner has three options in determining whether retainage is withheld on the project. The Owner must insert the clauses for the option that applies and delete the clauses for the other two options. Proper use of this language assists with meeting the requirements of 49 CFR § 26.29.

Option 1: **No retainage is held from the Prime Contractor, and the Prime Contractor is prohibited from holding retainage on subcontractors.**

a. No retainage will be withheld by the Owner from progress payments made to the Contractor. The Contractor must not hold any retainage on payments due or made to subcontractors.

b. The Prime Contractor is required to pay subcontractors for satisfactory performance of their contracts within 30 days of receipt of Owner payment to Prime Contractor. When the Owner has made incremental acceptance of a portion of a prime contract, the work of the subcontractor covered by that acceptance is considered satisfactorily completed.

Option 2: **No retainage will be held from the Prime Contractor, and the Prime Contractor must make prompt and full payment of any retainage kept by the Prime Contractors due to the subcontractors within 30 days after the subcontractors' work is satisfactorily completed. Insert this clause if Option 2 is selected:**

a. No retainage is held by the Owner from progress payments due the prime.

b. The Contractor is required to pay all subcontractors for satisfactory performance of their contracts no later than 30 days after the Contractor has received a partial payment. The Contractor must provide the Owner evidence of prompt and full payment of retainage held by 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 are accomplished and documented as required by the Owner. When the Owner makes incremental acceptance of a portion of a prime contract, the work of a subcontractor covered by that acceptance is deemed to be satisfactorily completed.

c. When at least 95% of the project work is completed to the satisfaction of the RPR, the RPR, at the Owner's discretion and with the consent of the surety, prepare estimates of both the contract value and the cost of the remaining work to be done.

Option 3: **The Owner may hold retainage from Prime Contractors and provide for prompt and regular incremental acceptances of portions of the prime contract, pay retainage to Prime Contractors based on these acceptances, and require a contract clause obligating the Prime Contractor to pay all retainage owed to the subcontractor for satisfactory completion of the accepted work within 30 days after the Owner's payment to the Prime Contractor.**

If Option 3 is selected, the percent withheld may range from 0% to 10% but in no case may it exceed 10%. When establishing a suitable retainage value that protects the Owner's interests, give consideration that the performance and payment bonds also provide similar protection of Owner interests. The

Owner may elect to incrementally release retainage if the Owner is satisfied its interest with completion of the project are protected in an adequate manner. If Option 3 is selected, insert the following clause and specify a suitable value where indicated:

a. From the total of the amount determined to be payable on a partial payment, [`insert amount of retainage, not to exceed 10%` **] percent of such total amount will be deducted and retained by the Owner for protection of the Owner's interests. Unless otherwise instructed by the Owner, the amount retained by the Owner will be in effect until the final payment is made except as follows**

  (1) The Contractor may request release of retainage on work partially accepted by the Owner according to Section 50-03. The Contractor must provide the RPR a certified invoice that supports the value of retainage held by the Owner for partially accepted work.

  (2) In lieu of retainage, the Contractor may exercise at its option the establishment of an escrow account per paragraph 90-08.

b. The Contractor is required to pay all subcontractors for satisfactory performance of their contracts no later than 30 days after the Contractor has received a partial payment. Contractor must provide the Owner evidence of prompt and full payment of retainage held by 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 tasks called for in the subcontract are accomplished and documented as required by the Owner. When the Owner makes 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.

c. When at least 95% of the work is completed to the satisfaction the RPR, at the Owner's discretion and with the consent of the surety, prepares estimates of both the contract value and the cost of the remaining work. The Owner may retain an amount not less than twice the contract value or estimated cost, whichever is greater, of the remaining work. The remainder, less all previous payments and deductions, is then certified for payment to the Contractor.

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It is understood and agreed that the Contractor is not entitled to demand or receive partial payment based on the quantities of work more than those provided in the proposal or covered by approved Change Orders or supplemental agreements, except when the RPR determines such excess quantities to be a part of the final quantity for the item of work in question. No partial payment binds the Owner 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, *Adjustment of* Payment *Due to Economic Price Changes*.

The Contractor must deliver to the Owner 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 Owner to indemnify the Owner against any potential lien or other such claim. The bond or collateral must include all costs, expenses, and attorney fees the Owner may be compelled to pay in discharging any such lien or claim.

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In some areas, release of liens prior to paying the full amount to the Prime Contractor may void the contract. In those areas, revise the previous paragraph as required to meet all state and local regulations.

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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 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:

1. The material has been stored or stockpiled in a manner acceptable to the RPR, at or on, an approved site.
2. The Contractor furnished the RPR with acceptable evidence of the quantity and quality of such stored or stockpiled materials.
3. The Contractor furnished the RPR with satisfactory evidence that the material and transportation costs have been paid.
4. The Contractor furnished the Owner legal title (free of liens or encumbrances of any kind) to the material stored or stockpiled.
5. The Contractor furnished the Owner 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, in no way relieves the Contractor of their responsibility for furnishing and placing such materials according to the requirements of the contract, plans, and specifications. In no case, will the total 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 is made for stored or stockpiled living or perishable plant materials. The Contractor bears all costs associated with the partial payment of stored or stockpiled materials according to the provisions of this paragraph.

90-08 Payment of Withheld Funds.

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

1. The Contractor bears all expenses of establishing and maintaining an escrow account and escrow agreement acceptable to the Owner.
2. The Contractor must deposit to and maintain in such escrow, only those securities or bank Certificates of Deposit (CDs) acceptable to the Owner and having a value not less than the retainage that would otherwise be withheld from partial payment.
3. The Contractor must enter into an escrow agreement satisfactory to the Owner.
4. The Contractor must obtain the written consent of the surety to such agreement.

[90-09 Adjustment of Payment Due to Economic Price Changes.

When the price of materials and/or labor have changed significantly between the time of the Contractor's bid and when the Contractor completed the accepted work, a Contractor may request adjustment in unit price of an Item of work. To request an adjustment in unit price the Contractor will provide sufficient documentation to support their claim of the change in price, and proof that the price changed due to economic trends, and not due to other conditions.

90-09.1 **Request for Adjustment due to Change in Material Prices.**

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See PGL __ for requirements for inclusion of adjustments in material costs.

For Airport Improvement Program (AIP) contracts, or other FAA administrated grants, if the Owner plans to seek grant reimbursement for economic price adjustments they must receive FAA approval prior to executing the Change Order or supplement agreement. The FAA must review the Contractor's request and RPRs recommendation and approve the determination prior to grant reimbursement.

Any grant reimbursements for economic price adjustments will be limited by the statutory limit for increases in grant amounts. The FAA does not guarantee grant funds are available for price adjustments.

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When the price of a material that is a component of a work item changes between bid and construction the Contractor may submit a request for adjustment of the unit price of any affected items. At a minimum, the request must include:

1. A breakdown of the unit price of affected items identifying all components of the unit price. The Contractor must also provide any price quotes from suppliers that were used to develop the unit price of the affected items.
2. Purchase orders or invoices that show the actual cost paid by the Contractor of the affected item(s) used in the completion of the final accepted work.
3. An industry accepted economic trend analysis that proves that the difference in price between bid and construction is due to economic trends and not just a change in pricing by the supplier. If an industry accepted trend analysis is not available for the item, the Contractor may submit alternative economic analyses for RPR review and approval.

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Industry trend analyses may be available from industry associations such as the Portland Cement Association or Asphalt Institute, Economic analyses by industry firms such as Goldman Sachs or Standard and Poor's, or construction industry publications such as Engineering News Records. The RPR will determine if the submitted industry analysis is appropriate.

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90-09.2 Request for Adjustment due to Change in Labor.

When labor wage rates increase between bid and construction due to economic factors the Contractor may submit a request for adjustment in unit price due to these changes. The request must include at a minimum:

1. A breakdown of the unit price of affected items identifying all labor components of the unit price. The labor component must include the Davis-Bacon labor

classification of the laborers included in the labor component of the unit price.

2. A comparison of Davis-Bacon wage rates for the labor classifications in the unit price at the time of bid versus at the time of project execution.

3. Summary of certified payrolls for employees in the affected Davis-Bacon labor classifications at the time of bid versus at the time of construction that verify that labor costs have increased proportional to changes in Davis-Bacon wage rates.

The Contractor will submit their proposal for economic price adjustment including any material or labor adjustment requests to the RPR. The proposal will include a recommended adjustment to the Item unit price in the contract. This proposed adjusted unit price may include adjustments to non-material price components that are affected by the change in material price or labor rate. This may include things such as overhead and profit that are based on a percentage of costs.

The RPR will review the Contractor’s request and verify that all required components of the proposal are included and properly support the Contractor’s proposed revised unit price. The RPR will also review economic trends of other contract Items that may result in a decrease in unit price due to economic changes in material costs or labor rates. If the RPR finds that there is reasonable cause to decrease any Item unit prices due to economic trends they will notify the Contractor and the Contractor must review the RPR’s findings and adjust their proposal to include adjustments to any unit prices identified by the RPR.

If the RPR deems the Contractor’s request for price adjustment to be justified, they will document their findings and either recommend accepting the Contractor’s proposed adjusted unit prices or recommend a unit price they deem acceptable based on their analysis. The Owner may use the RPR’s recommendation for adjusted unit price to negotiate a final adjustment to unit price with the Contractor. Once a final revised unit price is agreed on by the Contractor and Owner a Change Order or supplemental agreement will be executed to adjust the unit price.

Economic price adjustments must be approved prior to final payment of the affected Item. After final payment of an Item the Contractor may no longer request adjustment to the unit price due to economic trends. If there is a resultant decrease in unit price of any Item that the Contractor has already received payment for, they must issue a credit or refund to the Owner prior to final payment and release of any contingency.]

90-10 Acceptance and Final Payment.

When the contract work has been accepted according to the requirements of Section 50, paragraph 50-15, *Final Acceptance*, the RPR prepares the final estimate of the work items actually performed. The Contractor must approve the RPR's final estimate or advise the RPR of the Contractor's objections to the final estimate 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 must 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 the Owner considers such disputed quantities as a claim according to 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 90-12, *Contractor's Final Project Documentation*, final payment is 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 are subject to correction in the final estimate and payment.

If the Contractor 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, the Owner will consider such claims according to local laws or ordinances. Upon final adjudication of such claims, any additional payment determined due the Contractor is paid pursuant to a supplemental final estimate.

90-11 Construction Warranty.

1. 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.
2. This warranty continues for a period of one year from the date of final acceptance of the work, except as noted. If the Owner takes possession of any part of the work before final acceptance, the warranty for the part the Owner took possession of continues for a period of one year from the date the Owner takes possession. [However, this does not relieve the Contractor from

`corrective items required by the final acceptance of the project work. Light Emitting Diode emitting diode (LED) light fixtures except for obstruction lighting, must be warranted by the manufacturer for a minimum of four years after date of installation inclusive of all electronics.` **[___]**

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Delete the LED item if it is not included in the project.

Include any project specific materials that have a greater than one-year warranty period.

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3. The Contractor must remedy, at the Contractor's expense, any failure to conform, or any defect. In addition, the Contractor must remedy at the Contractor's expense any damage to the Owner's 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.
4. The Contractor must restore any work damaged in fulfilling the terms and conditions of this clause. The Contractor's warranty with respect to work repaired or replaced runs for one year from the date of repair or replacement.
5. The Owner notifies the Contractor, in writing, within **[** `seven` **]** days after the discovery of any failure, defect, or damage.
6. If the Contractor fails to remedy any failure, defect, or damage within **[** `14` **]** days after receipt of notice, the Owner has the right to replace, repair, or otherwise remedy the failure, defect, or damage at the Contractor's expense.
7. With respect to all warranties, express or implied, from subcontractors, manufacturers, or suppliers for work performed and materials furnished under this contract, the Contractor must:
   a. Obtain all warranties that would be given in normal commercial practice
   b. Require all warranties to be executed, in writing, for the benefit of the Owner, as directed by the Owner
   c. Enforce all warranties for the benefit of the Owner.
8. This warranty does not limit the Owner's rights with respect to latent defects, gross mistakes, or fraud.

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Notification times in items 5 and 6 may be changed to meet specific project requirements.

On federally funded airport grant projects, typically there is no participation in warranties beyond one year.

Note: EB 67, *Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures*, requires that all LED light fixtures with the exception of obstruction lighting, AC 150/5345-43) must be warranted by the manufacturer for a minimum of four years after date of installation inclusive of all electronics.

It is recommended the Owner and Engineer perform a warranty inspection with the Contractor approximately three months before the end of the one year warranty period.

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90-12 Contractor's Final Project Documentation.

Approval of final payment to the Contractor is contingent upon completion and submittal of the items listed below. The final payment is not approved until the RPR approves the Contractor's final submittal. The Contractor must:

1. Provide two copies of all manufacturer's warranties specified for materials, equipment, and installations.
2. Provide weekly payroll records (not previously received) from the general Contractor and all subcontractors.
3. Complete final cleanup according to Section 40, paragraph 40-08, *Final Cleanup*.
4. Complete all punch list items identified during the Final Inspection.
5. Provide complete release of all claims for labor and material arising out of the Contract.
6. Provide a certified statement signed by the subcontractors, indicating actual amounts paid to the DBE subcontractors and/or suppliers associated with the project.
7. Return copies of sales tax completion forms when applicable per state requirements.
8. Provide manufacturer's certifications for all items incorporated in the work.
9. Provide all required record drawings, as-built drawings, or as-constructed drawings.
10. Provide the Project Operation and Maintenance (O&M) Manual(s).

11. Provide security for Construction Warranty.

12. Provide equipment commissioning documentation submitted, if required.

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Additional items may be added as necessary to address State requirements and specific project requirements. This section's intent is to withhold final project payment until all necessary paperwork, project work, and cleanup of work/staging areas have been completed.

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END OF SECTION 90

Part 2 – General Construction Items

Item C-100 Contractor Quality Control Program (CQCP)

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The CQCP's intent is to ensure that quality of materials and production is monitored to be within acceptance limits, and that as materials or production processes vary beyond pre-established limits, the Contractor implements corrective actions.

Rather than waiting to develop the corrective action plan after identifying a problem, it is preferable to implement a pre-approved plan. In addition, CQCPs purpose is to ensure that Contractor Quality Control (QC) personnel are coordinating with the Owner's Quality Acceptance (QA) personnel throughout the project, not just when disputes arise. QA is the Owner's responsibility to ensure payment is only for acceptable work.

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100-1 GENERAL

100-1.1 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 establishes, provides, and maintains an effective Contractor Quality Control Program (CQCP) detailing the methods and procedures taken ensuring 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 this document establishes guidelines and specifies certain minimum requirements here and elsewhere in the contract technical specifications, the Contractor assumes full responsibility for accomplishing the stated purpose.

The Contractor establishes a CQCP that includes:

1. Personnel required to develop and implement the CQCP.
2. Processes to meet the specification requirements for the materials and construction process.
3. QC facilities
4. Project progress schedule
5. Project submittal schedule

6. How submittals are controlled
7. QC testing and inspection plan
8. How QC is documented and how reports are distributed
9. Regular meetings between Contractor and owner to review QC
10. Documents the CQCP process.

100-1.2 The Contractor must not begin any construction or production of materials to be incorporated into the completed work until the Resident Project Representative (RPR) reviews and approves the CQCP. No partial payment is made for materials subject to specific QC requirements until the CQCP is 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 QA testing requirements. QA testing requirements are the RPR's or Contractor's responsibility, as specified in the specifications.

100-1.3 The **[** `Contractor` **|** `RPR` **]** facilitates a QC/QA workshop with the Engineer, RPR, Contractor, subcontractors, testing laboratories, and Owner's representative prior to start of construction. The Contractor must coordinate with the Airport and RPR on the time and location of the QC/QA workshop. Items to be addressed, at a minimum, must include:

1. Review of the CQCP including submittals, QC testing, action and suspension limits for Production, Corrective Action Plans, QC report distribution, and Control Charts.
2. Discussion of the QA program.
3. Discussion of the QC and QA Organization, and authority including coordination and information exchange between QC and QA.
4. Establishment of regular meetings to discuss control of materials, methods, and testing.
5. Establishment of the overall QC culture.

100-2 DESCRIPTION OF PROGRAM

100-2.1 General Description.

The Contractor establishes a CQCP to perform QC inspection and testing of all work items the technical specifications require, including those performed by subcontractors. The CQCP must ensure conformance to applicable specifications and plans with respect to materials, off-site fabrication, workmanship, construction, finish, and functional performance. The CQCP must be effective for control of all construction work performed under this Contract. The CQCP must specifically include surveillance and tests the technical specifications require, in addition to other requirements of this section and any other activities the Contractor deems necessary to establish an effective QC level.

100-2.2 Use of CQCP.

The Contractor must use the CQCP to control the production and construction processes applicable to the project specifications. The Contractor must use testing and monitoring performed under the CQCP by the Contractor to adjust materials and construction processes when necessary. If the Contractor fails to properly control materials and processes, the RPR halts production until satisfactory corrective actions to get materials and processes back into compliance with the implemented specifications. Final acceptance and payment for individual items is made based upon the specified material acceptance criteria.

100-2.3 CQCP.

In a written document, the Contractor describes the CQCP for the RPR's review and approval prior to the start of any production, construction, or off-site fabrication. The Contractor must submit the written CQCP to the RPR for review and approval at least **[** `10` **]** calendar days before the CQCP Workshop. The RPR must approve, in writing, the Contractor's CQCP and QC testing laboratory prior to the Notice to Proceed (NTP).

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The Engineer chooses an adequate period for review. Submittal of the written CQCP allows the Engineer to review the contents and make suggestions prior to the CQCP Workshop.

Submittal of the written CQCP prior to the start of work allows for detailed discussion of the requirements before the NTP is issued.

When selecting the required days for the Contractor to submit the CQCP, allow adequate time for the CQCP to be a supplement to the Owner's Construction Management Plan (CMP).

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Organize the CQCP to address, at a minimum, the following:

1. QC organization and resumes of key staff. This includes:
    a. The Quality Control Program Manager
    b. Quality Control Inspectors for all phases of pavement construction
    c. Quality Control Inspectors for Electrical, **[** `Quality Control Inspectors for all work to be performed` **]**
    d. Quality Control Laboratory including current accreditation, Quality Control Laboratory field and laboratory staff

2. Project progress schedule
3. Submittals schedule
4. Inspection of materials and production
5. QC Testing Plan
6. Documenting QC activities and distributing QC reports
7. Meetings to discuss materials, production, and testing (weekly, as a minimum, daily for major work items)
8. Corrective action requirements when QC and/or QA acceptance criteria are not met
9. Material quality and construction means and methods. Address all elements applicable to the project affecting the pavement structure's quality including subgrade, subbase, base, and surface course. Required elements to address, include, but are not limited to mix design, aggregate grading, stockpile management, mixing and transporting, placing, and finishing, QC testing and inspection, smoothness, equipment Laydown Plan, and Temperature Management Plan.

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

100-3 CQCP ORGANIZATION

100-3.1 Implement the CQCP by establishing a QC organization. Develop an organizational chart to show all QC personnel, their authority, and how these personnel integrate with other management/production and construction functions and personnel. The organizational chart must identify all QC staff by name and function, and indicate the total staff required to implement all CQCP elements, including inspection and testing for each work item. If necessary, different technicians can be used for specific inspection and testing functions for different work items. All personnel assigned are subject to the qualification requirements of paragraphs 100-3.2 and 100-3.3. The organizational chart must indicate which personnel are Contractor employees and which are provided by an outside organization. The minimum QC organization will consist of the following personnel.

100-3.2 **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 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 years of paving/QC experience, the CQCPA must meet at least one of the following requirements:

1. Professional Engineer (PE) with one year of airport paving experience. **[** `PE with two years of airfield lighting experience.` **]**
2. Engineer-in-training with two years of airport paving experience.
3. National Institute for Certification in Engineering Technologies (NICET) Civil Engineering Technology Level IV with three years of airport paving experience.
4. An individual with four 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 all actions necessary for the successful implementation of the CQCP to ensure compliance with the contract plans and technical specifications. The CQCPA's authority must include the ability to immediately stop production until materials and/or processes are in compliance with contract specifications. The CQCPA reports directly to a principal officer of the construction firm. The CQCPA may supervise the QCP on more than one project, if that person can be at the job site within two hours after notification of a problem.

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Coordinate with Owner and FAA regarding when full time on site is not required. Default is a full time on site CQCP manager on paving projects.

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100-3.3 QC Technicians.

Provide enough QC technicians necessary to adequately implement the CQCP. Personnel must be Engineers, engineering technicians, or experienced craftsperson with qualifications in the appropriate field equivalent to NICET Level II in Civil Engineering Technology or higher, and possess a minimum of two years of experience in their area of expertise.

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

1. Inspect all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by paragraph 100-6.
2. Perform all QC tests, as the technical specifications require and as listed in the QC Testing Plan.
3. Perform tests for the RPR, when the technical specifications require.

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

100-3.4 Staffing Levels.

The Contractor must provide sufficient, qualified, QC personnel to monitor each work activity, at all times. The Contractor must provide separate plant and field technicians at each plant and field placement location producing material in a plant for incorporation into the work. The scheduling and coordinating of all inspection and testing must match the type and pace of work activity. The CQCP must state where different technicians are required for different work elements.

100-4 PROJECT PROGRESS SCHEDULE

100-4.1 Show critical QC activities on the project schedule, as required by Section 80, paragraph 80-03, *Execution and Progress*.

100-5 SUBMITTALS SCHEDULE

100-5.1 The Contractor must submit and maintain a detailed listing of all submittals (e.g., mix design, equipment, etc.) and shop drawings as required by the project specifications. Developing the listing in a spreadsheet format is an option, and includes as a minimum:

1. Specification item number
2. Item description
3. Description of submittal
4. Specification paragraph requiring submittal
5. Scheduled submittal date

100-6 INSPECTION REQUIREMENTS

100-6.1 Organize QC inspection functions to provide inspections for all definable features of work, as detailed below. The Contractor must document all inspections, as specified by paragraph 100-9, *Records and Reports,* as needed, to ensure continued compliance with contract requirements until completion of the particular feature of work. Inspections must include the following minimum requirements:

100-6.2 During plant operation for material production, use QC test results and periodic inspections to ensure the quality of aggregates and other mix components, and adjust and control mix proportioning to meet the approved mix design and other technical specification requirements. Inspect all equipment used in proportioning and mixing and ensure its proper operating condition. The CQCP details how to accomplish and use these and other QC function.

100-6.3 During field operations, use QC test results and conduct periodic inspections to ensure the quality of all materials and workmanship. Inspect all equipment used in placing, finishing, and compacting to ensure its proper operating condition, ensure all such operations conform to the technical specifications, and are within the plan dimensions, lines, grades, and tolerances specified. The CQCP must document how to accomplish these and other QC functions.

100-7 CONTRACTOR QC TESTING FACILITY

100-7.1 For projects including Item P-401, the Contractor ensures facilities, including all necessary equipment, materials, and current reference standards, 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

100-7.2 For projects including P-501, the Contractor ensures facilities, including all necessary equipment, materials, and current reference standards, meet the 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

100-8.1 As a part of the overall CQCP, the Contractor must implement a QC Testing Plan, as the technical specifications require. The QC Testing Plan must include the minimum tests and test frequencies required by each technical specification item, as well as any additional QC tests the Contractor deems necessary to adequately control production and/or construction processes.

100-8.2 The QC Testing Plan can be developed in a spreadsheet fashion and, as a minimum, include the following:

1. Specification item number (e.g., P-401)

2. Item description (e.g., Hot Mix Asphalt Pavements)
3. Test type (e.g., gradation, grade, asphalt content)
4. Test standard (e.g., ASTM or AASHTO test number, as applicable)
5. Test frequency (e.g., as required by technical specifications or minimum frequency when requirements are not stated)
6. Responsibility (e.g., plant technician)
7. Control requirements (e.g., target, permissible deviations)

100-8.3 The QC Testing Plan must contain a statistically based procedure of random sampling for acquiring test samples, according to ASTM D3665. The Contractor must provide the RPR the opportunity to witness QC sampling and testing. The Contractor must document all QC test results required by paragraph 100-9.

100-9 RECORDS AND REPORTS

100-9.1 The Contractor maintains current QC records of all inspections and tests performed. These records must include factual evidence that the required QC inspections or tests were performed, including type and number of inspections or tests involved; inspection or test results; nature of defects, deviations, rejection causes, etc., proposed remedial action; and corrective actions taken. The QC records must cover both conforming and defective or deficient features, and state that all supplies and materials incorporated in the work are in full compliance with the contract terms. The Contractor must provide the RPR [`electronic` | `hard`] copies of these records, daily. The records must cover all work placed after the previously furnished records and verified and signed by the CQCPA. Contractor QC records required for the contract must include, but are not necessarily limited to, the following records.

100-9.2 **Daily Inspection Reports.**

Each Contractor QC technician must maintain a daily log of all inspections performed for both Contractor and subcontractor operations. The technician's daily reports must provide factual evidence of performing continuous QC inspections and, 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 must identify all QC inspections and QC tests conducted, inspection results, location and nature of defects found, rejection causes, and remedial or corrective actions taken or proposed. The responsible QC technician is responsible for signing the daily inspection reports and the CQCPA. Provide the RPR at least one copy of each daily inspection report on the workday following the day of record. Archive the results when QC inspection and test results are recorded and transmitted electronically.

100-9.3 Daily Test Reports.

The Contractor is responsible for establishing a system that records all QC test results. Daily test reports must 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. Cause for rejection
8. Recommended remedial actions
9. Retests

100-9.4 Submit test results from each day's work period to the RPR prior to the start of the next day's work period. When the technical specifications require, the Contractor must maintain statistical QC charts. When results are recorded and transmitted electronically, archive results.

100-10 CORRECTIVE ACTION REQUIREMENTS

100-10.1 Include in the CQCP the appropriate action to take when a process is deemed, or believed, to be out of control (out of tolerance) and detail the actions taken to bring the process into control. Include corrective actions for both general requirements for operation of the CQCP and for individual work items contained in the technical specifications. Detail in the CQCP how to use the QC inspections and test results to determine the need for corrective action. The CQCP must contain clear rules to gauge when a process is out of control and the type of correction taken to regain process control. When applicable or the technical specifications require, the Contractor establishes and uses statistical QC charts for individual QC tests. Link the requirements for corrective action to the control charts.

100-11 RPR INSPECTIONS AND/OR OBSERVATIONS

100-11.1 All items of material and equipment are subject to the RPR's inspection and/or observation 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. Additionally, all items of materials, equipment, and work in place are subject to the RPR's inspection and/or observation at the site for the same purpose. RPR inspections and/or observations do not relieve the Contractor of performing QC inspections of either on-site or off-site Contractor's or subcontractor's work.

100-12 NONCOMPLIANCE

100-12.1 The Contractor, upon receipt of written notice of noncompliance from the RPR, implements corrective action.

100-12.2 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 were 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.

100-13 METHOD OF MEASUREMENT

100-13.1 Basis of Measurement and Payment.

The CQCP is for the personnel, tests, facilities, and documentation required to implement the CQCP. The CQCP is paid as a lump sum with the following schedule of partial payments:

`[ 1.    With first pay request, 25% with approval of CQCP and completion of the QC)/QA (QA) workshop.`

1. When 25% or more of the original contract is earned, an additional 25%.
2. When 50% or more of the original contract is earned, an additional 20%.
3. When 75% or more of the original contract is earned, an additional 20%.
4. After final inspection and acceptance of project, the final 10%. **]**

****

The payment schedule and percentages of payment can be altered based on the size and complexity of the project.

****

100-14 BASIS OF PAYMENT

100-14.1 Payment is Made Under:

[Item C-100 CQCP **]**

100-15 REFERENCES

100-15.1 The listed publications 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 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-101 Airfield Work Zone Operational Safety

****

This item is currently being developed by a FAA working group. It is currently in Draft Engineering Brief (EB) 109, *Draft Specification Item C-101 Operational Safety for Airfield Construction.*

****

See Engineering Brief (EB) 109, *Draft Specification Item C-101 Operational Safety for Airfield Construction.*

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

102-1 DESCRIPTION

****

The Engineer may add or edit this item as necessary to address any temporary erosion control means and methods required by federal, state, or local authorities.

Locate all erosion control devices outside the safety areas of active runways or taxiways, unless necessary and shown on the project plans. Consider potential impact of type of type of erosion control device with airport operations. In or near operations areas, provide erosion control devices that can withstand jet, rotor, or prop wash. Remove erosion control devices located within a runway or taxiway safety area prior to re-activation of the runway or taxiway.

Refer to Advisory Circular (AC) 150/5200-33, *Hazardous Wildlife Attractants on or Near Airports*, and the Federal Aviation Administration (FAA)/United States Department of Agriculture (USDA), *Wildlife Hazard Management at Airports, A Manual for Airport Personnel,* for information on hazardous wildlife attractants.

Coordinate with the approved CWD, Wildlife Hazard Assessment, and Wildlife Hazard Management Plan.

Check state and local requirements for Stormwater Prevention Plan Best management practices.

On federally funded projects coordinate modifications with the FAA ADO or Regional Office.

Some states, municipalities, and pollution control authorities have very specific regulations for air and water pollution controls. Check state and local requirements.

****

102-1.1 This item consists of temporary control measures as shown on the plans or as the RPR ordered 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 conforms to the approved erosion control plan and operational safety measures within Item C-101 and the CSDs. Coordinate the temporary and the permanent erosion control measures to the extent practical to ensure economical, effective, and continuous erosion control throughout the construction period. Temporary control may include work areas outside the construction limits such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites. Design, install, and maintain temporary control measures to minimize the creation of wildlife attractants.

102-2 MATERIALS

102-2.1 Grass.

Use quick growing grasses, such as ryegrass or cereal grasses, to provide temporary cover per Item T-901. Use grass species that do not create a wildlife attraction.

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. Use mulches that do not create a wildlife attractant.

102-2.3 Fertilizer.

Use a standard commercial grade fertilizer conforming to all federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

102-2.4 Slope Protection.

Use slope protection constructed of pipe, fiber mats, rubble, concrete, asphalt, or other materials that adequately control erosion.

102-2.5 Silt Fence.

Use silt fence that meets the requirements of ASTM D6461.

102-2.6 Other.

[`List other materials included in the approved erosion control plan and as indicated on the OSD.`] Use commercial grade erosion control materials. Prior to incorporating into the project, obtain approval of the RPR. The RPR ensures all other materials meet commercial grade standards and must approve before being incorporated into the project.

102-3 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 apply. The RPR is responsible for ensuring compliance to the extent that construction practices, construction operations, and construction work are involved.

102-3.2 Locate temporary control measures outside the safety area of active taxiways or runways. Remove all erosion control devices from runway or taxiway safety areas prior to reopening of the taxiway of runway to aircraft traffic.

102-3.3 Erosion Control Schedule.

Prior to the start of construction, submit a project erosion control schedule conforming to the phasing criteria within the OSDs and Item C-101. Include the anticipated time to complete work activities per phase including:

- mobilization
- erosion control
- clearing
- grubbing
- grading
- construction
- paving
- structures at watercourses

Submit a proposed method of erosion and dust control on haul roads and borrow pits and a disposal plan for waste materials. Do not start work until RPR accepts the erosion control schedules and methods of operation for the applicable construction.

102-3.4 Construction Details.

The Contractor must install erosion control features as indicated in the erosion control plan, the project plans, and on the OSD at the earliest practical time. Perform the seeding and mulching and other specified slope protection work in stages, except where future construction operations will damage slopes. Use temporary erosion and pollution control measures to correct conditions that develop during construction, not foreseen during the design stage; needed prior to installation of permanent control features; or needed temporarily to control erosion that develops during normal construction practices.

102-3.4.1 Install temporary erosion control measures prior to clearing and grubbing operations. Schedule work so that grading operations and permanent erosion control features can follow immediately if project conditions permit. The RPR limits 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 control measures current with the accepted schedule. When seasonal limitations make such coordination unrealistic, implement temporary erosion control measures as directed by the RPR.

102-3.4.2 The Contractor provides 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 the RPR directed. 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 the RPR directed, the Contractor performs the work and the cost is incidental to this item.

102-3.4.3 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. Maintain erosion control features throughout the construction period. Where equipment frequently crosses watercourses, provide temporary erosion control structures. Do not allow pollutants such as fuel, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, slurry from sawcutting and grooving, and other harmful materials to be discharged into any waterway, impoundment, or manufactured channel.

102-3.5 Installation, Maintenance, and Removal of Silt Fence.

[Install silt fences in accordance with [local or state] provisions, see [__]. | Extend silt fences a minimum of 16 inches (41 cm) and a maximum of 34 inches (86 cm) above the ground surface. Do not set posts any more than 10 feet (3 m) on center. Cut filter fabric from a continuous roll to the length required minimizing joints where possible. When joints are necessary, splice the fabric at a support post with a minimum 12-inch (300-mm) overlap and securely sealed. Excavate a trench approximately 4 inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the silt fence. Backfill the trench and the soil compacted over the silt fence fabric.] The Contractor removes and disposes of silt that accumulates during construction, and prior to establishment of permanent erosion control. Maintain silt fences in good working condition until permanent erosion control is established. Upon the RPR's approval, remove the silt fence.

102-4 METHOD OF MEASUREMENT

102-4.1 Perform any temporary erosion and pollution control work as scheduled or the RPR directed. Measure completed and accepted work as follows:

1. Temporary seeding and mulching by the square yard (square meter).
2. Temporary slope drain protection by the linear foot (meter).

3. Temporary benches, dikes, dams, and sediment basins by the cubic yard (cubic meter) of excavation performed, including necessary cleaning of sediment basins, and the cubic yard (cubic meter) of embankment placed as the RPR directed.
4. All fertilizing by the ton (kg).
5. Installation and removal of silt fence by the **[** linear foot (meter) **|** Lump sum **]**.

102-4.2 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, is not measured and paid for directly but is considered as a subsidiary obligation of the Contractor.

102-4.3 **[** Add additional control items. **|** Not used. **]**

102-5 BASIS OF PAYMENT

102-5.1 Pay for accepted quantities of temporary water pollution, soil erosion, and siltation control work the RPR ordered and measured as provided in paragraph 102-4.1 under:

Item C-102-5.1a	Temporary seeding and mulching - per square yard (square meter)
Item C-102-5.1b	Temporary slope protection - per linear foot (meter)
Item C-102-5.1c	Temporary benches, dikes, dams, and sediment basins - per cubic yard (cubic meter)
Item C-102-5.1d	Fertilizing - per ton (kg)
Item C-102-5.1e	Installation and removal of silt fence **[** per linear feet (meter) **|** lump sum **]**
Item C-102-5.3	**[** List individual items as described in paragraph 102-4.3 **|** method of measurement **|** lump sum **]**

Where other directed work falls within the specifications for a work item with a contract price, measure and pay for the units of work at the contract unit price bid for the various items.

Pay for temporary control features not covered by contract items the RPR ordered for according to Section 90, paragraph 90-05, *Payment for Extra Work*.

102-6 REFERENCES

102-6.1 This list of publications forms 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	*Hazardous Wildlife Attractants on or Near Airports*

ASTM International

ASTM D6461	*Standard Specification for Silt Fence Materials*

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 work item consists of work and operations necessary for the movement of personnel, equipment, materials, and supplies to and from the project site for work on the project except as provided in the contract as separate pay items.

105-1.1 Mobilization Limit.

Mobilization is limited to **[** 10 **]** percent of the total project cost. **[** Document costs over 10% of the total project cost. Costs will be paid only if incurred. **]**

****

Coordinate with Section 20, paragraph 20-03, *Proposal Forms Contents.*

****

105-1.2 Posted Notices.

Prior to the commencement of work, post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the Prime Contractor and subcontractors engaged by the Prime Contractor: Equal Employment Opportunity (EEO) Poster "Equal Employment Opportunity is the Law" according to the Office of Federal Contract Compliance Programs (OFCCP) Executive Order 11246, as amended; Davis Bacon Wage Poster (WH 1321) - DOL "Notice to All Employees" Poster; and Applicable Davis-Bacon Wage Rate Determination. Do not remove these notices until the Owner accepts the final work.

****

The Owner may include additional posted notices as required by local and State law. Links to the posters available at: https://www.faa.gov/airports/engineering/

****

105-1.3 Engineer/Resident Project Representative (RPR) Field Office.

[The Contractor provides dedicated space for the field RPR and inspectors, as a field office for the duration of the project. This space is to be located conveniently near the construction site and be separate from any space used by the Contractor. The Contractor furnishes water, sanitary facilities, heat, air conditioning, and electricity according to local building codes. |An Engineer/RPR field office is not required.]

****

Coordinate requirements for specifying the Engineer/RPR's field office with the Owner and Engineer/RPR since such facilities are not needed for all airport construction projects. If a field office is required for the project, establish a separate line item for payment. Other equipment may be appropriate with approval of the Owner based on the size and duration of the project.

****

105-2 METHOD OF MEASUREMENT

105-2.1 Basis of Measurement and Payment.

Based upon the contract lump sum price for "Mobilization", partial payments is allowed as follows:

1. [With first pay request, 25%.
2. When 25% or more of the original contract is earned, an additional 25%.
3. When 50% or more of the original contract is earned, an additional 40%.
4. After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90, paragraph 90-12, *Contractor's Final Project Documentation,* the final 10%.]

****

The payment schedule and percentages of payment can be altered based on the size and complexity of the project.

****

105-3 BASIS OF PAYMENT

105-3.1 Payment is Made Under:

[Item C-105 Mobilization]

****

Item Mobilization may be added to project at Owner’s discretion. Rather than paying the Contractor 100% of mobilization on first pay request, many Owners find a payment schedule an effective way to reimburse the Contractor for mobilization and demobilization. It is recommended that the final 10% of this bid item not be paid until the Contractor cleans the project staging area. The payment schedule can be altered, e.g., on small projects. It may not be appropriate to have more than two payments.

****

105-4 REFERENCES

105-4.1 This list of publications forms 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*

END OF ITEM C-105

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

****

Delete Item C-110 in its entirety when Item P-401 or Item P-501 are not included in project specifications. On very small projects, or on maintenance repair-type projects, PWL may not be appropriate. The PWL concept works best when placing sufficient material to have at least one lot, per day.

Spreadsheets for PWL calculations are available at the following website: .

Use Engineering Brief (EB) 57, *Extended Q-Value Table for Estimating Percent of Lot Within Limits (PWL)*, and the Microsoft Excel PWL Table at https://www.faa.gov/airports/engineering/design_software when the number of samples (n) is greater than 10. Find EBs at the following website: https://www.faa.gov/airports/engineering/engineering_briefs.

****

110-1 GENERAL.

110-1.1 Determine the PWL when the specifications provide for acceptance of material based on the method of estimating PWL, are according to this section. Analyze all test results for a lot statistically to determine the total estimated percent of the lot that is within specification limits. The PWL is computed using the sample average (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 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 110-2.1a or Table 110-2.1b. All specification limits specified in the technical sections are absolute values. Test results used in the calculations are to the significant figure given in the test procedure.

110-1.2 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.

110-1.3 Maintain the acceptable quality specified, or higher, to offset the Contractor risk for material evaluated. In all cases, it is the Contractor’s responsibility to produce at quality levels meeting the specified acceptance criteria when sampled and tested at the frequencies specified.

110-2 METHOD FOR COMPUTING PWL.

110-2.1 The computational sequence for computing PWL is:

1. Divide the lot into sublots according to the acceptance requirements of the specification.
2. Locate the random sampling position within the sublot according to the requirements of the specification.
3. Make a measurement at each location or take a test portion and make the measurement on the test portion according to the testing requirements of the specification.
4. Find the sample average (X) for all sublot test values within the lot, using the following formula:

$$\mathbf{X = (x_1 + x_2 + x_3 + \ldots x_n)/n}$$

Where: X = Sample average of all sublot test values within a lot

$x_1, x_2, \ldots x_n$ = Individual sublot test values

n = Number of sublot test values

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

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

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

$d_1, d_2, \ldots d_n$ = Deviations of the individual sublot test values $x_1, x_2, \ldots$ from the average value X

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

n = Number of sublot test values

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

$$\mathbf{Q_L = (X – L)/S_n}$$

Where: L = specification lower tolerance limit

Estimate the (PWL) by entering Table 110-2.1a 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.

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

$$\mathbf{Q_L = (X - L)/S_n}$$
and
$$\mathbf{Q_U = (U - X)/S_n}$$

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 110-2.1a 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. Use the following formula to determine the PWL:

$$\mathbf{PWL = (P_U + P_L) - 100}$$

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.

$X = (x_1 + x_2 + x_3 + \ldots x_n)/n$

$X = (96.60 + 97.55 + 99.30 + 98.35)/4$

X = 97.95% density

3. Calculate the standard deviation for the lot.

$S_n = \mathbf{[}((96.60 - 97.95)^2 + (97.55 - 97.95)^2 +(99.30 -97.95)^2 + (98.35 - 97.95)^2))/(4 - 1)\mathbf{]}^{1/2}$

$S_n = \mathbf{[}(1.82 + 0.16 + 1.82 + 0.16)/3\mathbf{]}^{1/2}$

$S_n = 1.15$

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 110-2.1a 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.

$X = (x_1 + x_2 + x_3 \ldots n)/n$

$X = (5.00 + 3.74 + 2.30 + 3.25)/4$

$X = 3.57\%$

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 110-2.1a 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 110-2.1a 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 1.435 is less than 1.463, the value is not an outlier.

Note: In this example, a measurement is considered an outlier if the density is:

Greater than (97.95 + 1.463 × 1.15) = 99.63%

OR

less than (97.95 – 1.463 × 1.15) = 96.27%.

Table 110-2: Estimating Percent of Lot Within Limits (PWL)

PWLs (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

PWLs (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

PWLs (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**
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
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
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

PWLs (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
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

PWLs (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**
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

110-3 REFERENCES

110-3.1 This list of publications forms 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 E178	*Standard Practice for Dealing with Outlying Observations*

END OF ITEM C-110

Part 3 – Sitework

Item P-101 Site Preparation

****

The Engineer may add or edit this item as necessary to address project site preparation requirements.

- **This item includes initial work to prepare for pavement overlay, sealcoats, pavement removal, removal of lights, signs, and sign bases, removal of other structures.**
- **Prior to specifying milling, the Engineer must determine the existing pavement structure including prior construction lift thickness, and if the layers are bonded together.**
- **The Engineer may need to limit the weight of milling equipment to ensure there is not any damage to the existing pavements and pavement remaining after milling, due to the weight of the milling equipment.**
- **When establishing the milling depth, consider leaving or taking sufficient material to minimize the potential for delamination. The entire layer may require removal or full depth reclamation in lieu of milling. Delamination potential exists anytime milling depth is approximately equal to the thickness layer being milled, and when the lift is not bonded firmly to the layer below.**
- **When repairing cracks, the Engineer must consider:**
    - **Why are the cracks being repaired, different methods and materials may be needed to prepare for an overlay versus preparing for a surface treatment.**
    - **The properties of the sealant or repair materials.**
    - **When filling cracks use a mastic type material.**
    - **When placing patches, smaller patches may use either a specialized material or asphalt.**
    - **Seal cracks < 1½ inches**
    - **Fill cracks 1½ inches to 3 inches**
    - **Patch/Repair cracks > 3 inches**
        - **Patch/Repair to replace all failed surface/base/subbase or subgrade material.**
        - **Patch size depends on patch depth and size of equipment to be used to repair.**

- **This specification is primarily focused on pavement projects; however, it can be edited for other site work projects.**
- **The items included in P-101 are not intended to be all-inclusive. The Engineer my add additional items required to prepare the project site.**

****

101-1 DESCRIPTION

101-1.1 General.

This item consists of: **[** `preparation of existing pavement surfaces for` **[** `overlay,` **|** `preparation of existing pavement surface for surface treatment,` **|** `crack sealing,` **|** `crack filling,` **|** `removal of existing pavement` **]**, and **[** `removal of drainage structures` **|** `removal of light bases` **|** `removal of sign bases` **|** `other miscellaneous items` **]]**. Accomplish the work according to these specifications and the applicable plans.

101-2 EQUIPMENT AND MATERIALS

101-2.1 General.

The Resident Project Representative (RPR) approves all equipment and materials used for site preparation. The equipment must not cause damage to the pavement that is to remain in place. See paragraph 101-3.5, Control Strip.

101-3 CONSTRUCTION

101-3.1 Preparation Prior to [`Overlay` | `FDR`] [`Not Used.`]

101-3.1.1 Cold Milling. **[** `Not Used.` **]**

1. The RPR lays out the area to be milled in increments of one-foot (30 cm) widths.
2. Perform milling with a power-operated milling machine or grinder, capable of producing a uniform finished surface while not damaging the underlying pavement.
3. The milling machine must have a minimum width of **[** `7 feet (2 m)` **]** and be equipped with electronic grade and slope controls

capable of controlling the depth of milling to the grade specified. [Maintain tolerances within +0 inch and -¼ inch (+0 mm and -6mm) of the specified grade.]

4. The machine must cut vertical edges, have a positive method of dust control, and the ability to [windrow the millings or cuttings | remove the millings or cuttings from the pavement and load them into a truck].

5. Immediately sweep the milled surface and remove all residual materials from the pavement surface. Prior to paving, thoroughly sweep and/or blow the surface to remove loose residual material [then, wet down the milled surface]. Collect and remove waste materials from the pavement surface and adjacent areas by sweeping or vacuuming. Dispose of waste materials. [off airport property | in areas as designated on the plans].

6. Remove and dispose of all millings [off the airport | in areas as designated on the plans].

7. If the Contractor mills or grinds deeper or wider than the plans specify, the Contractor must replace the material removed with new material at the Contractor's expense.

****

The Engineer must consider the overall weight of milling equipment proposed by the Contractor to ensure there is no damage to the existing pavements and pavement remaining, after milling due to the weight of the equipment.

Prior to specifying milling, the Engineer must determine the existing pavement structure including prior construction lift thickness. The limits of milling must consider leaving or taking sufficient material to minimize the potential for delamination or the entire layer may require removal or full depth reclamation in lieu of cold milling. Delamination potential exists anytime cold milling depth is approximately equal to the layer placed.

****

101-3.1.2 Repair Cracks. [Not Used.]

101-3.1.2.1 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 the RPR approved.

101-3.1.2.2 Seal all cracks greater than ¼ inch (6 mm) wide) with a crack sealant per ASTM D6690. The crack sealant, preparation, and application must be compatible with the surface treatment/overlay to be used. Underfill the crack sealant a minimum of ⅛ inch (3 mm) but not more than ¼ inch (6 mm). Remove any excess joint or crack sealer from the pavement surface.

101-3.1.2.3 Fill wider cracks over 1½ inches wide (38 mm) [with a hot applied, pourable, aggregate filled, self-adhesive pavement repair mastic meeting ASTM D8260].

101-3.1.2.4 [Fill cracks and joints with a mixture of emulsified asphalt and aggregate. Use aggregate consisting of limestone, volcanic ash, sand, or other material that cures to form a hard substance. Use a combined gradation from Table 101-3.3.

Table 101-3.3: Gradation

Sieve Size	Percent Passing
No. 4 (4.75 mm)	100
No. 8 (2.36 mm)	90-100
No. 16 (1.18 mm)	65-90
No. 30 (600 µm)	40-60
No. 50 (300 µm)	25-42
No. 100 (150 µm)	15-30
No. 200 (75 µm)	10-20

Add up to 3% cement to accelerate the set time, if needed. Natural sand must be less than 20%, unless the RPR approves it in writing. Determine the proportions of asphalt emulsion and aggregate in the field. Proportions may be varied to facilitate construction requirements.

Normally, these proportions are approximately one part asphalt emulsion to five parts aggregate by volume. Pour or place the material into the joints or cracks and compact to eliminate any voids. Fill the joints or cracks to within +0 to -⅛ inches (+0 to -3 mm) of the surface. Remove any material spilled outside the width of the joint from the pavement surface prior to constructing the overlay. Where concrete overlays are to be constructed, remove any excess joint material on the pavement surface and vegetation in the joints.]

101-3.1.3 Repair Failed/Damaged Pavement.

Repair all failed asphalt concrete as shown on the plans or as the RPR directs.

101-3.1.4 Remove Foreign Substances/Contaminates. [Not Used.]

101-3.4.1 [Remove all foreign substances/contaminates from existing pavement that will affect the bond of the overlay or surface treatment. Foreign substances/contaminates consist of rubber, fuel spills, oil, crack sealer, [all loose paint,] at least [90% | 50%] of paint, and other foreign substances from the surface of the pavement.]

101-3.4.2 Use [rotary grinding | sandblasting | high-pressure water | chemicals | heater scarifier (asphaltic concrete only)]. Chemicals, if used, must comply with the local and state environmental protection regulations. Removal methods must 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 ¼ inch (6 mm) deep. If the RPR deems that removals are causing major damage to the existing pavement, revise the removal methods to a different method. The Contractor must repair any major damage caused by operational error, such as permitting the application method to dwell in one location for too long, without compensation, as the RPR directed. Water used for high-pressure equipment is at the Contractor's expense.

101-3.1.4.1 The Contractor must demonstrate the means and methods used for foreign substance / contaminate removals with a control strip. The RPR must approve control strip prior to removal.

101-3.1.4.2 Dispose all waste in areas shown on the plans or areas as the RPR designates.

****

Designate the areas and methods for removal of foreign substances/contaminates on the project plans.

This specification is not used for removal of rubber deposits to improve skid resistance or obliterate traffic markings where a new overlay is not constructed. Refer to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, for guidance on removing contaminates.

****

101-3.2 Preparation Prior to Sealcoat. [`Not Used.` **]**

101-3.2.1 Crack Preparation.

Widen cracks with **[** `router` **|** `random crack saw` **]** by removing a minimum of ⅛ inch (4 mm) from each side of the crack. Immediately before sealing, blow out cracks with a hot air lance combined with oil and water-free compressed air.

101-3.2..1.1 Removal of Existing Crack Sealant.

Remove existing sealants by **[** `routing` **|** `random crack saw` **]**. Following **[** `routing` **|** `sawing` **],** remove any remaining debris by use of a hot lance combined with oil and water-free compressed air. Remove a minimum of ⅛ inch (4 mm) from each side of the exiting crack.

101-3.2.1.2 Seal Cracks.

Use crack sealant material according to **[** `Item P-605` **]**. Clean out crack with dry, oil free air. Install sealant with appropriate wand band or tip resulting in a ⅛ inch (4 mm) underfill. Do not install sealant with an overband.

101-3.2.2 Remove All Foreign Substances/Contaminates.

101-3.2.2.1 Remove all rubber, oil, crack sealer, fuel spills, and other foreign substances that will affect the bond of the overlay or surface treatment. Remove **[** `all loose paint,` **]** at least **[** `90%` **|** `50%` **]** of paint, and other foreign substances from the surface of the pavement.

101-3.2.2.2 Use **[** `rotary grinding` **|** `sandblasting` **|** `high-pressure water` **|** `chemicals` **|** `heater scarifier (asphaltic concrete only)` **]**. Chemicals, if used, must comply with the local and state environmental protection regulations. Removal methods must 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 ¼ inch (6 mm) deep. If the RPR deems that removals are causing major damage to the existing pavement, revise the removal methods to a different method. The Contractor must repair any major damage caused by operational error, such as permitting the application method to dwell in one location for too long, without compensation, as the RPR directed. Water used for high-pressure equipment is at the Contractor's expense.

101-3.2.2.3 The Contractor must demonstrate the means and methods used for foreign substance / contaminate removals with a control strip. The RPR must approve control strip prior to removal.

101-3.2.2.4 Dispose all waste in areas shown on the plans or areas as the RPR designates.

101-3.2.3 [Removal of Existing Pavement. |Not Used.]

101-3.2.3.1 Document Existing Condition.

Prior to removing pavement, the Contractor and RPR document the condition of the existing pavement that is to remain adjacent to areas of pavement removal.

101-3.2.3.2 Control Removal.

Control the pavement removal operation to ensure means and methods do not damage the remaining pavement structure, remaining base material, cables, utility ducts, pipelines, or drainage structures.

101-3.2.3.3 Concrete Pavement Removal. [Not Used.]

Make full depth saw cuts perpendicular to the slab surface. Saw through the full depth of the slab including any dowels at the joint, remove the pavement, and install new dowels, as shown on the plans and per the specifications. Saw cut the perimeter the full depth of the pavement where the perimeter of the removal limits is not located on the joint and dowels are not present. Remove the pavement inside the saw cut by methods that do not cause distress or damage to the remaining pavement. If the material is to be wasted on the airport site, reduce pieces to a maximum size of **[__]**. Repair concrete slabs damaged by under breaking or remove and replace, as the RPR directed. Protect the edges of existing concrete pavement adjacent to any new pavement. Repair spalls and underbreaks, according to the plans. Recompact or replace any underlaying material that is to remain in place, as shown on the plans. Areas damaged during repair are repaired or replaced at the Contractor’s expense.

****

Indicate repair details for spalls, underbreaks, and remaining underlaying materials on the plans.

Select the maximum size for materials wasted on the airport site.

****

101-3.2.3.4 Asphalt Pavement Removal. [Not Used.]

Cut asphalt pavement to the full depth of the asphalt around the perimeter of the area to be removed, offsetting joint for each layer of pavement replacement by one foot from the joint in the layer below unless removed pavement to be replaced with soil or concrete. The material is to be [wasted on the airport site |

incorporated into embankment | broken to a maximum size of [__] inches (mm).].

****

Remove pavement so the joint for each layer of pavement replacement is offset 1 foot (0.3 m) from the joint in the preceding layer. This does not apply if the removed pavement is to be replaced with concrete or soil.

The Engineer designates the maximum size or insert the gradation requires. The maximum size of the pavement is determined by where in the embankment the material is to be placed.

****

101-3.2.3.5 Repair or Removal of Surface, Base, Subbase, and/or Subgrade.

Remove all failed material including surface, base course, subbase course, and subgrade and repair as shown on the plans or as the RPR directed. Materials and methods of construction must comply with the applicable sections of these specifications. Any damage caused by Contractor's removal process is repaired at the Contractor's expense.

101-3.3 Joint Preparation in Rigid Pavement Prior to Resealing. [Not Used.]

[Clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture, and other foreign matter prior to the application of joint sealant. The Contractor demonstrates, in the RPR's presence, that the method used cleans the joint without damage.]

101-3.3.1 Removing the Existing Joint Sealant.

Remove all existing joint sealants by plowing or use of hand tools. Remove any remaining sealant and or debris 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.

101-3.3.2 Cleaning Prior to Sealing.

Clean each joint face immediately before sealing, by removing any remaining laitance and other foreign material. Allow sufficient time to dry out joints prior to sealing. Joint surfaces must be surface-dry prior to installation of sealant.

101-3.3.3 Joint Sealant.

Joint material and installation must be according to [Item P-605 | Item P-604].

101-3.4 Removal of [Pipe, | Light Bases, | Sign Bases, | Inlets/Manholes,] and other [Buried Structures]. [Not Used.]

101-3.4.1 Removal of Existing Pipe Material.

[Remove the types of pipe as indicated on the plans. Legally dispose all pipe material off-site in a timely manner following removal. Backfill trenches with material equal to or better in quality than adjacent embankment. Compact trenches under paved areas to [95%] of [ASTM D1557 | ASTM D698]. [Not used.]]

101-3.4.2 Removal of [Light Bases, | Sign Bases, | Inlets/Manholes].

[Remove and legally dispose of off-site inlets and manholes where indicated on the plans or as the RPR directs in a timely fashion after removal. Backfill excavations after removal with material equal or better in quality than adjacent embankment. Compact backfill material when under paved areas to [95%] of [ASTM D1557 | ASTM D698], and when outside paved areas compact to [95%] of ASTM D698. [Not used.]]

101-3.4.3 Removal of [__].

101-3.5 Control Strip.

****

This section's intent is to require the Contractor to demonstrate to the RPR the equipment, materials, and construction processes meet the requirements of this specification. The RPR ensures that the equipment and processes will not damage remaining pavement and other in-place utilities. For example, is the equipment sized appropriately for the quantity of work? Is the equipment sized to not damage remaining pavement?

****

Prior to full production, the Contractor must demonstrate to the RPR that the equipment, material, construction means, and methods meet the specifications. Do not begin full production until the RPR approves the control strip.

Control strips are required for each separate removal or site preparation activity including:

1. [Preparation of existing pavement surfaces for overlay,][cold milling,][crack repair,][crack sealing,]
2. [Preparation of existing pavement surface for surface treatment]
3. [Removal of existing pavement]
4. [Removal of drainage structures]
5. [Removal of light bases]
6. [Removal of sign bases]
7. [Other miscellaneous items]

101-4 METHOD OF MEASUREMENT

[No separate measurement for payment is made. The work covered by this section is considered as a subsidiary obligation of the Contractor and covered under the other contract items][made at the contract unit price for each completed and accepted item. This price is full compensation for all labor, equipment, tools, and incidentals necessary to complete this item].

[101-4.1 Lump Sum.]

[No separate measurement for payment is made. | The work covered by this section is a subsidiary obligation of the Contractor and covered under the other contract items.]

101-4.2 Preparation Prior to Overlay. [Not Used.]

The unit of measure for preparation Prior to overlay is:

[[Cold Milling [lump sum | Square Yard].] The location and average depth of the cold milling is as shown on the plans. If the initial cut does not correct the condition, the Contractor must re-mill the area and is paid for the total depth of milling.]

[Crack Repair [lump sum | linear foot]]

[Pavement Repair [lump sum | square yard | square foot]]

[Removal of foreign substances [lump sum | square yard | square foot]]

101-4.3 Preparation Prior to Sealcoat. [Not Used.]

The unit of measure for preparation prior to sealcoat is:

[Crack Repair [lump sum | linear foot]]

[Removal of foreign substances/contaminates [lump sum | square yard | square foot]]

101-4.4 Removal of Existing Pavement. [Not Used.]

[The unit of measure for removal of pavement is:

[Asphalt Pavement Removal [lump sum | square yard | square foot].]

[Cement Pavement Removal [lump sum | square yard | square foot].]

101-4.5 Preparation of Joints Prior to Reseal. [Not Used.]

[The unit of measure for preparation of joints is: [lump sum | linear foot].]

101-4.6 Preparation of Cracks Prior to Sealing. [Not Used.]

[The unit of measure for preparation of cracks is: [lump sum | linear foot].]

101-4.7 Removal of [[Pipe,] [Light Bases,] [Sign Bases,] [Inlets/Manholes,] Other [Buried Structures]].

The unit of measure for removals is:

1. [Pipe,] [Not Used.] [lump sum | __]

2. [Light Bases,] [Not Used.] [lump sum | each]

3. [Sign Bases,] [Not Used.] [lump sum | each]

4. [Inlets/Manholes,] [Not Used.] [lump sum | each]

5. Other [Buried Structures.] [Not Used.] [lump sum | each]

****

The Engineer must select the applicable items above for each project and delete the others. Items such as cold milling may be specified multiple times, e.g., at cold milling 4 inches, cold milling 2 inches, profile cold milling, etc.

****

101-5 BASIS OF PAYMENT

101-5.1 Payment.

Payment is made at contract unit price for the unit of measurement as specified above. This price is 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.

[101-5.1 Lump Sum.]

[The work covered by this section is a subsidiary obligation of the Contractor and covered under the other contract items.]

101-5.2 Preparation Prior to Overlay. [Not Used.]

Payment is made:

[Crack Repair [lump sum | linear foot]]

[Pavement Repair [lump sum | square yard | square foot]]

[Removal of foreign substances [lump sum | square yard | square foot]]

101-5.3 Preparation Prior to Sealcoat. [Not Used.]

Payment for preparation prior to sealcoat:

[Crack Repair [lump sum | linear foot]]

[Removal of foreign substances/contaminates [lump sum | square yard | square foot]]

101-5.4 Removal of Existing Pavement. [Not Used.]

[Payment for removal of pavement is:

[Asphalt Pavement Removal [lump sum | square yard | square foot].]

[Cement Pavement Removal [lump sum | square yard | square foot].]

101-5.5 Preparation of Joints Prior to Reseal. [Not Used.]

[Payment for preparation of joints is: [lump sum | linear foot].]

101-5.6 Preparation of Cracks prior to Sealing. [Not Used.]

[Payment for preparation of cracks is: [lump sum | linear foot].]

101-5.7 Removal of [[Pipe,] [Light Bases,] [Sign Bases,] [Inlets/Manholes,] Other [Buried Structures]].

Payment for removals is:

1. [Pipe,] [Not Used.] [lump sum | __]

2. [Light Bases,] [Not Used.] [lump sum | each]

3. [Sign Bases,] [Not Used.] [lump sum | each]

4. [Inlets/Manholes,] [Not Used.] [lump sum | each]

5. Other [Buried Structures]. [Not Used.] [lump sum | each]

101-6 REFERENCES

The following publications 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 D698	*Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³)*
ASTM D1557	*Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³))*
ASTM D6690	*Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements*
ASTM D8260	*Standard Specification for Hot-Applied Asphalt Aggregate-Filled Mastic*

END OF ITEM P-101

Item P-151 Clearing and Grubbing

****

The Engineer may add or edit this item as necessary to address project requirements.

Coordinate modifications according to FAA Order 5300.1.

****

151-1 DESCRIPTION

151-1.1 General.

This item consists of [clearing | clearing and grubbing | tree removal] and the disposal of materials for all areas as designated on the plans.

151-1.2 **Clearing.** [**Not Used.**]

[Clearing consists of the cutting and removal of all vegetation, surface objects, brush, trees, stumps, logs, hedges, fences, and other materials projecting above the surface from the designated areas.]

151-1.3 **Clearing and Grubbing.** [**Not Used.**]

[Clearing and grubbing consists of cutting and removal of all vegetation, surface objects, brush, trees, stumps, roots, matted roots, logs, hedges, fences, structures, foundations, heavy growth of grass or weeds, debris, and rubbish of any nature. Remove all material under areas to be paved to a depth of [24] inches.]

151-1.4 **Tree Removal.** [**Not Used.**]

[Tree removal consists of the cutting and removal of isolated single trees or isolated groups of trees, and the grubbing of stumps and roots.]

151-1.5 **Disposal.** [**Not Used.**]

[Disposal consists of the disposal of all material from clearing, clearing and grubbing, or trees.]

151-2 CONSTRUCTION METHODS

151-2.1 General.

The [`RPR` | `Contractor`] is responsible for marking areas as denoted on the plans to be [`cleared` | `cleared and grubbed`], [`and trees removed`] with stakes and/or paint.

Unless otherwise shown on the plans, the removal of utilities and associated existing utility structures required to permit orderly progress of work is accomplished by [`local agencies`]. The Contractor notifies the RPR, verbally and in writing, whenever a telephone pole, pipeline, conduit, sewer, roadway, or other utility is encountered that needs to be removed or relocated. The RPR is responsible for promptly notifying the proper [`local authority or utility`] owner of the need to remove or relocate the subject items.

151-2.1.1 Blasting.

[`Blasting is not permitted.` | `Perform blasting and store explosives according to Section 70, paragraph 70-09, and all federal, state, and local safety regulations. Submit notice 15 days prior to starting work. Submit a Blasting Plan to the RPR, prepared and signed by a blasting consultant having at least five years' experience, that includes calculations for overpressure and debris hazard, provisions for storing, handling and transporting explosives as well as for the blasting operations in the plan. Prior to performing any blasting, obtain written approval from the RPR of the blasting plan. Notify the RPR verbally and in writing 24 hours prior to blasting. The Contractor is responsible for damage caused by blasting operations.`]

151-2.2 Clearing and Tree Removal.

The Contractor clears the staked or indicated area of all materials as indicated on the plans. Fell trees toward the center of the area being cleared. Cut up, remove, and dispose of in a satisfactory manner trees that fall outside the specified clearing limits. Preserve and protect all trees not being removed. Cut trees, stumps, and brush flush with the original ground surface. Grubbing stumps and roots is not required. Remove and dispose of fences as the RPR directs. Neatly roll fence wire and store at location designated on the project plans or location as designated by the RPR.

151-2.3 Clearing and Grubbing.

In areas designated to be cleared and grubbed, remove all stumps, roots, buried logs, brush, grass, and other unsatisfactory materials as indicated on the plans, except where embankments exceeding 3½ feet (105 cm) in depth is constructed outside of paved areas. For embankments constructed outside of paved areas, remove all unsatisfactory materials, but sound trees, stumps, and brush can be cut off flush with the original ground and allowed to remain. Grub tap roots and other projections over 1½ inches (38 mm) in diameter to a depth of at least 18 inches (0.5 m) below the finished subgrade or slope elevation.

Demolish or remove any buildings and miscellaneous structures shown on the plans to be removed, and dispose of all materials by removal from the site. The cost of removal is incidental to this item. Destroy any remaining or existing foundations, wells, cesspools, and similar structures by breaking down to a depth at least 2 feet (60 cm) below the existing surrounding ground surface. The Contractor removes and disposes of any broken concrete, blocks, or other objectionable material that cannot be used in backfill. Backfill and compact holes or openings with material the RPR approves.

Flatten and compact all holes in embankment areas remaining after the grubbing operation with material the RPR approved and as required in Item P-152. Apply the same procedure to all holes remaining after grubbing in areas where the depth of holes exceeds the depth of the proposed excavation.

****

Indicate extent of grading required after clearing, or clearing and grubbing, on the plans including any required surface tolerances.

****

151-2.4 Tree Removal.

Cut trees as designated on the plans or as directed by the RPR flush with the ground surface. [Grub roots greater than 1½ inches (38 mm) to a depth of 18 inches (0.5 m) below finished subgrade or slope elevation.]

151-2.5 Disposal.

Dispose of all materials removed [in the designated waste disposal area | outside the Airport’s limits at the Contractor’s responsibility | by burning], except when the RPR directs otherwise. [Provide constant oversight of burning with a watchperson to ensure the surrounding vegetation and other adjacent property is not jeopardized. Perform burning according to all applicable federal, state, and local laws, ordinances, and regulations. Obtain all approvals in writing and notify the agency having jurisdiction before starting any burning operations.]

[Concrete or masonry may be used in embankments only when material is placed in accordance with paragraph P-152-2.8, Formation of Embankments. Dispose of concrete or masonry that cannot be used in embankments in areas as designated on the plans or as directed by the RPR.] Provide the RPR with written approval from property owner designating the disposal area and method of disposal for disposal areas outside airport property limits.

151-3 METHOD OF MEASUREMENT

151-3.1 The quantities of clearing as shown by the limits on the plans is the [number of acres (square meters) or fractions. |lump sum] of land specifically cleared.

151-3.2 The quantities of clearing and grubbing as shown by the limits on the plans is [the number of acres (square meters) or fractions. |the lump sum] of land specifically cleared and grubbed.

151-3.3 The quantity of tree removal as shown on the plans is the [number of individual trees |number of acres (square meters) or fractions. |per lump sum] of land specifically cleared.

151-4 BASIS OF PAYMENT

151-4.1 Payment is made at the contract unit price [per acre (square meter) or fractions |per lump sum] for clearing. This price is full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

151-4.2 Payment is made at the contract unit price [per acre (square meter) |per lump sum] for clearing and grubbing. This price is full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

151-4.3 Payment is made at the contract unit price [per number of individual trees |per acre (square meter) |per lump sum] for tree removal. This price is full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item P-151-4.1	Clearing – [per acre (square meter) or fractions|per lump sum]
Item P-151-4.2	Clearing and grubbing - [per acre (square meter) or fractions |per lump sum]

Item P-152-4.3 Tree Removal – **[** per number of individual trees **|**per acre (square meter) or fractions **|**per lump sum **]**

END OF ITEM P-151

Item P-152 Excavation, Subgrade, and Embankment

****

Some projects may require use of materials or methods not included in this item, and the project's Geotechnical Report may require additions or modifications of this item to address specific project requirements.

When adding materials or methods include item description, construction method, method of measurement, and basis of payment. Typical items may include additional classifications of materials, such as shot or quarried rock; specialized types of excavation; or construction methods identified during project design such as dewatering.

Coordinate modifications according to FAA Order 5300.1.

****

152-1 DESCRIPTION

151-1.1 General.

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 according to these specifications and in conformity to the dimensions and typical sections shown on the plans.

152-1.2 Classification.

All excavated material is classified as:

152-1.2.1 Unclassified Excavation.

Unclassified excavation consists of the excavation and disposal of all material, regardless of its nature [not otherwise classified and paid for under one of the following items].

[152-1.2.1 [__]

[**Rock Excavation.** Rock excavation includes all solid rock in ledges, bedded deposits, unstratified masses, and conglomerate deposits which are so firmly cemented they cannot be removed without blasting or using rippers. All boulders containing a volume of more than ½ cubic yard (0.4 m^3) are classified as "rock excavation."]

[**Muck Excavation.** Muck excavation consists of the removal and disposal of deposits or mixtures of soils and organic matter not suitable for foundation material. Muck includes materials that decay or produce subsidence in the embankment. Muck includes decaying stumps, roots, logs, humus, or other material not satisfactory for incorporation in the embankment.]

[**Drainage Excavation.** Drainage excavation consists of all excavation made for the primary purpose of drainage and includes drainage ditches, such as intercepting, inlet or outlet ditches; temporary levee construction; or any other type as shown on the plans.]

[**Borrow Excavation.** Borrow excavation consists of excavation of approved material required for the construction of embankments or for other portions of the work more than the quantity of usable material available within the limits for grading. Obtain borrowed material from areas designated by the Resident Project Representative (RPR) within the limits of the airport property but outside the normal limits of necessary grading, or from areas outside the airport boundaries.]

[**Other.**]

****

All material excavated is considered “unclassified” unless the Engineer specifies other classifications in the project specifications. Add or delete the classifications not applicable for the project.

****

152-1.3 Unsuitable Excavation.

Materials containing vegetable or organic matter, such as muck, peat, organic silt, or sod are considered unsuitable for use in embankment construction. Dispose of all unsuitable material in waste areas as designated on the plans. Material suitable for topsoil may be used on the embankment slope when the RPR approves.

152-2 CONSTRUCTION METHODS

152-2.1 General.

Before beginning excavation, grading, and embankment operations, clear, or clear and grub, according to Item P-151. Prior to placement, obtain RPR approval of material to be used in embankments. Dispose all unsuitable material in waste areas, as designated on the plans. Grade all waste areas to allow positive drainage of the area and adjacent areas. The surface elevation of waste areas is as specified on the plans or as the RPR approved.

When excavation encounters artifacts of historical or archaeological significance, stop operations and notify the RPR per Section 70, paragraph 70-20. When directed by the RPR, the Contractor must excavate the site in such a manner to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Before placing embankment in areas outside the limits of where pavement will be constructed, where the top layer of soil has become compacted by hauling or other Contractor activities, loosen and pulverize the soil by scarifying and discing to a depth of 4 inches (100 mm).

Take necessary measures to preserve or provide temporary services when it is necessary to interrupt drainage, sewers or under-drainage, conduits, utilities. Notify the RPR when such facilities are encountered and the RPR will make arrangements to remove or relocate these items if required. The Contractor, at their own expense, must repair to the RPR's satisfaction or pay the cost of all damage to such facilities or structures resulting from any of the Contractor's operations during the contract.

152-2.1.1 Blasting.

[Blasting is not permitted. |Blasting is only permitted as the RPR directs and according to the following:

Prior to blasting, take all proper precautions for the safety of all persons, work, and property. The Contractor repairs any damage to the work or property due to blasting. The cost of repair is incidental to this item. All operations of the Contractor in connection with the transportation, storage, and use of explosives must conform to all federal, state, local regulations, and explosive manufacturers' instructions, with applicable approved permits the RPR reviewed. Any approvals do not relieve the Contractor of their responsibility in blasting operations.

Where blasting is approved, the Contractor must employ a blasting vibration consultant, the RPR approves, to advise on explosive charge weights per delay and to analyze records from seismograph recordings. The seismograph must be able to produce a permanent record of the three components of the motion in terms of particle velocity, and capable of internal dynamic calibration.

In each distinct blasting area, the Contractor must submit a Blasting Plan to the RPR for approval. This plan must consist of hole size, depth, spacing, burden, type of explosives, type of delay sequence, maximum amount of explosive on any one delay period, depth of rock, and depth of overburden, if any. The maximum explosive charge weights per delay included in the plan must not be increased without the RPR's approval.

The Contractor must keep a record of each blast, its date, time, and location; the amount of explosives used, maximum explosive charge weight per delay period, and, where necessary, seismograph records identified by instrument number and location.

Blasting and explosive storage must be according to Section 70, paragraph 70-09, and all federal, state, and local safety regulations.

These records must be available to the RPR monthly or in tabulated form at other times, as required. **]**

152-2.2 Excavation.

Do not start excavation until the Contractor stakes out the work and the RPR has obtained the survey notes of the elevations and measurements of the ground surface. The Contractor and RPR must 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 prior to excavation starting.

[Digital elevation model (DEM) files of the existing surfaces, finished surfaces, and other various surfaces were used to develop the design plans.

[Volumetric quantities were calculated by comparing DEM files of the applicable design surfaces and generating Triangle Volume Reports. Electronic copies of DEM files and a paper copy of the original topographic map is issued to the successful Bidder.]

[Volumetric quantities were calculated using design cross sections created for this project using the DEM files of the applicable design surfaces and generating End Area Volume Reports. The successful Bidder is issued paper copies of design cross sections and a paper copy of the original topographic map.]

[Existing grades on the design cross sections or DEMs, where they do not match the locations of actual spot elevations shown on the topographic map, were developed by computer interpolation from those spot elevations. Prior to disturbing original grade, the Contractor must verify the accuracy of the existing ground surface by verifying spot elevations at the same locations where original field survey data was obtained as indicated on the topographic map.

The Contractor must recognize that, due to the interpolation process, the actual ground surface at any location may differ somewhat from the interpolated surface shown on the design cross sections or obtained from the DEM's. The Contractor's verification of original ground surface, however, is limited to verification of spot elevations as indicated herein, and no adjustments made to the original ground surface unless the Contractor demonstrates that spot elevations shown are incorrect.

For this purpose, spot elevations which are within [0.1 foot (30 mm)] of the stated elevations for ground surfaces, or within [0.04 foot (12 mm)] for hard surfaces (pavements, buildings, foundations, structures, etc.) are considered "no change". Only consider deviations exceeding these, for adjustment of the original ground surface. If the Contractor's verification identifies discrepancies in the topographic map, the Contractor must notify the RPR in writing at least [two weeks] before disturbance of existing grade to allow sufficient time to verify the submitted information and make adjustments to the design cross sections or DEM's. Disturbance of existing grade in any area constitutes acceptance by the Contractor of the accuracy of the original elevations shown on the topographic map for that area.]

****

Delete bracketed DEM paragraphs if DEM is not used.

****

Strip vegetation and topsoil from all areas to be excavated. Stockpile topsoil in areas designated on the plans or as designated by the RPR. Use all suitable excavated material in the formation of embankment, subgrade, or other purposes, as shown on the plans. Dispose of all unsuitable material in areas designated on the plans. The Contractor must maintain the grade 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, dispose the excess as the RPR directs. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, obtain additional embankment material from borrow areas.

****

During the Design Phase, perform subsurface investigations to identify existing subsurface conditions to minimize the potential for unforeseen conditions arising during excavation, such as the need for dewatering or removal of unsuitable materials.

****

152-2.2.1 Selective Grading.

When selective grading is indicated on the plans, use the more suitable material the RPR designates in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place the more suitable material in its final location, stockpile it in approved areas until it can be placed. Consider selective grading incidental to the work involved. Include the cost of stockpiling and placing the material in the various pay work items involved.

152-2.2.2 Undercutting.

Excavate rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth the RPR specifies. Remove muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, to the depth specified. Unsuitable materials must be **[** `disposed of at locations shown on the plans.` **|** `disposed of at the airport. The cost is incidental to this item.` **]** Material excavated as undercut is considered **[** `excavation` **|** `rock excavation` **]**. Backfill and compact the excavated undercut area with suitable material obtained from the grading operations or borrow areas. The backfill of the undercut constitutes a part of the embankment. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface are drained according to the details shown on the plans.

****

The Engineer specifies the appropriate class of excavation. The plans must show details for draining pockets created in rock cuts.

****

152-2.2.3 Over-break.

Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work, as the RPR plans or authorizes. The Contractor must grade or remove all over-break and dispose of as the RPR directs. The RPR makes the final determination whether the overbreak was avoidable or unavoidable. Payment is not made for the removal and disposal of over-break that the RPR determines as avoidable. Unavoidable over-break is classified as, “Unclassified Excavation.”

152-2.2.4 Removal of Existing Structures and Utilities.

The removal of existing structures and utilities required to permit the orderly progress of work is accomplished **[** `by someone other than the Contractor` **|**`by the Contractor according to Item P-101` **]**.

152-2.3 Borrow Excavation.

[`Borrow areas are not required.` **|**`Borrow areas within the airport property are as indicated on the plans. Make borrow excavations only at designated locations within the horizontal and vertical limits as staked or as the RPR directs. Remove and dispose of all unsuitable material as shown on the plans. All borrow pits must be opened to expose the various strata of acceptable material to allow obtaining a uniform product. Drain borrow areas and leave in a neat, presentable condition with all slopes dressed uniformly. Borrow areas must not create a hazardous wildlife attractant.` **[__]]**

[`The Contractor must locate and obtain borrow sources, subject to the RPR’s approval. The Contractor must notify the RPR at least` **[** `15` **]** `days prior to beginning the excavation so the RPR can make the necessary measurements and tests. Open all borrow pits exposing the various strata. Drain borrow areas and leave in a neat, presentable condition with all slopes dressed uniformly.`

`Borrow areas must not create a hazardous wildlife attractant.` **[__]]**

****

For on-site borrow areas, the Engineer determines the acceptability of the borrow material before identifying the area on the plans.

For off-site borrow areas obtained by the Contractor, the RPR determines the acceptability of the borrow material before its use on the project.

Address hazardous wildlife attractants when opening borrow sites on or near an airport. Add references and sources addressing standing water, permitting, approvals, and zoning. Reference AC 150/5200-33, *Hazardous Wildlife Attractants on or near Airports.*

****

152-2.4 Drainage Excavation.

Drainage excavation consists of excavation of drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. Perform the work in sequence with the other construction. Construct ditches prior to starting adjacent excavation operations. Place all satisfactory material in embankment fills; place unsuitable material in designated waste areas, or as the RPR directs. Perform all necessary drainage excavation true to final line, elevation, and cross-section. The Contractor must maintain ditches constructed on the project to the required cross-section and keep them free of debris or obstructions until the project is accepted.

152-2.5 Preparation of Embankment Area.

Remove all sod and vegetative matter from the surface upon which the embankment is to be placed. Break up the cleared surface by plowing or scarifying to a minimum depth of 6 inches (150 mm) and then compact per paragraph 152-2.10.

Plow, step, bench, or breakup sloped surfaces steeper than one vertical to four horizontal so that the fill material bonds with the existing material. When the subgrade is part fill and part excavation, or natural ground, scarify the excavated or natural ground portion to a depth of 12 inches (300 mm) and compact as specified for the adjacent fill.

****

The Engineer must include benching details on the plans based on the type of material, degree of consolidation of the material, and the degree of homogeneity of the material. The minimum width of the bench must be sufficient to accommodate construction equipment.

The Engineer should consider the consolidation of embankments over 4 feet (1.2 m) and installation of monitoring equipment such as settlement plates and inclinometers for deep fills.

****

No direct payment is made for the work performed under this section.

152-2.6 Control Strip.

Consider the first half-day of construction of subgrade and/or embankment the control strip. The Contractor must demonstrate, in the RPR's presence, that the materials, equipment, and construction processes meet the requirements of this specification. The control strip establishes the lift thickness, moisture content, spreading and compaction equipment, and the sequence and manner of compaction necessary to meet specified density requirements. The lift thickness may be increased to a maximum of 12 inches (300 mm) upon demonstration that the 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 not meeting specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor's expense. Do not begin full operations until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve any adjustments in the equipment, materials, and construction methods in advance.

152-2.7 Preparation of Cut Areas or Where Existing Pavement Has Been Removed.

In those areas on which a subbase or base course is to be placed, compact the top **[** `12 inches (300 mm)` **]** of subgrade to not less than **[** `100%` **]** of maximum density for non-cohesive soils, and **[** `95%` **]** of maximum density for cohesive soils as determined by ASTM **[__]**. As used in this specification, "non-cohesive" means those soils having a plasticity index (PI) of less than three as determined by ASTM D4318.

****

For subgrade under flexible and rigid pavements, the Engineer specifies the required compaction depth and density as determined from the Geotechnical Report and the FAA Rigid and Flexible Iterative Elastic Layered Design. (FAARFIELD) Airport Pavement Design compaction recommendations. The current version of FAARFIELD is available at: www.faa.gov/airports/engineering/design_software/

Specify ASTM D698 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

For soils with expansive characteristics, determine the maximum density according to ASTM D698 regardless of aircraft weight.

****

152-2.8 Formation of Embankments.

Construct embankments in lifts as established in the control strip, but not less than 6 inches (150 mm). When more than one lift is required to establish the layer thickness shown on the plans, the construction procedures described here applies to each lift. Do not cover lifts by subsequent lifts until tests verify that compaction requirements have been met. The Contractor must rework, re-compact, and retest any material placed not meeting the specifications. Place the lifts to produce a soil structure, as shown on the typical cross-section, or as the RPR directs. Do not incorporate or bury unsuitable materials such as brush, hedge, roots, stumps, grass, and other organic matter, in the embankment.

Suspend earthwork operations any time satisfactory results cannot be obtained due to rain, freezing, or other unsatisfactory weather conditions in the field. Do not place frozen material in the embankment. Do not place the embankment upon frozen or muddy surfaces. The Contractor must drag, blade, or slope the embankment to provide surface drainage, at all times.

The material in each lift must be within ±2% of optimum moisture content before rolling to obtain the prescribed compaction. Moisten or aerate the material as necessary to achieve a uniform moisture content throughout the lift. Accelerate natural drying by blending in dry material, or manipulation alone, to increase the rate of evaporation.

The Contractor makes the necessary corrections and adjustments in methods, materials, or moisture content to achieve the specified embankment density. The RPR takes samples of excavated materials used in embankment for testing to obtain a Moisture-Density Relations of Soils Report (Proctor) according to **[** `ASTM D698` **|** `ASTM D1557` **]**. Obtain a new Proctor for each soil type based on visual classification. The RPR takes density tests for every **[** `3,000` **]** square yard of compacted embankment for each lift which is required to be compacted, or other appropriate frequencies, as the RPR determines. If the material has greater than 30% retained on the ¾ inch (19.0 mm) sieve, follow American Association of State Highway and Transportation Officials (AASHTO) T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

****

It is recommended that density tests be made for each 3,000 square yards (2,500 square meters) of material placed per lift. The Geotechnical Engineer should determine the testing frequency. The Engineer may specify other frequencies as appropriate to the job size. If necessary to apply special controls to the soil's moisture content during or after compaction to ensure

strength because of the presence of expansive soils or other unusually sensitive soils, the Engineer must specify the appropriate moisture content.

The Engineer specifies the moisture limitations using the acceptable moisture ranges, as determined by ASTM D698 or ASTM D1557. Refer to FAA RD-76-66, *Design and Construction of Airport Pavements on Expansive Soils*, for additional guidance.

If the material has greater than 30% retained on the ¾ inch (19.0 mm) sieve, follow AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles.

If nuclear density machines are used for density determination, calibrate the machines according to ASTM D6938.

Include testing frequencies per square yard for density and moisture acceptance tests.

****

Continue rolling operations 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 **[__]**. Compact embankments under all areas to be paved to a depth of **[__]** and a density of not less than **[__]** percent of the maximum density as determined by ASTM **[__]**. As used in this specification, "non-cohesive" means those soils having a plasticity index (PI) of less than three as determined by ASTM D4318.

****

For subgrade under flexible and rigid pavements, the Engineer specifies the required compaction depth and density as determined from the Geotechnical Report and the FAARFIELD Airport Pavement Design compaction recommendations. The current version of FAARFIELD is available at: https://www.faa.gov/airports/engineering/design_software/

Specify ASTM D698 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

Determine the maximum density for soils with expansive characteristics according to ASTM D698 regardless of aircraft weight.

****

Determine the in-place field density according to **[[** ASTM 6938 using Procedure A, the direct transmission method, and ASTM D6938 to determine the moisture content of the material. Calibrate the machine according to ASTM D6938 **|** ASTM D7830 **|** ASTM D8167 for in place density **]** and **[** ASTM D4959, **|** ASTM D8153, **|** ASTM D4643, **|** ASTM D4944 **]** for moisture **]**.

Perform all density tests by the **[** `RPR` **|**`Contractor’s laboratory in the RPR’s presence and provide the test results to the RPR for acceptance` **]**. The Contractor must rework, and/or re-compact, and conduct additional random tests made if the specified density is not attained, the area represented by the test, or as designated by. Follow this procedure until the specified density is reached. Keep compaction areas separate, and do not cover a lift by another lift until the proper density is obtained. During construction of the embankment, the Contractor routes all construction equipment evenly over the entire width of the embankment as each lift is placed. Begin lift placement in the deepest portion of the embankment fill. As placement progresses, construct the lifts approximately parallel to the finished pavement grade line.

Incorporate rock, concrete pavement, asphalt pavement, and other embankment material excavated at approximately the same time as the subgrade, into the outer portion of the embankment and incorporate subgrade material under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4 inches (100 mm) in their greatest dimensions are not permitted in the top 12 inches (300 mm) of the subgrade. Bring rockfill up in lifts, as specified or as the RPR directs, and the finer material used to fill the voids forming a dense, compact mass. Dispose of rock, cement concrete pavement, asphalt pavement, and other embankment material at places and in the manner designated on the plans or 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. Level and smooth each lift with suitable equipment by distribution of spalls and finer fragments of rock. Lifts of this rock material must be at least 4 feet (1.2 m) in elevation below the finished subgrade elevation.

On all areas outside of the pavement areas, no compaction is required on the top **[** `4 inches (100 mm)` **]** which is prepared for a seedbed according to **[** `Item T-901` **|**`T-905` **]**.

[`There is not any 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 is included in the contract price for excavation, borrow, or other items.` **|**`Payment for compacted embankment is made under embankment in-place and no payment is made for excavation, borrow, or other items.` **]**

152-2.9 Proof Rolling.

The purpose of proof rolling the subgrade is to identify any weak areas in the subgrade and not for compaction of the subgrade. **[** `Before start of embankment,` **|** `and` **|**`After compaction is completed,` **]** the subgrade area must be proof rolled with a **[** **[** `20 ton (18.1 metric ton)` **]**`Tandem axle Dual`

Wheel Dump Truck loaded to the legal limit with tires inflated to **[** 80/100/150 psi (0.551 MPa/0.689 MPa/1.034 MPa) **] [__]** ton Proof Roller with tires spaced not more than 32 inches (0.8 m) on-center with tires inflated to **[** 100/125/150 psi (0.689 MPa/0.861 MPa/1.034 MPa) **]]** in the presence of the RPR. Apply a minimum of **[__]** coverage, or as the RPR specifies, under pavement areas. A coverage is defined as the application of one tire print over the designated area. Remove soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) and replace with suitable material or reworked to conform to the moisture content and compaction requirements according to these specifications. Removal and replacement of soft areas is incidental to this item.

****

The Engineer selects the proof-rolling method and number of coverages.

Check drawings to ensure that any supplementary information required by this paragraph is shown and that there is no conflict between the drawings and the specifications.

****

152-2.10 Compaction Acceptance Testing.

Subgrade under areas to be paved must 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 **|**ASTM D698 **]**. Subgrade in areas outside the limits of the pavement areas must 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 **[** D698 **]**.

The material must be within ±2% of optimum moisture content (except for expansive soils). When the material has greater than 30% retained on the ¾ inch (19.0 mm) sieve, follow the **[** methods in **[** ASTM D698 **|**ASTM D1557 **]** procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles. **]** Take tests for moisture content and compaction at a minimum of **[__]** square yards of subgrade. **[** The RPR **]** performs all quality acceptance (QA) testing. **[** The Contractor's laboratory performs density tests, in the RPR's presence, and furnishes results to the RPR for determination of acceptance. **]**

****

The Engineer specifies the required compaction depths and densities as determined from FAARFIELD Airport Pavement Design Report. The current version of FAARFIELD is available at: https://www.faa.gov/airports/engineering/design_software/

The Engineer must specify ASTM D698 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less, and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, follow the methods in the ASTM D698 or D1557; or AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles.

Include testing frequencies per square yard (square meter) for density and moisture acceptance tests. Edit specification to allow use of non-nuclear, or low nuclear devices.

****

Determine the in-place field density according to **[** `ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material. Calibrate the machine according to ASTM D6938 within twelve months prior to its use on this contract. Daily, field standardize the gauge.` **]** or **[** `ASTM D7830` **]** or **[** `ASTM D8167 for in place density and` **[** `ASTM D4959,` **|**`ASTM D8153,` **|** `ASTM D4643,` **]** `or` **[** `ASTM D4944` **]** `for moisture` **]**.

If a nuclear gauge is used for density determination, take two random readings for each **[** `1200` **]** square yard (meter) of each lift. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

If the specified density is not attained, the entire lift must be reworked and/or re-compacted and additional random tests made if the specified density is not attained. This procedure must be followed until the specified density is reached. All cut-and-fill slopes must be uniformly dressed to the slope, cross-section, and alignment shown on the plans, or as the RPR directs and the finished subgrade must be maintained.

152-2.11 Finishing and Protection of Subgrade.

Finishing and protection of the subgrade is incidental to this item. Perform grading and compacting of the subgrade so that it drains readily. Bring all low areas, holes, or depressions in the subgrade to grade. Perform scarifying, blading, rolling, and other methods to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. Grade, re-compact, and retest all ruts or rough places that develop in the completed subgrade. The Contractor must protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes. The Contractor must maintain the completed course in satisfactory condition throughout placement of subsequent layers. Do not place subsequent layers of subbase, base, or surface course, until the RPR accepts the subgrade.

152-2.12 Haul.

Hauling is a necessary and incidental part of the work. No payment is made separately or directly for hauling on any part of the work. The Contractor's equipment must not cause damage to any excavated surface, compacted lift, or to the subgrade because of hauling operations. The Contractor must repair any damage caused due to the Contractor's hauling operations at the Contractor's expense. The Contractor is responsible for providing, maintaining, and removing, any haul roads or routes within or outside of the work area, and must return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment is made for any work or materials associated with providing, maintaining, and removing haul roads or routes.

152-2.13 Surface Tolerances – Grade.

The Contractor is responsible for measuring the grade and crown on a **[** `50` **|** `25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement, and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR prior to construction of the next pavement layer.

152-2.14 Topsoil.

When topsoil is specified or required, as shown on the plans or under Item T-905, salvage it from stripping or other grading operations. The topsoil must meet the requirements of Item T-905. If the topsoil cannot be placed in its final location, stockpile the topsoil material at approved locations. Locate stockpiles as shown on the plans and the approved Construction Safety and Phasing Plan (CSPP), as shown on the OSD. Do not place stockpiles on areas that subsequently will require any excavation or embankment fill.

152-3 METHOD OF MEASUREMENT

152-3.1 Measurement for payment specified by the cubic yard (cubic meter) is computed by the **[[** `average end areas of design cross sections` | `the comparison of DEM surfaces` **]** `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, are subject to the RPR's verification.

****

The Engineer may edit method of volume calculations. The method of calculating volumes must meet or exceed the accuracy of the average end

area method. Describe the method of field verification. It must meet or exceed what is currently specified for the average end area method.

****

152-3.2 [The quantity of [unclassified | rock | muck | drainage] excavation paid for is the number of cubic yards (cubic meters) measured in its original position. Do 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.]

[**152-3.3** The quantity of embankment in place is the number of cubic yards (cubic meters) measured in its final position.]

[**152-3.4** [The quantity of stockpiled material is the number of cubic yards (cubic meters) measured in the stockpiled position. | Do not measure stockpiled material for payment in the stockpiled position.]]

152-4 BASIS OF PAYMENT

152-4.1 [Unclassified excavation | Rock Excavation | Muck Excavation | Drainage Excavation | Stockpiled Material] payment is at the contract unit price per cubic yard (cubic meter). This price is full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

[**152-4.2** For embankment in place, payment is made at the contract unit price per cubic yard (cubic meter). This price is full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.]

[**152-4.3** Pay for stockpiled material based on the number of cubic yards (cubic meters) measured in the stockpiled position.]

Payment is made under:

[Item P-152-4.1 [[Unclassified | Rock | Muck | Drainage | Excavation | Stockpiled material]]-per cubic yard (cubic meter)]

[Item P-152-4.2 Embankment in place - per cubic yard (cubic meter)]

`[ Item P-152-4.3 Stockpiled material - per cubic yard (cubic meter) ]`

****

The Engineer includes only those classifications shown in the bid schedule.

****

152-5 REFERENCES

152.5.1 This list of publications forms 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 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 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 D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

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)

****

Item P-153 is for backfill around conduits and/or any irregular areas where it is difficult to achieve compaction.

****

153-1 DESCRIPTION

153-1.1 This item consists 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 the Resident Project Representative (RPR) directs.

153-2 MATERIALS

153-2.1 Cement.

Cement must conform to the requirements of ASTM **[__]** Type **[__]**.

****

The Engineer specifies all applicable cements:

ASTM C150 - Type I, II, V

ASTM C595 - Type IL, IS, IP, or IT

ASTM 989

****

153-2.2 Coal Ash.

Coal ash must conform to ASTM C618, Class C or F.

153-2.3 Aggregate Requirements.

Fine aggregate must 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, is acceptable.

Table 153-2.3: Aggregate Requirements

Sieve Size	Percent Passing by Weight
¾ inch (19.0 mm)	100
No. 200 (75 µm)	0 - 12

153-2.4 Water.

Use potable water for mixing and curing. Other sources must be tested according to ASTM C1602 prior to use.

****

Incorporate dyes and other methods of coloring the backfill material, if desired.

****

153-3 MIX DESIGN

153-3.1 Proportions.

The Contractor must submit a mix design to the RPR that includes the laboratory prepared proportions and source of aggregate, coal ash, cement, water, and admixtures. The RPR's written approval is required prior to production and placement of CLSM mixture. The proportions establish a single percentage or weight for aggregate, coal ash, cement, water, and any admixtures proposed. Laboratory costs are incidental to this item.

153-3.1.1 Compressive Strength.

Design CLSM to achieve a 28-day compressive strength of 100 to 200 psi (690 to 1379 kPa) when tested according to ASTM D4832, with no significant strength gain after 28 days.

153-3.1.2 Consistency.

Design CLSM to achieve a consistency that produces an approximate 8-inch (200 mm) diameter circular-type spread without segregation. Determine CLSM consistency per ASTM D6103.

153-4 CONSTRUCTION METHODS

153-4.1 Placement.

Place CLSM by any reasonable means from the mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Perform placement so structures or pipes are not displaced from their final position and intrusion of CLSM into unwanted areas is avoided. Uniformly bring the CLSM up to the fill line shown on the plans or as the RPR directs. Each placement of CLSM must be as continuous an operation as possible. If CLSM is placed in more than one lift, the base lift must be free of surface water and loose foreign material prior to placement of the next lift.

153-4.2 Contractor QC.

The Contractor must collect all batch tickets to verify the CLSM delivered to the project conforms to the mix design. The Contractor provides the RPR all batch tickets.

153-4.3 Limitations of Placement.

Do not place CLSM 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 must stop when the air temperature is 40°F (4°C) and falling or when the anticipated air or ground temperature is 35°F (2°C) or less in the 24-hour period following proposed placement. At the time of placement, CLSM must have a temperature of at least 50°F (10°C).

153-4.4 Curing and Protection.

153-4.4.1 Curing.

Maintain the air in contact with the CLSM at temperatures above freezing for a minimum of 72 hours. The RPR will reject CLSM subjected to temperatures below 32°F (0°C), if damage to the material is observed.

153-4.4.2 Protection.

The CLSM must remain undisturbed by construction activities and external loads for a period of 48 hours.

153-4.5 QA Acceptance.

The Contractor provides the RPR batch tickets verifying that the material delivered conforms to the approved mix design for CLSM QA acceptance.

153-5 METHOD OF MEASUREMENT

153-5.1 Measurement.

`[ No separate measurement for payment is made for controlled low strength material (CLSM). CLSM is considered necessary and incidental to the work of this Contract. ]`

`[ Controlled low-strength material (CLSM) will be measured by the number of [ cubic yards (cubic meters) ] as specified, completed, and accepted. ]`

153-6 BASIS OF PAYMENT

153-6.1 Payment.

[No payment is made separately or directly for controlled low strength material (CLSM). CLSM is considered necessary and incidental to the work of this Contract. **]**

[Controlled low-strength material (CLSM)is paid for at the contract unit price per **[** cubic yard (cubic meter) **].** Payment is full compensation for all materials, equipment, labor, and incidentals required to complete the work as specified.

Payment is made under:

Item P-153-6.1	Controlled low-strength material (CLSM) per **[** cubic yard **|**cubic meter **].** **]**

153-7 REFERENCES

153-7.1 This list of publications forms 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 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

Item P-155 Lime-Treated Subgrade

****

- **Lime treatment is generally performed on clay soils to reduce the plasticity index (PI) and to improve the working platform.**
- **When lime treatment is done to strengthen the subgrade, perform an unconfined compressive strength test and target a minimum increase in strength of 50 psi after 48 hours, per ASTM D2166.**
- **Lime treatment increases the optimum water content and dries out the soil, permitting compaction under wet conditions.**
- **Secondary benefits are increased strength and stability.**
- **The typical lime content required to bring the soil pH to greater than twelve identifies the minimum lime content needed. Generally, this is 3-7%.**
- **In areas susceptible to freeze-thaw, a drainage layer should be provided over the modified layer.**

Caution: The Engineer must check the soluble sulfate contents of the soils during design to determine if stabilization with lime can react and induce heave. Sulfate reaction, with either the soil to be stabilized or mixing water used in the stabilization process, may be detrimental to the finished product due to the expansive nature of the sulfate reaction. During the Design Phase, test the soils and water anticipated for inclusion in the stabilized materials for the potential to cause an adverse expansion reaction.

****

155-1 DESCRIPTION

155-1.1 This item consists of constructing one or more courses of a mixture of soil, lime, and water according to this specification, and in conformity with the lines, grades, thicknesses, and typical cross-sections shown on the plans.

Lime treatment is generally performed on clay soils to reduce the plasticity index (PI) to less than 10, and to reduce the Liquid Limit (LL) to less than 30. This increases the optimum water content, allowing soils to dry out more rapidly thus permitting compaction under wet conditions. Secondary benefits are increased strength and stability. The typical lime content required to bring the soil pH to greater than 12 identifies the minimum lime content needed. The amount of lime added depends on whether the lime treatment is to make a stable working platform or if the lime treatment is to increase the strength of the subgrade.

155-2 MATERIALS

155-2.1 Lime.

Quicklime, hydrated lime, and either high-calcium dolomitic, or magnesium lime, as defined by ASTM C51, must conform to the requirements of ASTM C977. Produce the lime from calcining limestone.

155-2.2 Commercial Lime Slurry.

Commercial lime slurry must be a pumpable suspension of solids in water. The water or liquid portion of the slurry must not contain dissolved material injurious or objectionable for the intended purpose. The solids portion of the mixture, must consist principally of hydrated lime of a quality and fineness sufficient to meet the following chemical composition and residue requirements.

155-2.2.1 Chemical Composition.

The “solids content” of the lime slurry must consist of a minimum of 70%, by weight, of calcium and magnesium oxides.

155-2.2.2 Residue.

The percent by weight of residue retained in the “solids content” of lime slurry must conform to the following requirements:

- Residue retained on a No. 6 (3.35 µm) sieve = maximum 0.0%
- Residue retained on a No. 10 (2.00 µm) sieve = maximum 1.0%
- Residue retained on a No. 30 (600 µm) sieve = maximum 2.5%

155-2.2.3 Grade.

Use either Grades 1 or 2 commercial lime slurry.

- Grade 1. The “dry solids content” is at least 31% by weight, of the slurry.
- Grade 2. The “dry solids content” is at least 35%, by weight, of the slurry.

155-2.3 Water.

Use water from potable water sources for mixing and curing. Prior to use, test other sources according to ASTM C1602.

155-2.4 Soil.

The soil for this work consists of on-site materials free of roots, sod, weeds, and stones larger than 2½ inches (60 mm) with a sulfate content of less than 0.3%.

155-3 COMPOSITION

155-3.1 Soil-Lime Mixture.

Apply lime at **[__]** % dry unit weight of soil for the depth of subgrade treatment as shown on the plans. The amount of lime must be sufficient to lower the liquid limit to less than 30 and the PI to less than 10. **[** `The amount of lime must be sufficient to increase the unconfined compressive strength of soil by 50 psi after 48 hours over strength of untreated soil as measured with ASTM D2166.` **]**

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Based on the on the results of the Geotechnical Report, the Engineer specifies the amount of lime sufficient to lower the LL to less than 30 and the PI to less than 10 and depth of treatment.

****

155-3.2 Tolerances.

At final compaction, the lime and water content for each course of subgrade treatment must meet the following tolerances.

Table 155-3.2: Tolerances

Material	Tolerance
Lime	+ 0.5%
Water	+ 2%, -0%

155-4 WEATHER LIMITATIONS

155-4.1 Weather Limitation.

Do not construct subgrade when weather conditions detrimentally affect the quality of the materials. Do not apply lime unless the air temperature is at least 40°F (4°C) and rising. Do not apply lime to soils that are frozen or contain frost. Protect completed lime-treated areas from freezing if the air temperature falls below 35°F (2°C), with methods the Resident Project Representative (RPR) approves. Remove and replace any damaged portion of the completed soil-lime treated area with new soil-lime material according to this specification.

155-5 EQUIPMENT

155-5.1 Equipment.

Provide all equipment necessary to grade, scarify, spread, mix, and compact the material. Prior to the start of treatment, the RPR must approve the Contractor's proposed equipment.

155-6 CONSTRUCTION METHODS

155-6.1 General.

This specification is to construct a subgrade consisting of a uniform lime mixture, free from loose or segregated areas. The subgrade is to be of uniform density and moisture content, well-mixed for its full depth, and have a smooth surface suitable for placing subsequent lifts. Prior to any treatment, construct the subgrade as specified in Item P-152, *Excavation, Subgrade and Embankment*, and shape to the typical sections, lines, and grades as shown on the plans. The mixing equipment must give visible indication at all times that it is cutting, pulverizing and mixing the material uniformly to the proper depth over the full width of the cut.

155-6.2 Application.

Spread lime uniformly. Spread only over an area where the initial mixing operations can be completed during the same workday. Do not apply lime when wind conditions are detrimental to proper application. Do not use a motor grader to spread the lime. Add adequate moisture to the lime/soil mixture to maintain the proper moisture content. Handle, store, and apply materials according to all federal, state, and local requirements.

155-6.3 Mixing.

The mixing procedure follows.

155-6.3.1 Preliminary Mixing.

Using an approved mixing machine, mix the subgrade to be treated with two full depth coverages. Do not leave lime exposed for more than six hours. Add water to the subgrade and lime during mixing to provide a moisture content approximately 3% to 5% above the optimum moisture of the material. After mixing, seal the surface with light rolling to slow the evaporation of moisture. Maintain the water content of the subgrade mixture at or above the optimum moisture content for a minimum of 4 to 24 hours or until the material becomes friable.

155-6.3.2 Final Mixing.

After the required curing time, uniformly mix the material using approved methods. Reduce clods in size by blading, discing, harrowing, scarifying, or using other approved pulverization methods. After curing, pulverize lime treated material until 100% of soil particles pass a 1-inch (25.0 mm) sieve and 60% pass the No. 4 (4.75 mm) sieve when tested dry by laboratory sieves. If resultant mixture contains clods, reduce their size by scarifying, remixing, or pulverization to meet specified gradation.

155-6.4 Control Strip.

Consider the first half-day of construction the control strip. The Contractor must demonstrate, in the RPR's presence, that the materials, equipment, and construction processes meet the requirements of this specification. In addition to the spreading and mixing, the construction of the control strip establishes depth of mixing, moisture content, and the compaction equipment and process to obtain specified requirements. Control strips not meeting the specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor's expense. Do not begin full operations until the RPR accepts the control strip. Upon the RPR's acceptance of the control strip, the Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve, in advance, adjustments to materials, equipment, or procedures.

155-6.5 Treatment Application and Depth Checks.

The depth and amount of stabilization is measured by the Contractor and the RPR witnessed with no less than two tests per day of material placed. Measurements must be made in test holes excavated to show the full mixing depth and the pH checked by spraying the side of the test hole with a pH indicator such as phenolphthalein. Phenolphthalein changes from clear to red between pH 8.3 and 10. The color change indicates the location of the bottom of the mixing zone. pH indicators other than phenolphthalein can be used to measure pH levels. Add additional lime treatment and remix the material if the pH is not at least 8.3 and/or if the depth of the treated subgrade is more than ½ inch (12 mm) deficient. The Contractor must correct all such areas to the RPR's satisfaction.

155-6.6 Compaction.

Compaction of the mixture must be initiated immediately following the final mixing operation and completed within one to four hours after final mixing. During compaction, maintain the moisture content of the material to the limits specified in paragraph 155-3.2. Compact the mixture to a field density at least **[** 95% **]** of the maximum density as specified in paragraph 155-6.10. Perform an in-place density test to determine degree of compaction 24 and 72 hours after final compaction and the 24-hour moist cure period. Rework material that fails to meet the density requirements. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

155-6.7 Finishing and Curing.

After compaction, the lime treated subgrade must meet the lines and grades as indicated on the project plans and typical sections. Finish the completed section rolling with a pneumatic or other suitable roller sufficiently light enough to prevent hairline cracking.

Moist-cure the completed section for a minimum of seven days before further courses are added or any traffic is permitted. Do not expose the final lift of lime treated subgrade for more than 14 days without protection or the placement of a base course material.

155-6.8 Maintenance.

The Contractor must protect and maintain the lime-treated subgrade from yielding until the lime-treated subgrade is covered by placement of the next lift. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, the Contractor must verify that materials still meet all specification requirements, prior to placement of additional material The maintenance cost is incidental to this item.

155-6.9 Surface Tolerance – Grade.

The Contractor is responsible for measuring the grade and crown on a [50 | 25 | 12.5] foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement, and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide final grade checks to the RPR prior to construction of the next pavement layer.

155-6.10 Acceptance Sampling and Testing.

The lime treated subgrade is accepted for density and thickness on an area basis. The lime-treated subgrade is tested a minimum of one compaction and thickness test per [[1200] square yards ([1000] square meters)], but not less than four tests per day of production. Determine sampling locations on a random basis, per ASTM D3665.

155-6.10.1 Density.

All testing is done by [the RPR. | the Contractor’s laboratory in the RPR’s presence and density test results furnished upon completion to the RPR for acceptance determination.]

The field density of the compacted mixture must be at least [95%] of the maximum density of laboratory specimens prepared from samples taken from the material in place. Compact and test specimens according to [ASTM D698 | ASTM D1557] to determine maximum density and optimum moisture content. Determine the in-place field density according to [ASTM D6938, Procedure A, direct transmission method] or [ASTM D7830] or [ASTM D8167 for in place density and [ASTM D4959, | ASTM D8153, | ASTM D4643,] or [ASTM D4944] for moisture]. If the material fails to meet the density requirements, rework and recompact the area represented by the failed test to meet the density requirements. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

May be modified as appropriate to comply with the Geotechnical Engineer's recommendations and/or requirements to achieve a specified strength, etc. Test frequency should reflect a typical day's placement. Recommend not less than one test per 1,000 square yards (840 m^2) or a minimum of four tests per day.

****

155-6.10.2 Thickness.

The thickness of the course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each area. Where the thickness is deficient by more than ½-inch (12 mm), the Contractor must correct such areas at no additional cost. The Contractor must replace, at their expense, material where depth tests have been taken.

155-6.11 Handling and Safety.

The Contractor obtains and enforces the lime supplier's instructions for proper safety and handling of the lime to prevent physical eye or skin contact with lime during transport or application.

155-7 METHOD OF MEASUREMENT

155-7.1 Lime-treated subgrade measured by the square yard (square meter) in the completed and accepted work.

155-7.2 Lime is paid by the number of tons (kg) of Hydrated Lime applied at the application rate specified in paragraph 155-3.1.

155-7.2.1 Hydrated Lime delivered to the project in dry form is measured according to the actual tonnage either spread on the subgrade or batched onsite into a slurry, whichever is applicable.

155-7.2.2 Quicklime delivered to the project in dry form is measured for payment based on the tons of equivalent hydrated lime using the following formula:

Equivalent Hydrated Lime ($Ca(OH)_2$) = Total Quicklime (CaO) × 1.32

155-7.2.3 Lime delivered to the project in slurry form is measured for payment in tons **[** `kg` **]**, dry weight of hydrated lime, or equivalent hydrated lime according to paragraph 155-7.2.2.

155-8 BASIS OF PAYMENT

155-8.1 Payment is made at the contract unit price per square yard (square meter) for the lime-treated subgrade at the thickness specified. The price is full compensation for furnishing all material, except the lime, and for all preparation, delivering, placing, and mixing these materials, and all labor, equipment, tools, and incidentals necessary to complete this item.

155-8.2 Payment is made at the contract unit price per ton (kg). This price is full compensation for furnishing, delivery, and placing this material.

Payment is made under:

Item P-155-8.1	Lime-treated subgrade - per square yard (square meters)
Item P-155-8.2	Lime - per pound (kg)

155-9 REFERENCES

155-9.1 This list of publications forms 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 C51	*Standard Terminology Relating to Lime and Limestone (as used by the Industry)*
ASTM C977	*Standard Specification for Quicklime and Hydrated Lime for Soil Stabilization*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
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 D2166	*Standard Test Method for Unconfined Compressive Strength of Cohesive Soil*
ASTM D2487	*Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*
ASTM D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*

ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

Software

FAARFIELD	*FAA Rigid and Flexible Iterative Elastic Layered Design*

END OF ITEM P-155

Item P-157 [Cement | Cement Kiln Dust (CKD) | Lime Kiln Dust (LKD)] Treated Subgrade

****

Cement stabilization works best with granular soils combined with granular pavement material. Coarse grained soils which conform to ASTM D2487 classified as GW, GP, GM, GC, SW, SM, SC, SP and/or combination(s), generally may be cement stabilized.

Lime kiln dust (LKD) or cement kiln dust (CKD) works with fine grained or granular soils. In areas susceptible to freeze-thaw, provide a drainage layer over the stabilized layer. LKD/CKD work is like using lime + cement, where you lower the plasticity index (PI) and achieve strength gains.

Stabilization with cementitious materials results in a stabilized subgrade layer that may be used under either a flexible or rigid pavement structure. The objective of stabilization is to reduce the PI of the soil, increase the strength, and reduce shrink-swell potential.

Cement is generally added at 3-5%, and LKD or CKD is typically added at 4-7%. To allow for field variations, content is generally increased by 1-2% over the design criteria. A minimum 12-inch (300 mm) layer is needed to consider this layer as an improved subgrade in FAARFIELD. See AC 150/5320-6, Chapter 2. Use laboratory tests to establish what long-term strength to assign to the stabilized layer.

Kiln dust is not readily available throughout the U.S. The Engineer must confirm an adequate supply is available prior to advertisement.

Caution: The Engineer must check the soluble sulfate content of the soils during design to determine if stabilization reacts and induces heave. Sulfate reaction, with either the soil to be stabilized or mixing water used in the stabilization process, may be detrimental to the finished product due to the expansive nature of the sulfate reaction. During the Design Phase, test the soils and water anticipated for inclusion in the stabilized material for the potential to cause an adverse expansion reaction.

****

157-1 DESCRIPTION

157-1.1 This item consists of constructing one or more courses of a mixture of soil, stabilizer, and water according to this specification, and in conformity with the lines, grades, thickness, and typical cross-sections shown on the plans.

157-2 MATERIALS

157-2.1 [Cement | Cement Kiln Dust (CKD) |Lime Kiln Dust (LKD].

[Cement must conform to the requirements of ASTM C150, Type I, IA, II, or IIA or ASTM C595, Type IS, IL, IP, or IS(A).| Cement kiln dust must contain a minimum of 40% CaO, a maximum of 6% SO3, and be capable of providing the soil modification specified for this project. The Contractor must identify sources and the RPR must approve in advance of stabilization operations.

Store and handle cement kiln dust in closed waterproof containers until immediately before distribution. Discard cement kiln dust exposed to moisture prior to mixing with soils.]

[**Cement kiln dust (CKD).** Cement kiln dust must contain a minimum of 40% CaO, a maximum of 6% SO3, and be capable of providing the soil modification specified for this project. Sources must be identified and approved in advance of stabilization operations.

Cement kiln dust must be stored and handled in closed waterproof containers until immediately before distribution. Cement kiln dust exposed to moisture prior to mixing with soils must be discarded.]

[**Lime Kiln Dust (LKD).** Use LKD for stabilization that meets the following chemical and physical requirements:

Table 157-2.1: LKD Properties

LKD Properties	%
Total Calcium & Magnesium Oxides (non-volatile basis) minimum	60%
Available Calcium Hydroxide (ASTM C25) plus total MgO content to be equivalent to $CaOH_2$; minimum	30%
Free Water (as received); maximum	4%
Loss on Ignition (as received, carbon dioxide plus moisture, combined and free); maximum	40%

Store and handle lime kiln dust in closed waterproof containers until immediately before distribution. Discard lime kiln dust exposed to moisture prior to mixing with soils.]

157-2.2 Water.

Use water from potable sources for mixing or curing. Test other sources according to ASTM C1602 prior to use.

157-2.3 Soil.

Use soil from with a sulfate content of less than 0.3% from on-site materials that is free of roots, sod, weeds, and stones larger than 2½ inches (60 mm).

157-3 COMPOSITION

157-3.1 Mixture.

Add [cement | kiln dust] at an application rate of [__] percent dry unit weight of soil.

****

A stabilized subgrade layer is the result of stabilization with cementitious materials for use under either a flexible or rigid pavement structure. The objective of stabilization is to reduce the PI of the soil, increase the strength, and reduce shrink-swell potential. LKD or CKD is typically added at 4-7%.

Cement is typically added at 3-5% and LKD or CKD is typically added at 4-7%. To allow for field variations, LKD/CKD content is generally increased by 1-2% over the design criteria.

****

157-3.2 Tolerances.

At final compaction, the cement | kiln dust] and water content for each course of subgrade treatment must conform to the following tolerances.

Table 157-3.2: Tolerances

Material/Properties	Target	Tolerance	Specifications
[cement | Kiln Dust]	[__]%	0 to +2%	% Total Dry Materials
Moisture Content	Optimum	0% to 4%	[ASTM D698 | ASTM D1557]
Plastic Index	< [__]	None	ASTM D4318

****

Enter the appropriate values as identified in paragraph 157-3.1.

****

157-4 WEATHER LIMITATIONS

157-4.1 Weather Limitation.

Do not construct subgrade when weather conditions detrimentally affect the quality of the materials. Do not apply [cement | kiln dust] unless the air temperature is at least 40°F (4°C) and rising. Do not apply [cement | kiln dust] to soils that are frozen or contain frost. Do not apply [cement | kiln dust] when conditions are too windy to allow even distribution of the [cement | kiln dust] to the subgrade. If the air temperature falls below 35°F (2°C), protect completed [cement | kiln dust] treated areas by methods the RPR approves. Remove and replace any damaged portion of the completed soil-[cement | kiln dust] treated area according to this specification.

157-5 EQUIPMENT

157-5.1 Equipment.

Prior to the start of treatment, the RPR must approve the contractor's equipment necessary to grade, scarify, spread, mix, and compact the material.

157-6 CONSTRUCTION METHODS

157-6.1 General.

Prior to any treatment, construct the subgrade as specified in Item P-152, *Excavation, Subgrade, and Embankment.* The machine must give visible indication, at all times, it is cutting, pulverizing, and mixing the material uniformly to the proper depth over the full width of the cut.

157-6.2 Application.

Only spread [cement | kiln dust] over an area where the initial mixing operations and compaction can be completed during the same workday. Do not apply [cement | kiln dust] when wind conditions are detrimental to proper application. Maintain the moisture of the [cement | kiln dust] soil mixture as specified in paragraph 157-3.2. Handle, store, and apply, materials according to all federal, state, and local requirements.

157-6.3 Mixing Procedure.

Mix the treated subgrade full depth with equipment the RPR approved. Do not leave [cement | kiln dust] exposed for more than one hour after distribution. Continue mixing until the mixture contains no clods greater than 1½ inches (38 mm) in size. Prior to compaction, the Contractor must determine the final moisture content of the mix according to ASTM D2216 or ASTM D4959.

157-6.4 Control Strip.

Consider the first half-day of construction the control strip. The Contractor must demonstrate, in the RPR's presence, that the materials, equipment, and construction processes meet the requirements of this specification. In addition to the spreading and mixing, the construction of the control strip establishes depth of mixing, moisture content, and the compaction equipment and compaction process obtain specified requirements. Control strips not meeting the specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor's expense. Do not begin full operations until the RPR accepts the control strip. Upon the RPR's acceptance of the control strip, the Contractor must use the same equipment, materials, and construction methods for the remainder of construction, adjustments to materials, equipment or procedures must be approved by the RPR advance.

157-6.5 Treatment Application and Depth Checks.

The Contractor must monitor the amount of [`cement` | `kiln dust`] applied to ensure that no less than the amount specified in paragraph 157-3.1 is applied. The Contractor, with the RPR as a witness, must make a minimum of two test holes per day to measure the depth of stabilization.

157-6.6 Compaction.

Maintain the moisture content within the tolerance as specified in paragraph 157-3.2. The field density of the compacted mixture must be at least [`95%`] of the maximum density as specified in paragraph 157-6.10. [`Start compaction of the` [`cement` | `CKD`] `layer within 30 minutes of the start of moist mixing.` | `Start compaction of LKD layer within one to four hours from the start of moist mixing.`] Complete all compaction operations within [`2 hours` | `3-7 hours`] from the start of mixing. Perform in-place density test immediately after completion of compaction to determine compaction. If the material fails to meet the density requirements, compaction must continue, or remove and replace the material. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

Note: CKD behaves more like cement stabilization. Begin compaction within thirty (30) minutes of mixing and complete within two hours. LKD behaves more like lime stabilization and requires a mellowing period of one to four hours after mixing and then compaction should be completed.

****

157-6.7 Finishing and Curing.

After the final lift or course of treated subgrade is compacted, trim to the lines and grades according to the project plans. Protect finished portions of treated subgrade from marring, deformation, or similar damage by construction equipment.

Cure the surface of the treated subgrade within 24 hours after completion of final finishing, [with an application of emulsified asphalt | by being kept continuously moist for a period of 7 days with a fog-type water spray]. Protect the treated subgrade from freezing for at least seven days after construction unless otherwise approved by the RPR.

157-6.8 Maintenance.

The Contractor must maintain the entire treated subgrade in good condition from the start of work until the RPR verifies and accepts the work as cured and complete. The Contractor must verify that materials still meet all specification requirements when exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material. The cost is incidental to this item.

157-6.9 Surface Tolerance – Grade.

The Contractor is responsible for measuring the grade and crown on a [50 | 25 | 12.5] foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement, and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide final grade checks to the RPR prior to construction of the next pavement layer.

157-6.10 Acceptance Sampling and Testing.

Treated subgrade is accepted for density and thickness on an area basis with a minimum of one compaction and thickness test per [[1200] square yards | [1000] m²] of stabilized subgrade, but not less than four tests per day of production. Sampling locations are determined on a random basis per ASTM D3665.

157-6.10.1 Density.

The [RPR performs all density tests | Contractor’s laboratory performs all density tests in the RPR’s presence and provide the test results upon completion to the RPR for acceptance].

Each area is accepted for density when the field density is at least [95%] of the maximum density of laboratory specimens compacted and tested per [ASTM D1557 | ASTM D698]. The in-place field density is determined per [[ASTM D6938 using Procedure A, the direct transmission method. ASTM D6938 is used to determine the moisture content of the material. Calibrate the machine according to ASTM D6938] or [ASTM D7830] or [ASTM D8167 for in place density] and [ASTM D4959], [ASTM D8153], [ASTM D4643], or [ASTM D4944] for moisture].

****

The Engineer may specify ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). The Engineer specifies ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

May be modified as appropriate to comply with the Geotechnical Engineer's recommendations and/or requirements to achieve a specified strength, etc.

Test frequency should reflect typical day's placement. Recommend not less than one test per 1,000 square yards (840 m^2) or a minimum of four tests per day.

****

157- 6.10.2 Thickness.

The thickness of the treated subgrade must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each area. Where the thickness is deficient by more than ½-inch (12 mm), the Contractor must 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 blended and recompacted to grade. The Contractor replaces, base material where the Contractor took tests, at their expense.

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after placement of the base. Base the survey interval on the project's size since cement/CKD/LKD mixed in place survey for thickness may not be practicable.

****

157-7 METHOD OF MEASUREMENT

157-7.1 [The amount of treated subgrade is the number of square yards [square meters] complete and accepted.]

[The amount of [cement | cement kiln dust | lime kiln dust] used is based upon the application rate as determined in paragraph 157-3.1. The amount of [cement | cement kiln dust | lime kiln dust] is measured by the number of tons (kg) of [cement | cement kiln dust | lime kiln dust] used in the completed and accepted work. The price is full compensation for all preparation, delivering, placing, and mixing these materials, and all labor, equipment, tools, and incidentals necessary to complete this item.]

****

Select the method of measurement and associated basis of payment and delete the other option.

****

157-8 BASIS OF PAYMENT

157-8.1 [Payment is made at the contract unit price per square yard for the [cement | cement kiln dust | lime kiln dust] treated subgrade for the thickness specified. The price is full compensation for furnishing all material, and for all preparation, delivering, placing, and mixing these materials, and all labor, equipment, tools, and incidentals necessary to complete this item.]

[Payment for kiln dust is made at the contract unit price per ton [kg].]

Payment is made under:

Item P 157-8.1	[Kiln dust treated subgrade per square yard (square meter)]
	[Kiln dust per ton [kg]]

157-9 REFERENCES

157-9.1 This list of publications forms 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 C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D558	*Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures*
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 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 D2216	*Test Methods for Laboratory Determination of Water (Moisture) Soil and Rock by Mass*
ASTM D2487	*Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*
ASTM D4318	*Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils*
ASTM D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

END OF ITEM P-157

Item P-158 Coal Ash Treated Subgrade

****

Class C coal ash works to modify fine-grained or granular soils. In areas susceptible to freeze-thaw, provide a drainage layer sover the modified layer.

Coal ash treated subgrade is generally used to create a stable work platform. Coal ash quickly dries a wet soil. Often, coal ash is used just to dry the subgrade to create a working platform. A minimum 12-inch (300 mm) layer and laboratory testing are required to consider a structural benefit to treatment with coal ash. Class C coal ash is typically added at 7-15% by dry weight. To allow for field variations the field coal ash content is generally increased by 2-3% over the design criteria.

Caution: The Engineer must check the soluble sulfate contents of the soils during design to determine if modification can react and induce heave. Sulfate reaction, with either the soil to be modified or mixing water used in the modification process, may be detrimental to the finished product due to the expansive nature of the sulfate reaction. During the Design Phase, test soils and water anticipated for inclusion in the modified material for the potential to cause an adverse expansion reaction.

****

158-1 DESCRIPTION

158-1.1 This item consists of constructing one or more courses of a mixture of soil, coal ash, and water according to this specification, and in conformity with the lines, grades, thicknesses, and typical cross-sections shown on the project plans.

158-2 MATERIALS

158-2.1 Coal Ash.

Coal ash must meet ASTM C618. Sample and test the coal ash according to ASTM C311. The Contractor must identify, and the Resident Project Representative (RPR) approve, the source of the coal ash in advance of modification operations. Handle and store coal ash in closed weatherproof containers until immediately before distribution. Dispose of coal ash exposed to moisture prior to mixing with soils.

158-2.2 Water.

Use water from potable sources for mixing or curing. Test other sources prior to use according to ASTM C1602.

158-2.3 Soil.

The soil consists of on-site materials and free of roots, sod, weeds, and stones larger than 2½ inches (60 mm) with a sulfate content of less than 0.3%.

158-3 COMPOSITION

158-3.1 Coal Ash.

Apply coal ash at **[** `12` **]** percent dry weight, to a depth of **[** `12` **]** inches of subgrade treatment.

****

This paragraph should specify the amount of coal ash and the depth to be incorporated to achieve the results recommended by the Geotechnical Engineer. Typically coal ash is applied at 7-15%. Add 2-3% over design criteria to allow for field variations.

Samples for determination of coal ash content should be from material which represent the final placement of material to be treated. The coal ash content should be sufficient at target design, so the liquid limit of the soils is reduced, the PH is increased, and an increase in bearing capacity is achieved.

****

158-3.2 Tolerances.

Maintain the coal ash and water content for each course of subgrade treatment during compaction to the following tolerances.

Table 158-3.2: Tolerances

Material	Target	Tolerance	Specifications
Coal ash	[__] %	0 to + 2%	% Total Dry Materials
Moisture Content	Optimum	0 to +2%	**[** `ASTM D698` **|** `ASTM D1557` **]**

****

Enter the appropriate values as identified in paragraph 157-3.1.

****

158-4 WEATHER LIMITATIONS

158-4.1 Weather Limitation.

Do not construct subgrade when weather conditions detrimentally affect the quality of the materials. Do not apply coal ash unless the air temperature is at least 40°F (4°C) and rising. Do not apply coal ash to soils that are frozen or contain frost. If the air temperature falls below 35°F (2°C), protect completed coal ash-treated areas by approved methods against the detrimental effects of freezing.

158-5 EQUIPMENT

158-5.1 Equipment.

The RPR must approve the contractors proposed equipment necessary to grade, scarify, spread, mix, and compact the material.

158-6 CONSTRUCTION METHODS

158-6.1 General.

Prior to any treatment, construct the subgrade as specified in Item P-152, *Excavation, Subgrade and Embankment*, and shape to conform to the typical sections, lines, and grades as shown on the project plans. The machine must give visible indication at all times that it is cutting, pulverizing and mixing the material uniformly to the proper depth over the full width of the cut.

158-6.2 Application.

Spread coal ash uniformly over an area where the initial mixing and compaction operations can be completed within the same workday. Do not apply coal ash when wind conditions are detrimental to proper application. Do not use motor graders to spread the coal ash. Maintain adequate moisture in the coal ash/soil mixture. Handle, store, and apply materials according to all federal, state, and local requirements.

158-6.3 Mixing.

Mix the full depth of the treated subgrade with equipment as approved by the RPR. Do not leave coal ash exposed for more than one hour after distribution. Continue mixing and pulverization until the mixture contains clods no greater than 1½ inches (38 mm) in size. The Contractor must determine the final moisture content of the mix prior to compaction according to ASTM D2216 or ASTM D4959.

158-6.4 Control Strip.

Consider the first half-day of construction as the control strip. The Contractor must demonstrate, in the RPR’s presence, that the materials, equipment, and construction processes meet the requirements of this specification. In addition to spreading and mixing, the construction of the control strip establishes depth of mixing, the moisture content, the compaction equipment, and compaction process obtain specified requirements. Control strips not meeting specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor's expense. Do not begin full operations until the RPR accepts the control strip. Upon the RPR's acceptance of the control strip, the Contractor must use the same equipment, materials, and construction methods for the remainder of construction, adjustments to materials, equipment, or procedures and the RPR approved in advance.

158-6.5 Treatment Application and Depth Checks.

The Contractor must monitor the amount of coal ash applied to ensure that no less than the amount specified in paragraph 158-3.1 is applied. The Contractor must measure the depth of modification, no less than two tests per day of material placed. The RPR must witness the test. Take measurements in the excavated test holes to show the full depth of mixing.

158-6.6 Compaction.

During compaction, the moisture content is as specified in paragraph 158-3.2. The field density of the compacted mixture must be at least **[** `95%` **]** of the maximum density as specified in paragraph 158-6.10. Begin compaction of the coal ash - soil mixture within **[** `30 minutes` **]** after mixing the coal ash into the subgrade. Complete all compaction operations within **[** `2 hours` **]** from the start of mixing. Perform in-place density tests to determine degree of compaction. If the material fails to meet the density requirements, compaction must continue or the material must be removed and replaced. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

158-6.7 Finishing and Curing.

After compacting the final lift or course of treated subgrade, bring it to the required lines and grades according to the typical sections. Protect finished portions of treated subgrade from marring, permanently deforming, or damaging completed work. Provide protection from freezing for at least seven days after construction or as the RPR approved.

158-6.8 Maintenance.

The Contractor must maintain the coal ash treated subgrade in good condition until the RPR accepts all completed work. The Contractor must verify that materials still meet all specification requirements when material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material. The cost is incidental to this item.

158-6.9 Surface Tolerance – Grade.

The Contractor is responsible for measuring the grade and crown on a **[** `50` **|** `25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement, and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide final grade checks to the RPR prior to construction of the next pavement layer.

158-6.10 Acceptance Sampling and Testing.

Coal ash treated subgrade is accepted for density and thickness on an area basis. Testing frequency is a minimum of one compaction and thickness test per [[1200] square yards | [1000] m^2] of stabilized subgrade, but not less than four tests per day of production. Determine sampling locations must on a random basis per ASTM D3665.

158-6.10.1 Density.

The [RPR performs all density tests | Contractor's laboratory performs all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance].

The field density of the compacted mixture must be at least [95%] of the maximum density as determined by ASTM [D698 | ASTM D1557]. Each area is accepted for density when the field density is at least [95%] of the maximum density of laboratory specimens compacted and tested per ASTM [D1557 | D698]. Determine the in-place field density per [ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material. Calibrate the machine according to ASTM D6938] or [ASTM D7830] or [ASTM D8167 for in place density and [ASTM D4959], [ASTM D8153], [ASTM D4643], or [ASTM D4944] for moisture]. 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. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

May be modified as appropriate to comply with the Geotechnical Engineer's recommendations and/or requirements to achieve a specified strength, etc.

Test frequency should reflect typical day's placement. Recommend not less than one test per 1,000 square yards (840 m^2) or a minimum of four tests per day.

The Engineer specifies ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). The Engineer specifies ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

****

158-6.10.2 Thickness.

The thickness of the base course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests the Contractor takes in the RPR's presence for each area. Where the thickness is deficient by more than ½-inch (12 mm), the Contractor must correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding and compacting to grade. The Contractor must replace, at their expense, base material where depth tests have been taken.

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after base placement. Base the survey interval on the project's size. However, since coal ash mixed in place, generally it is not practical to determine thickness by survey.

****

158-7 METHOD OF MEASUREMENT

158-7.1 **[** Coal ash treated subgrade is measured by the number of square yards (square meters) completed and accepted. **]**

[Coal ash is paid for by the number of tons (kg) of coal ash to achieve the application rate specified in paragraph 158-3.1. **]**

158-8 BASIS OF PAYMENT

158-8.1 **[** Payment is made at the contract unit price per square yard (square meter) for the coal ash treated subgrade at the specified thickness. The price is full compensation for furnishing all material, except the coal ash, and for all preparation, delivering, placing, and mixing these `materials, and all labor, equipment, tools, and incidentals, necessary to complete this item.` **]**

[`Payment is made at the contract unit price per pound (kg) of coal ash. This price is full compensation for furnishing this material; for all delivery, placing and incorporation of this material; and for all labor, equipment, tools, and incidentals, necessary to complete this item.` **]**

Payment is made under:

Item P-158-8.1	**[** `Coal ash treated subgrade per square yard (square meter)` **]**
	[`Coal ash per ton (kg)` **]**

158-9 REFERENCES

This list of publications forms 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 C311	*Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete*
ASTM C618	*Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*
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 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 C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D1883	*Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils*
ASTM D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*

ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

END OF ITEM P-158

Part 4 – Aggregate Subbase and Base Courses

Item P-204 Subbase Course

****

- **Item P-204 (referred to as Item P-154 in prior specifications) can be used as a subbase under flexible and rigid pavements.**
- **Many State Highway Departments of Transportation (DOT) granular subbase materials meet the requirement for Item P-204. It is acceptable to adjust the P-204 gradations to match the State DOT gradations but use the construction and acceptance requirements of Item P-204. The gradations of Item P-204 may be modified to meet locally available aggregates so long as the finished subbase has a CBR of at least 20. Adjustments of gradation are not considered a MOS.**
- **Item P-204 material is a subbase course that provides a long-term performance equal to or better than a California Bearing Ratio (CBR) of 20.**

****

204-1 DESCRIPTION

204-1.1 This item consists of a subbase course composed of granular materials constructed on a prepared subgrade or underlying course according to these specifications and conforming with the dimensions and typical cross-section shown on the plans.

204-2 MATERIALS

204-2.1 Materials.

The subbase material consists 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 of virgin or recycled aggregate, or produced from a crushing and screening plant with proper blending. Materials from these sources must meet the requirements for gradation, quality, and consistency. The subbase material must exhibit a CBR value of at least 20 when tested according to ASTM D1883. The subbase material must meet the gradation specified in Table 204-2.1.

****

Excessive amounts of recycled asphalt pavement (RAP) and/or recycled concrete pavement (RCO) may not be capable of compaction into a dense, stable subbase.

When non-frost susceptible material is required, reduce the maximum allowable material passing the No. 200 (75 µm) sieve from 0-15% to 0-10%, and the limit the amount passing the 0.02mm sieve to no more than 3%. The Engineer should reference the geotechnical report.

****

Table 204-2.1: Subbase Gradation Requirements

Sieve designation	Percentage by weight passing sieves		Contractor's Final Gradation	Job Control Grading Band Tolerances[1] (Percent)
	Subbase Aggregate	Recycled pavement (RAP or RCO)		
3 inches (75 mm)	100			0
1½ inches (37.5 mm)		100		0
¾ inch (19.0 mm)	70-100	70-100		±10
No. 10 (2.00 mm)	20-100	20-100		±10
No. 40 (425 µm)	5-60	5-60		±5
No. 200[2] (75 µm)	[0-15]	[0-15]		±5

[1] Apply the "Job Control Grading Band Tolerances" to "Contractor's Final Gradation" to establish the job control grading band. The full tolerance still applies if application of the tolerances results in a job control gradation band outside the design range.s

[2] When non frost susceptible material is required, reduce the maximum allowable material passing the No 200 (75µm) sieve to 0-10% and limit the amount passing the 0.02mm sieve to no more than 3%.

The portion of the material passing the No. 40 (425 µm) sieve must have a liquid limit of not more than 25 and a plasticity index of not more than six when tested according to ASTM D4318.

204-2.2 Sampling and Testing.

204-2.2.1 Aggregate Base Materials.

Use samples taken by the Contractor per ASTM D75 for laboratory testing to verify that the aggregate meets requirements as specified in paragraph 204-2.1. As a minimum, test material for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons. The Contractor must submit certified test results to the Resident Project Representative (RPR) showing that the aggregate meets the Material requirements of this section. Use material representative of material to be used for the project for Tests.

204-2.2.2 Gradation Requirements.

The Contractor must take at least [one] aggregate subbase sample per day in the RPR's presence to check the final gradation. Take samples per ASTM D3665 from the in-place, un-compacted material at random sampling locations, as the RPR determines. Sampling must be per ASTM D75 and tested per ASTM C136 and ASTM C117. Results must be furnished to the RPR by the Contractor each day during construction. Material must meet the requirements in paragraph 204-2.1.

204-2.3 Separation Geotextile.

[Not used.][Separation geotextile must 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.]

****

The use of a geotextile for separation, to prevent mixing of a subgrade soil and an aggregate subbase/base, is generally appropriate for pavement structures constructed over soils with a California Bearing Ratio greater than 3.

Generally, on airport projects a Class 2 geotextile with a permittivity of 0.02 and maximum average opening size (AOS) of 0.60 mm will be sufficient.

See the American Association of State Highway and Transportation's Official (AASHTO) M288 for additional notes regarding separation geotextiles.

****

204-2.4 Geogrid.

[Not used.]___]

****

Geogrid material acceptance is based on ASTM D4759. Insert specific geogrid property requirements above as necessary to describe salient features of the geogrid.

The use of geogrid must be supported and designed by a Geotechnical Engineer. Federal Aviation Administration's (FAA) thickness design procedures do not currently consider any reductions in pavement structure for the use of any geosynthetics.

The FAA is currently researching the use of geosynthetics with aircraft loadings.

****

204-3 CONSTRUCTION METHODS

204-3.1 General.

Place the subbase course where designated on the plans or as the RPR directed. Shape and thoroughly compact the material within the tolerances specified. Mechanically modify granular subbases which cannot support construction equipment without movement, to the depth necessary to provide stability as the RPR directed. Mechanical modification includes the addition of a fine-grained aggregate to bind the particles of the subbase material sufficiently so the course will not deform under construction equipment traffic.

204-3.2 Preparing Underlying Course.

The surface of the underlying course or subgrade must meet specified compaction and surface tolerances for grade according to Item P-152, **[** `P-155` **|** `P-157` **|** `P-158` **]**.

204-3.3 Control Strip.

The first half-day of subbase construction is considered 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 control strip establishes the equipment and methods to place and spread the material; the lift thickness moisture content; and the sequence and manner of compaction necessary to obtain specified density requirements. The maximum compacted thickness may be increased upon demonstration that the approved equipment and operations will uniformly compact the lift to the specified density. The RPR must approve the material, equipment, and procedures prior to proceeding to full production.

Control strips not meeting specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor's expense. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve any adjustments made by the Contractor to material, equipment, or procedures.

204-3.4 Placement.

Begin placement along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope. Place and spread the material to a uniform thickness and width on the prepared underlying layer using spreader boxes or other devices as the RPR approved. The equipment must have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling material is not permitted. Hauling over the uncompacted base course is not permitted. Do not place material when the underlying course is soft or yielding.

Prior to compaction the material must meet requirements for gradation and moisture. If the material is free draining, establish a minimum moisture content for placement and compaction of the material. Construct in lifts as established in the control strip, but not less than 4 inches (100 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 apply to each lift. Do not cover lifts by subsequent lifts until tests verify that compaction requirements have been met. The Contractor must rework, re-compact, and retest any material placed which does not meet the specifications.

204-3.5 Compaction.

Compact at the moisture content established during the control strip or within a ±2% of optimum moisture. Compact the subbase material to a field density at least **[** `100%` **]** of the maximum density as specified in paragraph 204-3.9.1. If the specified density is not attained, rework and recompact the area of the lift represented by the test prior to performing additional random tests. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

204-3.6 Weather Limitation.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not work on subbase course when the subgrade is wet or frozen or the subbase material contains frozen material.

204-3.7 Maintenance.

Do not place subsequent layers of base or surface course until the RPR accepts the subbase. 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 must 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 must be repaired by the Contractor at their expense.

204-3.8 Surface Tolerance – Grade.

The Contractor is responsible for measuring the grade and crown on a **[** `50` **|** `25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full strength pavement, and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR prior to construction of the next pavement layer.

204-3.9 Acceptance Sampling and Testing.

The aggregate base course is accepted for density and thickness on an area basis. Take two tests for density, moisture, and thickness for each [`1200 square yards (1000 square meters)`]. Determine sampling locations on a random basis per ASTM D3665.

204-3.9.1 Density.

The [`RPR performs all density tests` | `Contractor’s laboratory performs all density tests in the RPR’s presence and provide the test results upon completion to the RPR for acceptance`].

Each area is accepted for density when the field density is at least [`100%`] of the maximum density of laboratory specimens compacted and tested per ASTM [`D1557` | `D698`]. Determine the in-place field density per [`ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material.`] or [`ASTM D8167 for in place density and` [`ASTM D4959`], [`ASTM D8153`], [`ASTM D4643`], `or` [`ASTM D4944`] `for moisture`]. If the specified density is not attained, rework and recompact the area represented by the failed test and make two additional random tests. Follow this procedure 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% retained on the ¾ inch (19.0 mm) sieve, use methods in [`ASTM D698` | `ASTM D1557`] and the procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles.

****

The Engineer may adjust the testing area as appropriate to the job size.

Specify ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). Specify ASTM D1557 for

areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

****

204-3.9.2 Thickness.

[The thickness of the subbase course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each area. The Contractor must replace, at their expense, base material where depth tests have been taken. **]**

[The thickness of the subbase course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course the **[** Contractor **|** RPR **]** must survey the **[** subgrade **]** on a **[** 50 **|** 37.5 **|** 17.5 **|** 12.5 **]** foot grid relative to centerline of base. **]**. After placement of the base, the base surface is surveyed on the same grid and the thickness of base course determined. Where the thickness is deficient by more than ½ inch (12 mm), the Contractor must correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), add new material, blend, and recompact to grade.

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after base placement. Base the survey interval on the project's size.

****

204-4 METHOD OF MEASUREMENT

204-4.1 Subbase course is measured by the number of **[** square yards (square meters) **|** cubic yards (cubic meters) **]** of subbase course material placed and compacted to specified density and thickness requirements in the completed course. The quantity of subbase course material is measured in final position based upon **[** depth tests or cores taken the RPR directs, at the rate of two test per each **[** 1200 square yards (1000 square meters) **]** of subbase course **|** survey of the completed work computed from elevations to the nearest 0.01 foot (3 mm)]. On individual depth measurements, thicknesses more than ½ inch (12 mm), more than that shown on the plans, is considered as the specified thickness. Subbase material is not included in any other excavation quantities.

****

The Engineer may edit method of volume calculations.

****

[**204-4.2** Separation geotextile is measured by the number of [square yards | square meters] of materials placed and accepted by the RPR as complying with the plans and specifications excluding seam overlaps and edge anchoring.]

204-5 BASIS OF PAYMENT

204-5.1 Payment is made at the contract unit price per [square yard (square meter)] for subbase course. This price is 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.

[**204-5.2** Payment is made at the contract unit price per [square yard | square meter] for separation geotextile-Class 2. The price is full compensation for furnishing all labor, equipment, material, anchors, and necessary incidentals.]

Payment is made under:

Item P-204-5.1 Subbase Course - per [square yard (square meter)]

[Item P-204-5.2 Separation geotextile per [square yard | square meter]]

204-6 REFERENCES

204-6.1 This list of publications forms 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 C117	*Standard Test Method for Materials Finer than 75-µm (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 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)*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

American Association of State Highway and Transportation Officials (AASHTO)

M 288	*Geotextile Specification for Highway Applications*

END OF ITEM P-204

Item P-207 Full Depth Reclamation (FDR) Base Course

****

This specification is intended for projects that will utilize recycling operations to reuse existing asphalt pavement and aggregate base course to create a recycled in-place asphalt aggregate base course. Refer to Item P-219 for recycled concrete aggregate base course.
FDR is a viable option to correct the following distresses in flexible pavements:

- **Damaged asphalt pavement that is beyond resurfacing (more than 20% of the pavement requiring full depth patching)**
- **Excessive cracking of all types**
- **Surface deformations such as rutting, shoving, depressions, and patches**
- **Inadequate structural capacity and subgrade instability**
- **Loss of bond between pavement layers**

During the Design Phase the Engineer and Geotechnical Engineer must:

1. **Determine the structure of the existing pavement, and thickness of each layer.**
2. **Determine if the existing asphalt surface must be milled off (how much asphalt as compared to thickness of aggregate layers).**
3. **Determine depth of pulverization (up to 18” possible, but 6”-12” is more common. If greater, depths may need to compact in two lifts). It is recommended to leave sufficient aggregate material above the subgrade to minimize potential mixing of fines into the FDR material. Excessive fines in FDR material may compromise the quality of the FDR material.**
4. **Determine if mechanical or chemical stabilization is required, and if so, what type and how much stabilizing agent will be used. Stabilization will improve the ultimate stiffness of the FDR material. Stabilization often has benefits of providing a more stable material for construction of subsequent pavement layers. If material is to be used where traffic is > 60K then stabilization is required.**
5. **Determine the gradation requirements and laboratory CBR of the recycled material. Recommend auger samples to get material for laboratory analysis. Recommend DCP on subgrade to estimate subgrade strength. Note: if subgrade is too weak, e.g., CBR < 5 then subgrade may not be able to support the recycling equipment.**

Item P-207 may be used as a base course under flexible and rigid pavements when pavement loads are 60,000 lbs (27216 kg) or less, or when used as a base when chemically stabilized.

Item P-207 may be used under pavement loads greater than 60,000 lbs and less than 100,000 lbs (45,360 kg) if laboratory tests verify that it can achieve a CBR greater than 80.

A MOS is necessary when Item P-207 is used under pavement loads greater than 100,000 lbs ((45,360 kg).

Prior to full production, construction of a control strip is required to demonstrate the equipment and process to be used to pulverize, mix, spread, and compact the FDR material.

****

207-1 DESCRIPTION

207-1.1 This item consists of a recycled asphalt aggregate base course resulting from the in-place FDR of the existing pavement section (asphalt wearing surface and aggregate base), plus stabilization with additional aggregate or chemicals (cement, asphalt emulsion or coal ash) when required.

207-2 MATERIALS

207-2.1 Aggregate.

The FDR base consists of materials produced by recycling (pulverizing and mixing) the existing asphalt pavement, aggregate base, and any additional aggregate or chemical stabilizers as necessary. Material larger than three inches in any dimension is not permitted in the FDR base course. The FDR base course must meet the gradation in Table 207-2.1.

Table 207-2.1: Contractor’s Final Gradation

Sieve	Contractor’s Final Gradation	Minimum Percentage by weight passing sieves
3 inch (76 mm)		100
2 inch (51 mm)		[95-100]
No. 4 (4.75 mm)		[45-55]
No. 200 (75 µm)		[0-15][1]

[1] Limit the percent passing the No 200 to 0-5% in areas of frost.

****

The gradations may be modified to reflect the gradations proposed by the geotechnical investigations and laboratory testing.

****

207-2.1.1 Deleterious Substances.

Materials for FDR base must not contain weeds, sticks, grass, roots, or other foreign matter.

207-2.1.2 Uniformity.

Thoroughly pulverize and mix the material to ensure a well-graded FDR base.

207-2.2 Stabilization.

207-2.2.1 Mechanical Stabilization.

`[ Not required. |Use aggregate material with quality equivalent or better than P-209 to adjust the gradation. ]`

207-2.2.2 Chemical Stabilization.

`[ Cement must meet the requirements of ASTM C150, ASTM C595, or ASTM C989. |Coal ash must meet the requirements of ASTM C618. |Emulsified asphalt cement must meet the requirements of ASTM D977. |Stabilizing agent is not required. ]`. Handle, store, and apply materials according to all federal, state, and local requirements.

207-2.3 Water.

Water from a drinking water source is suitable for mixing and curing. If water is taken from other sources, it must meet the requirements of ASTM C1602.

207-2.4 Sampling and Testing.

207-2.4.1 Corrective Aggregate Materials.

Use samples taken by the Contractor per ASTM D75 for laboratory testing to verify that the material meets requirements as specified in paragraph 207-2.1. The Contractor must submit certified test results to the Resident Project Representative (RPR) showing that the material meets the requirements of this section.

207-2.4.2 Gradation Requirements.

The Contractor must take at least [`two`] samples of the FDR base, after pulverization and incorporation of any corrective aggregate, if used, but prior to compaction per day in the RPR's presence to check the final gradation. Take samples per ASTM D3665 from the in-place, un-compacted material at random sampling locations. Sampling must be per ASTM D75 and tested per ASTM C136 and ASTM C117. Results must be furnished to the RPR by the Contractor each day during construction. Material must meet the requirements in paragraph 207-2.1.

****

The Engineer defines if additional sampling and testing is needed.

****

207-3 CONSTRUCTION METHODS

207-3.1 Milling.

[Milling is not required. | Mill the existing asphalt pavement to a depth of [__] inches below surface grade.]

207-3.2 Control Strip.

Consider the first half-day of construction the control strip. The Contractor must demonstrate, in the RPR's presence, that the materials, equipment, and construction processes meet the requirements of this specification. The control strip establishes the target speed and/or revolutions per minute (RPM) of the reclaimer and spreading equipment, the depth of cut and mixing, the moisture content, the amount and type of stabilizing agent, if required, and the sequence and manner of rolling necessary to obtain the specified density requirements. Control strips not meeting specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor's expense. Do not begin full operations until the RPR accepts the control strip. Upon the RPR's acceptance of the control strip, the Contractor must use the same equipment, materials, and construction methods for the remainder of construction, unless the RPR approves adjustments made by the Contractor in advance.

207-3.3 Recycling (Pulverization and Mixing).

Recycle, e.g., pulverize, and mix the existing asphalt pavement, and aggregate base into a uniformly blended mixture with [[4] inches (100 mm) of [P-209] aggregate base | and | [6]% cement | [3] percent of emulsified asphalt | [12]% coal ash | by dry unit weight and water] to the depth indicated on the plans. The FDR mixing is [12 inches (300 mm)]. The Contractor must remove all material over approximately 3 inches (76 mm). Bring the mixture to the desired moisture content.

****

Plans must show depth of cut and be verified during construction of the control strip.

****

207-3.4 Grading and Compaction.

Immediately upon completion of recycling (pulverization and mixing), shape and grade the material according to the project plans. Compact the FDR base course within the same day to an in-place density of [95%] as determined by [ASTM D698 | ASTM D1557 | ASTM D558]. The moisture content of the material during compaction must be within ±2% of the optimum moisture content as determined by ASTM D2216. The number, type, and weight of rollers must be sufficient to compact the material to the required density. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

207-3.5 Finishing [and Curing].

Finish the surface of the aggregate base course by blading or with automated equipment designed for this purpose. If the top layer is more than 0.05 feet (15 mm) below grade, scarify the top layer to a depth of at least 3 inches (75mm), blend in new material, grade, and re-compact.

[Cure the surface of the treated subgrade within 24 hours after completion of final finishing, [with an application of emulsified asphalt | by being kept continuously moist for a period of 7 days with a fog-type water spray]. Provide the treated subgrade from freezing for at least seven days after construction unless otherwise approved by the RPR.]

207-3.6 Proof Rolling.

Proof roll the compacted FDR base course with a [tandem axle dual wheel dump truck loaded to the legal limit with tires inflated to 80 psi (550 kPa) | ___] ton Proof Roller with tires spaced not more than 32 inches (0.8 m) on-center with tires inflated to [[100 (690) | 125 (860) | 150 (1030)] psi (kPa)] in the RPR's presence. At the Contractor's expense, the Contractor must remove and rework all soft areas that deflect greater than 0.5 inch (12 mm) or show permanent deformation greater than 0.5 inch (12 mm).

****

The Engineer selects the proof-rolling method and number of coverages. Proof rollers are not commonly available, so a tandem axle dump truck is generally used for proof rolling.

****

207-3.7 Weather Limitations.

Stop construction when weather conditions affect the construction process and/or quality of the materials. Do not apply cement or coal ash when wind conditions affect the distribution of the materials. Stop construction when the aggregates contain frozen materials or when the underlying course is frozen or wet. Do not perform construction unless the atmospheric temperature is above 35°F (2°C) and rising or the RPR approved. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

207-3.8 Maintenance.

The Contractor must maintain the FDR base course in a satisfactory condition until the RPR accepts the work. Equipment used in the construction of an adjoining section may be routed over completed sections of FDR base course, provided that no damage results and equipment is routed over the full width of the completed FDR base course. The Contractor must repair any damage to the FDR base course at the Contractor's expense.

207-3.9 Surface Tolerances – Grade.

The Contractor is responsible for measuring the grade and crown on a **[** `50` **|** `25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense following paragraph 207-3.5, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must perform final grade checks in the presence of the RPR.

207-3.10 Acceptance Sampling and Testing for Density.

FDR base course is accepted for density and thickness on an area basis. Make two tests for density and one test for thickness. **[** `1200 square yds (1000 square meters)` **]**. Determine sampling locations on a random basis according to ASTM D3665.

207-3.10.1 Density.

The **[** `RPR performs all density tests` **|** `Contractor's laboratory performs all density tests in the RPR's presence and provides the test results upon completion to the RPR for acceptance` **]**.

Each area is accepted for density when the field density is at least **[** `95%` **]** of the maximum density of the FDR base course according to **[** `ASTM D698` **|** `ASTM D1557` **|** `ASTM D558` **]**. The in-place field density is determined according to **[** `ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture` content of the material.] or [ASTM D8167 for in place density and [ASTM D4959], [ASTM D8153], [ASTM D4643], or [ASTM D4944] for moisture]. 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. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer may adjust the testing area as appropriate to the job size.

Specify ASTM D698 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). Specify ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

Specify ASTM D558 for cement stabilized FDR base.

****

207-3.10.2 Thickness.

The thickness of the FDR base course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR’s presence for each area. Where the thickness is deficient by more than ½ inch (12 mm), the Contractor must correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material new material equivalent to Item P-209 or better, and recompacted to grade. The Contractor must replace, at their expense, base material where depth tests have been taken.

207-4 METHOD OF MEASUREMENT

207-4.1 The quantity of FDR base course is measured by the number of square yards (square meters) of material in compliance with the plans and specifications.

207-4.2 [The quantity of emulsified asphalt is measured by the [ton | kg].]

[The quantity of cement is measured by the [ton | kg].]

[The quantity of coal ash is measured by the [ton | kg].]

207-4.3 [The quantity of corrective aggregate material is measured by the [ton | kg | cubic yards | cubic meters].]

207-5 BASIS OF PAYMENT

207-5.1 Payment is made at the contract unit price per square yard (square meters) for recycling the existing asphalt pavement, aggregate base course, subgrade and mixing with stabilizing agent, if required, spreading, compacting, and maintaining the recycled material to the compacted thickness as indicated on the drawings. This price is full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools and incidentals to complete the item.

Payment is made under:

Item P-207-5.1	FDR base course –per square yard (square meters)

207-5.2 Payment is made at the contract unit price per **[** ton (kg) **]** for the stabilizing agent.

Item P-207-5.2	**[** Emulsified asphalt, per **[** ton | kg **]]**
	[Cement, per **[** ton | kg **]]**
	[Coal ash, per **[** ton | kg **]]**
Item P-207-5.3	**[** Corrective aggregate material per **[** ton | kg | cubic yards | cubic meters **]].**

207-6 REFERENCES

207-6.1 This list of publications forms 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 C29	*Unit Weight of Aggregate*
ASTM C88	*Soundness of Aggregates by Use of Sodium or Magnesium Sulfate*
ASTM C117	*Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregate by Washing*
ASTM C136	*Sieve or Screen Analysis of Fine and Coarse Aggregate*
ASTM C150	*Standard Specification for Portland Cement*
ASTM C595	*Standard Specification for Blended Hydraulic Cements*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D75	*Sampling Aggregate*

ASTM D558	*Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures*
ASTM C618	*Standard Specification for Coal Ash and RAW or Calcined Natural Pozzolan for use in Concrete*
ASTM D698	*Moisture Density Relations of Soils and Aggregate using 5.5 lb Rammer and 12-inch drop*
ASTM D977	*Standard Specification for Emulsified Asphalt*
ASTM D1557	*Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort*
ASTM D2216	*Test Methods for Laboratory Determination of Water (Moisture) Soil and Rock by Mass*
ASTM D2419	*Test Method for Sand Equivalent Value of Soils and Fine Aggregate*
ASTM D2487	*Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*
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 D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil by Direct Heating*
ASTM D4751	*Standard Test Methods for Determining Apparent Opening Size of a Geotextile*
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 D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*

ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

American Association of State Highway and Transportation Officials (AASHTO)

M288	*Standard Specification for Geosynthetic Specification for Highway Applications*

END OF ITEM P-207

Item P-209 Crushed Aggregate Base Course

****

Item P-209, Crushed Aggregate Base Course, can be used as a base course under flexible or rigid pavements. See AC 150/5320-6 for additional guidance.

Many State Highway Departments of Transportation (DOT) crushed aggregate materials meet requirements for Item P-209. It is acceptable to adjust the Item P-209 gradations to match the State DOT gradations, but use the construction and acceptance requirements of Item P-209. The gradations of P-209 may be modified to meet locally available aggregates so long as the finished base has a CBR of at least 80 when used as a base, and CBR of at least 100 when used as a stabilized base. Adjustments of gradation are not considered a MOS.

****

209-1 DESCRIPTION

209-1.1 This item consists of a base course composed of crushed aggregate base constructed on a prepared course according to these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

209-2 MATERIALS

209-2.1 Crushed Aggregate Base.

Crushed aggregate base consists of clean, sound, durable particles of crushed stone, crushed gravel, **[** `or crushed slag` **]** 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 must result in the fractured particles in the finished product being as consistent and uniform as practicable. Fine aggregate portion, defined as the portion passing the No. 4 (4.75 mm) sieve, consists of fines from the coarse aggregate crushing operation. The fine aggregate must be produced by crushing stone, gravel, **[** `or slag` **]** that meet the coarse aggregate requirements for wear and soundness. Table 209-2.1 lists aggregate base material requirements.

Table 209-2.1: Crushed Aggregate Base Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate		

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 45% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after five cycles: 12% maximum using sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Percentage of Fractured Particles [3]	Minimum [60% | 90%] by weight of particles with at least two fractured faces and [75% | 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 lbs 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	ASTM D4318

[1] The area of each face must 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 must 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; an elongated particle is one having a ratio of length to width greater than five.

[3] For use under pavements serving aircraft < 60,000 lbs fractured faces can be 60% with two fractured faces and 75% one fractured face. For all other uses, use 100% two fractured faces and 90% one fractured face.

****

Delete bracketed reference to crushed slag in above paragraph and table if slag will not be used in the project.

****

209-2.2 Gradation Requirements.

The gradation of the aggregate base material must meet the requirements of the gradation given in the Table 209-2.2 when tested per ASTM C117 and ASTM C136. The gradation must be well-graded from coarse to fine and not vary from the lower limit on one sieve to the high limit on an adjacent sieve or vice versa.

Table 209-2.2: 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
1½ inch (37.5 mm)	95-100		±5
1 inch (25.0 mm)	70-95		±8
¾ inch (19.0 mm)	55-85		±8
No. 4 (4.75 mm)	30-60		±8
No. 40 (425 µm)	10-30		±5
No. 200 (75 µm)	[`0-10`][2]		±3

[1] Apply the "Job Control Grading Band Tolerances for Contractor's Final Gradation" in the table 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] Limit the percent passing the No. 200 to 0-5% in areas of frost.

****

For areas subject to substantial frost penetration into base and subgrade layers, a separation fabric or separation layer is recommended.

Leave the column titled "Contractor's Final Gradation" blank in the above table.

The Contractor's Final Gradation approved by the Engineer/RPR will be used to populate this column and the "Job Control Grading Band Tolerances for Contractor's Final Gradation" will apply to this column for the project duration, and these limits establish quality control action limits for the Contractor.

****

209-2.3 Separation Geotextile.

[`Not used.` | `Separation geotextile is` [`Class 2`], [`0.02 sec`$^{-1}$] permittivity per ASTM D4491, Apparent opening size per ASTM D4751 with [`0.60 mm`] maximum average roll value.]

****

The use of a geotextile to prevent mixing of a subgrade soil and an aggregate subbase/base is appropriate for pavement structures constructed over soils with a California Bearing Ratio greater than 3.

Generally, on airport projects, a Class 2 geotextile with a permittivity of 0.02 and AOS of 0.6 mm is sufficient.

See AASHTO M288 for additional notes regarding separation geotextiles.

****

209-2.4 Sampling and Testing.

209-2.4.1 Aggregate Base Materials.

The Contractor must take samples of the aggregate base according to ASTM D75 for laboratory testing of aggregate material requirements and gradation. As a minimum, test material for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons. This sampling and testing is the basis for approval of the aggregate base quality requirements. Material must meet the requirements in paragraph 209-2.1. **[__]**

209-2.4.2 Gradation Requirements.

The Contractor must take at least **[** `two` **]** samples of aggregate base per day, per ASTM D75, in the Resident Project Representative’s (RPR) presence to check the final gradation. Material must meet the requirements in paragraph 209-2.2. The samples must be taken from the in-place, un-compacted material at sampling points and intervals the RPR designates.

****

The Engineer may require additional sampling points for quality requirements. The Engineer defines when additional sampling points are needed in the above paragraph.

On large projects and/or projects that span multiple construction seasons, additional aggregate tests may be necessary to validate consistency of aggregate produced and delivered for the project.

****

209-3 CONSTRUCTION METHODS

209-3.1 Control Strip.

The first half-day of base construction is considered 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 control strip establishes the equipment and methods to place and spread the material; the lift thickness, moisture content; and the sequence and manner of compaction necessary to obtain specified density requirements. The maximum compacted thickness may be increased upon demonstration that the approved equipment and operations will uniformly compact the lift to the specified density. The RPR must approve the material, equipment, and procedures prior to proceeding to full production.

Control strips not meeting specification requirements must be reworked, recompacted, or removed and replaced at the Contractor's expense. Do not begin full operations until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve any adjustments made by the Contractor to material, equipment, or procedures.

209-3.2 Preparing Underlying Subgrade and/or Subbase.

Before placing base course, the RPR must check and accept the underlying subgrade and/or subbase. The Contractor must correct any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, before the base course is placed. To ensure proper drainage, begin the spreading of the base 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.

Uniformly blend the aggregate and, when at a satisfactory moisture content per paragraph 209-3.5, transport the approved material directly to the placement.

209-3.4 Placement.

Place and spread the aggregate to a uniform thickness and width on the prepared underlying layer by spreader boxes or other devices as the RPR approved. The equipment has positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling and hauling over the uncompacted base course is not permitted. Prior to compaction, the aggregate must meet gradation and moisture requirements. Construct the base course in lifts as established in the control strip.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedures described here apply to each lift. Do not cover lifts by subsequent lifts until tests verify that compaction requirements are met. The Contractor must 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 with approved compaction equipment. Compact the base course to the required density within the same day that the aggregate is placed on the subgrade, using the equipment and procedures approved in the control strip.

The field density of each compacted lift of material must be at least **[** `100%` **]** of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. Compact and test the laboratory specimens according to **[** `ASTM D1557` **]**. Maintain the moisture content of the material during placement and compaction operations within ±2 percentage points of the optimum moisture content as determined by ASTM **[__]**. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

Material meeting the requirements of Item P-209 may be free-draining, and to achieve compaction may need to be compacted on the wet-side of optimum.

The Engineer specifies ASTM D698 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, ASTM D1557 or D698 has suggested procedures for dealing with oversize material. Use a method procedure for compaction as developed during construction of the control strip.

****

209-3.6 Weather Limitations.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not work on base course when the subgrade or subbase is wet or frozen or the base material contains frozen material.

209-3.7 Maintenance.

Maintain the base course in a condition that meets all specification requirements. Prior to placement of additional material, the Contractor must verify that materials meet all specification requirements when exposed to excessive rain, snow, or freeze-thaw conditions. 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. The Contractor repairs, at their expense, any damage resulting to the base course from routing equipment over the base course.

209-3.8 Surface Tolerances – Grade.

The Contractor is responsible for measuring the grade and crown on a **[** `50` **|** `25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR prior to construction of the next pavement layer.

209-3.9 Acceptance Sampling and Testing.

Crushed aggregate base course is accepted for density and thickness on an area basis. Make two tests for density and thickness for each [`1200 square yds (1000 m²)`]. Sampling locations are determined on a random basis per ASTM D3665.

209-3.9.1 Density.

The [`RPR performs all density tests` | `Contractor's laboratory will perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance`].

Each area is acceptable for density when the field density is at least [`100%`] of the maximum density of laboratory specimens compacted and tested per ASTM [`1557` | `D698`]. Determine the in-place field density per [[`ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material.`] `or` [`ASTM D8167 for in place density and` [`ASTM D4959`], [`ASTM D8153`], [`ASTM D4643`], `or` [`ASTM D4944`] `for moisture`]]. Rework areas where density tests fail must be reworked and/or recompacted and make two additional random tests. Repeat this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer may specify ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). The Engineer specifies ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

****

209-3.9.2 Thickness.

Make depth tests in test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course must be within +0 and -½ inch (12 mm) of the specified thickness, as determined by depth tests taken by the Contractor in the RPR's presence for each area. The Contractor, at no additional cost, must correct areas where the thickness is deficient by more than ½-inch (12 mm), by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation. Blend and recompact the material to grade. The Contractor replaces, at their expense, the base material where the Contractor took depth tests.

[[The thickness of the base course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course the [Contractor | RPR] surveys the [subgrade | subbase] on a [50 | 37.5 | 17.5 | 12.5] foot grid relative to centerline of base]. After placement of the base, the surface of the base is surveyed on the same grid and the thickness of base course determined.]

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after base placement. Base the survey interval on the project's size.

****

209-4 METHOD OF MEASUREMENT

209-4.1 Determine the quantity of crushed aggregate base course by measuring the number of [square yards (square meters) | cubic yards (cubic meters)] of material actually constructed, and the RPR accepted, complying with the plans and specifications. Do not include base materials in any other excavation quantities.

[**209-4.2** Measure separation geotextile by the number of [square yards | square meters] of materials placed and accepted by the RPR, complying with the plans and specifications excluding seam overlaps and edge anchoring.]

209-5 BASIS OF PAYMENT

209-5.1 Make payment at the contract unit price per **[** square yard (square meter) **|**cubic yard (cubic meter) **|**ton (kg) **]** for crushed aggregate base course. This price is 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.

[209-5.2 Make payment at the contract unit price per **[** square yard **|**square meter **]** for separation geotextile. The price is full compensation for furnishing all labor, equipment, material, anchors, and incidentals necessary. **]**

Payment is made under:

Item P-209-5.1	Crushed Aggregate Base Course - per **[** square yard (square meter **|**cubic yard (cubic meter) **|**ton (kg) **]**
[Item P-209-5.2	Separation geotextile per **[** square yard **|**square meter **]]**

209-6 REFERENCES

209-6.1 This list of publications forms 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 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 D1557	*Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2700 kN-m/m*^{3}*))*
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*

END OF ITEM P-209

Item P-210 Caliche Base Course

****

Item P-210 may be used as a base course under flexible and rigid pavements when pavement loads are 60,000 lbs or less, or when used under stabilized bases. The Engineer must verify that the material is readily available in the project area.

****

210-1 DESCRIPTION

210-1.1 This item consists of a base course composed of caliche, caliche-gravel, caliche limestone, or material of similar characteristics, constructed on the prepared underlying course per these specifications and in conformity to the dimensions and typical cross-section shown on the plans.

210-2 MATERIALS

210-2.1 Material consisting of caliche, caliche gravel, or caliche limestone must meet the following gradation when tested per ASTM C136.

Table 210-2.1: Caliche Base Coarse Gradation

Sieve Designation (Square Openings)	Percentage by Weight Passing Sieves
2 inch (50 mm)	100
No. 40 (425 µm)	15-35
No. 200 (75 µm)	0-15

210-2.2 Binder.

Binder is the portion of the material passing a No. 40 (425 µm) sieve. The binder must have a liquid limit (LL) of not more than 35 and a plasticity index (PI) of not more than 10 per ASTM D4318.

[Blend binder material uniformly with the base course material to correct the gradation and/or to provide sufficient fines passing the No. 40 (425 µm) sieve for satisfactory bonding. **]**

****

Need for additional binder (filler) is based on the Geotechnical Engineer's recommendations.

****

210-2.3 Sampling and Testing.

210-2.3.1 Aggregate Base Materials.

The Contractor must take samples of the aggregate base according to ASTM D75 to verify initial aggregate base requirements and gradation. Material must meet the requirements in paragraphs 210-2.1 and 210-2.2. As a minimum, test material for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons. This sampling and testing is the basis for approval of the aggregate base quality requirements. **[__]**

210-2.3.2 Gradation Requirements.

The Contractor must take at least **[** `two` **]** aggregate base samples per day in the Resident Project Representative's (RPR) presence to check the final gradation. Sampling must be per ASTM D75. Material must meet the requirements in paragraphs 210-2.1 and 210-2.2. The lot must be consistent with the lot size used for density. The samples must be taken from the in-place, un-compacted material at sampling points and intervals the RPR designated.

****

The Engineer may require additional sampling points for quality requirements. The Engineer defines when additional sampling points are needed in the above paragraph.

****

210-2.4 Separation Geotextile.

[`Not used.` **|** `Separation geotextile must 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.` **]**

****

The use of a geotextile to prevent mixing of a subgrade soil and an aggregate subbase/base is appropriate for pavement structures constructed over soils with a California bearing ratio greater than 3.

Generally, on airport projects a Class 2 geotextile with a permittivity of 0.02 and apparent opening size of 0.60 mm is sufficient.

See AASHTO M288 for additional notes regarding separation geotextiles.

****

210-3 CONSTRUCTION METHODS

210-3.1 Control Strip.

The first half-day of construction is considered 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 control strip establishes the equipment and methods to place and spread the material, the lift thickness, the moisture content, and the sequence and manner of compaction necessary to obtain specified density requirements. The maximum compacted thickness may be increased upon demonstration that the approved equipment and operations will uniformly compact the lift to the specified density. The RPR must approve the material, equipment, and procedures prior to proceeding to full production.

Control strips not meeting specification requirements must be reworked, recompacted, or removed and replaced at the Contractor's expense. Do not begin until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve any adjustments made by the Contractor to material, equipment, or procedures.

210-3.2 Preparing Underlying Course.

The RPR must check and accept the underlying subgrade and/or subbase before placing base course. Correct any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, before the base course is placed. To ensure proper drainage, begin spreading the base along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

210-3.3 Placement.

Place and spread the material on the prepared underlying layer by spreader boxes, or other devices the RPR approved, to a uniform thickness and width. The equipment must have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling, and hauling over the uncompacted base course, are not permitted.

The material must meet gradation and moisture requirements prior to compaction. Construct the layer in lifts as established in the control strip, but not less than 4 inches (100 mm) or 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 applies to each lift. Do not cover any lift by subsequent lifts until tests verify that compaction meets requirements. The Contractor must rework, re-compact, and retest any material placed which does not meet the specifications.

210-3.4 Compaction.

Immediately after completion of the spreading operations, compact each layer of the base course with approved compaction equipment. Compact the base course 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 must be at least **[** `100%` **]** of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. Compact and test the laboratory specimens according to **[** `ASTM D1557` **]**. Maintain the moisture content of the material during placement and compaction operations within ±2 percentage points of the optimum moisture content as determined by ASTM **[__]**. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

Specify either ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, ASTM D1557 or D698 has suggested procedures for dealing with oversize material.

Proof rolling is required when a method specification is used for compaction.

****

210-3.5 Finishing.

Finish the surface of the base course blading or other approved equipment designed for this purpose. It is not permitted to add thin layers of material to the top layer of base course to meet grade. If the elevation of the top layer is ½ inch (12 mm) or more below grade, the top layer of base must be scarified to a depth of at least 3 inches (75 mm), new material added, and the layer blended and recompacted to bring it to grade at the Contractor’s expense. If the finished surface is above plan grade, it must be cut to grade and rerolled.

210-3.6 Weather Limitations.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not work on base course when the subgrade or subbase is wet or frozen or the base material contains frozen material.

210-3.7 Maintenance.

Maintain the base course in a condition meeting all specification requirements until the RPR accepts the work. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor must 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. The Contractor must repair any damage resulting to the base course from routing equipment over the base course at the Contractor's expense.

210-3.8 Surface Tolerance – Grade.

The Contractor is responsible for measuring the grade and crown on a **[** `50` **|**`25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR prior to construction of the next pavement layer.

210-3.9 Acceptance Sampling and Testing.

Caliche base course will be accepted for thickness and density on an area basis. Make two tests for density and thickness for each **[** `1200 square yds (1000 m2)` **]**. Determine sampling locations on a random basis per ASTM D3665.

210-3.9.1 Density.

The **[** `RPR performs all density tests` **|** `Contractor's laboratory performs all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance` **]**.

Each lot is acceptable for density when the field density is at least **[** `100%` **]** of the maximum density of laboratory specimens compacted and tested per ASTM **[** `D1557` **|**`D698` **]**. Determine the in-place field density per **[** `ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material.` **]** or **[** `ASTM D8167 for in place density and` **[** `ASTM D4959` **]**, **[** `ASTM D8153` **]**, **[** `ASTM D4643` **]**, or **[** `ASTM D4944` **]** `for moisture` **]**. 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. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer may adjust the testing area as appropriate to the job size.

The Engineer may specify ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). The

Engineer specifies ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

****

210-3.9.2 Thickness.

Make depth tests in test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each area. Where the thickness is deficient by more than ½-inch (12 mm), the Contractor must 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 blending and recompacting the material recompacted to grade. The Contractor replaces base material where depth tests have been taken, at no additional cost.

[[The thickness of the base course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course the [Contractor | RPR] survey the [subgrade | subbase] on a [50 | 37.5 | 17.5 | 12.5] foot grid relative to centerline of base.]. After placement of the base, the surface of the base is surveyed on the same grid and the thickness of base course determined.]

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after base placement. Base the survey interval on the project's size.

****

210-4 METHOD OF MEASUREMENT

210-4.1 The quantity of caliche base course is the number of [square yards (square meters | cubic yards (cubic meters)] of base course material placed, bonded, and accepted in the completed base course. Measure the quantity of base course material in final position, [based upon depth tests or cores taken by the Contractor as the RPR directed. | based on the average end areas on the complete work computed from elevations to the nearest 0.01 foot (3 mm)]. On individual depth measurements, thickness more than ½ inch (12 mm) exceeding that shown on the plans is considered as specified thickness, plus ½ inch (12 mm) in computing the yardage for payment. Do not include base material in any other excavation quantities.

****

The Engineer may modify the above measurement paragraph to permit the thickness acceptance determination by a survey before and after placement of the base. The survey interval should be specified based on the project's size. Delete this sentence if surveys are not permitted.

****

[**210-4.2** Separation Geotextile will be measured by the number of [square yards | square meters] of materials placed and accepted by the RPR as complying with the plans and specifications excluding seam overlaps and edge anchoring.]

210-5 BASIS OF PAYMENT

210-5.1 Payment is made at the contract unit price per [square yards (square meters | cubic yard (cubic meter)] for caliche base course. This price is full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

[**210-5.2** Payment is made at the contract unit price per [square yard | square meter] for separation geotextile. The price is full compensation for furnishing all labor, equipment, material, anchors, and incidentals necessary.]

Payment is made under:

Item P-210-5.1	Caliche Base Course - per [square yards (square meters) | cubic yard (cubic meter)]
[Item P-210-5.2	Separation geotextile per [square yard | square meter]]

210-6 REFERENCES

210-6.1 This list of publications forms 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 C136	*Standard Test Method for Sieve or Screen 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 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 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 D4751	*Standard Test Methods for Determining Apparent Opening Size of a Geotextile*
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)

M288	*Standard Specification for Geosynthetic Specification for Highway Applications*

END OF ITEM P-210

Item P-211 Lime Rock Base Course

****

Item P-211 may be used under flexible and rigid pavements.

****

211-1 DESCRIPTION

211-1.1 This item consists of a base course composed of lime rock constructed on the prepared underlying course per these specifications and must conform to the dimensions and typical cross-section shown on the plans.

211-2 MATERIALS

211-2.1 The lime rock base course material consists of fossiliferous limestone of uniform quality. The material must not contain hard or flinty pieces that cause a rough surface containing pits and pockets. The rock must not show any tendencies to “air slake” or undergo a chemical change when exposed to the weather. When watered, the material must be able to compact to a dense and well-bonded base.

Table 211-2.1a: Lime Rock Base Course Material Properties [2]

	Oolitic	Non-Oolitic
Carbonates of calcium and magnesium [1]	70% minimum	70% minimum
Oxides of iron and aluminum[1]	Less than or equal to 2%	Less than or equal to 2%
Liquid limit	NA	Not greater than 35
Plasticity Index	NA	Not greater than 6
Organic or foreign matter [3]	Not more than 0.5%	Not more than 0.5%
Lime Bearing Ratio (LBR) [4]	125	125

[1] The combined amount of carbonates, oxides, and silica must be at least 97%. Use non-plastic material.

[2] Determining the chemical analysis of lime rock consists of determining the insoluble silica, iron oxide, and alumina by solution of the sample in hydrochloric (HCl) acid, evaporating, dehydrating, re-dissolving the residue, and neutralizing with ammonium hydroxide, filtering, washing, and igniting the residue lime rock. The difference between the percentage of insoluble matter and 100% is reported as carbonates of calcium and magnesium.

[3] Tested according to AASHTO T267.

[4] FM 5-515, Florida Method of Test for Lime Rock Bearing Ratio.

Table 211-2.1b: Lime Rock Base Course Gradation

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
3-½ inch (87.5 mm)	100
¾ inch (19.0 mm)	50-100

All fine material must consist entirely of dust of fracture (fine portion passing the No. 10 (2.00 mm) sieve).

211-2.2 Sampling and Testing.

211-2.2.1 Aggregate Base Materials.

The Contractor takes samples of the aggregate base according to ASTM D75 to verify initial aggregate base requirements and gradation. Material must meet the requirements in paragraph 211-2.1. As a minimum, test material for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons. This sampling and testing is the basis for approval of the aggregate base quality requirements. **[__]**

211-2.2.2 Gradation Requirements.

The Contractor takes at least **[** `two` **]** aggregate base samples, per day, in the Resident Project Representative’s (RPR) presence to check the final gradation. Sample per ASTM D75. Material must meet the requirements in paragraph 211-2.1. The samples must be taken from the in-place, un-compacted material at sampling points and intervals the RPR designates.

****

The Engineer may require additional sampling points for quality requirements. The Engineer must define when additional sampling points are needed in the above paragraph.

****

211-2.3 Separation Geotextile.

[`Not used.` **|** `Separation geotextile is` **[** `Class 2, 0.02 sec`$^{-1}$ **]** `permittivity per ASTM D4491, Apparent opening size per ASTM D4751 with` **[** `0.60 mm` **]** `maximum average roll value.` **]**

****

The use of a geotextile to prevent mixing of a subgrade soil and an aggregate subbase/base is appropriate for pavement structures constructed over soils with a California Bearing Ratio greater than 3.

Generally, on airport projects, a Class 2 geotextile with a permittivity of 0.02 and AOS of 0.6 mm is sufficient.

See AASHTO M288 for additional notes regarding separation geotextile.

****

211-3 CONSTRUCTION METHODS

211-3.1 Control Strip.

The first half-day of construction is considered the control strip. The Contractor must demonstrate, in the RPR’s presence, that the materials, equipment, and construction processes meet the requirements of this specification. The control strip establishes the equipment and methods to place and spread the material, the lift thickness, the moisture content, and the sequence and manner of compaction necessary to obtain specified density requirements for the thickness of material placed. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor’s demonstration that the 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.

Rework, recompact, remove, and replace control strips not meeting the specification requirements at the Contractor’s expense. Full operations must not begin until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The Contractor must get the RPR’s approval of any adjustments to equipment, material, or construction methods, prior to implementation.

211-3.2 Preparing Underlying Course.

The RPR must check and accept the underlying subgrade and/or subbase, before placing base course. Correct any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause before the base course is placed. To ensure proper drainage, begin spreading the base along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

211-3.3 Placement.

Place and spread the material to a uniform thickness and width on the prepared underlying layer by spreader boxes or other devices as the RPR approved. The equipment must have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling and hauling over the uncompacted base course are not permitted.

The material must meet gradation and moisture requirements prior to compaction. Construct the layer in lifts as established in the control strip, but not less than 4 inches (100 mm) or more than 12 inches (300 mm) of compacted thickness. When more than one lift is required, the construction procedures described apply to each lift. Verify that compaction requirements have been met prior to placement of subsequent lifts. The Contractor must rework, re-compact, and retest any material placed which does not meet the specifications.

211-3.4 Compaction.

Immediately after completion of the spreading operations, compact each layer of the base course with approved compaction equipment. Compact the base course 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 must be at least **[** `100%` **]** of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. Compact and test the laboratory specimens according to **[** `ASTM D1557` **]**. Maintain the moisture content of the material during placement and compaction operations within ±2 percentage points of the optimum moisture content as determined by ASTM **[__]**. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer specifies ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, ASTM D1557 or D698 has suggested procedures for dealing with oversize material.

Proof rolling is required when a method specification is used for compaction.

****

211-3.5 Finishing.

After the watering and rolling of the base course, scarify the entire surface to a depth of at least 3 inches (75 mm) and shaped to the exact crown and cross-section with a blade grader. The scarified material must be rewetted and thoroughly rolled. Continue rolling until the base is bonded and compacted to a dense, unyielding mass, true to grade and cross-section. Scarifying and rolling the surface of the base must follow the initial rolling of the lime rock by not more than four days. When the lime rock base is constructed in two layers, the scarifying of the surface must be to a depth of 2 inches (50 mm).

If cracks or checks appear in the base before the surface course is laid, the Contractor must rescarify, reshape, water, add lime rock where necessary, and recompact. If the underlying material becomes mixed with the base course material, the Contractor, without additional compensation, removes, reshapes, and recompacts the mixture.

211-3.6 Weather Limitations.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not work on base course when the subgrade or subbase is wet or frozen or the base material contains frozen material.

211-3.7 Maintenance.

Maintain the base course in a condition meeting all specification requirements until the work is accepted by the RPR. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, 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 must be repaired by the Contractor at the Contractor's expense.

211-3.8 Surface Tolerance – Grade.

The Contractor is responsible to measure the grade and crown on a [`50` | `25` | `12.5`] foot (15-m) grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR prior to construction of the next pavement layer.

211-3.9 Acceptance Sampling and Testing.

Lime rock base course is to be accepted for density and thickness on an area basis. Make two tests for density and one test for thickness [`1200 square yds (1000 m²)`]. Determine sampling locations on a random basis per ASTM D3665.

211-3.9.1 Density.

The [`RPR performs all density tests` | `Contractor's laboratory will perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance`].

Each area is acceptable for density when the field density is at least [`100%`] of the maximum density of laboratory specimens compacted and tested per ASTM [`D1557` | `D698`]. Determine the in-place field density per [`ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material. Calibrate the machine according to ASTM D6938.`] or [`ASTM D7830`] or [`ASTM D8167 for` in place density and [ASTM D4959], [ASTM D8153], [ASTM D4643], or [ASTM D4944] for moisture]. If the specified density is not attained, the entire area must be reworked and/or recompacted and two additional random tests made. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer specifies ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

****

211-3.9.2 Thickness.

[Make depth tests by test holes or cores at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each area.] The Contractor replaces, at their expense, base material where the Contractor took depth tests.

[[The thickness of the base course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course the [Contractor | RPR] will survey the [subgrade | subbase] on a [50 | 37.5 | 17.5 | 12.5] foot grid relative to centerline of base.] After placement of the base, the surface of the base is surveyed on the same grid and the thickness of base course determined.]

Where the thickness is deficient by more than ½-inch (12 mm), the Contractor corrects 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 blending and compacting the material to grade.

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after

base placement. Base the survey interval on the project's size. and the nature of the pavement.

****

211-4 METHOD OF MEASUREMENT

211-4.1 The quantity of lime rock base course is the number of **[** square yards (square meters) **|** cubic yards (cubic meters) **]** of base material placed, bonded, and accepted in the completed base course. The quantity of base course material is measured in final position **[** based upon depth tests taken as the RPR directed. **|** by means of average end areas on the complete work computed from elevations to the nearest 0.01 foot (3 mm) **].** On individual depth measurements, thicknesses more than ½ inch (12 mm) exceeding that shown on the plans are considered as the specified thickness plus ½ inch (12 mm) in computing the yardage for payment.

[211-4.2 Measure separation geotextile by the number of **[** square yards **|** square meters **]** of materials placed, and the RPR accepted, as complying with the plans and specifications excluding seam overlaps and edge anchoring. **]**

****

The Engineer selects the method of measurement.

****

211-5 BASIS OF PAYMENT

211-5.1 Payment is to be made at the contract unit price per **[** square yards (square meters) **|** cubic yard (cubic meter) **]** for lime rock base course. This price is full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

The cost of removing cracks and checks including the labor, and the additional lime rock necessary for crack elimination, will not be paid for separately but is included in the contract price per **[** square yard (square meter) **|** cubic yard (cubic meter) **]** for lime rock base course.

[211-5.2 Payment is made at the contract unit price per **[** square yard **|** square meter **]** for separation geotextile. The `price is full compensation for furnishing all labor, equipment, material, anchors, and incidentals necessary.` **]**

Payment is made under:

Item P-211-5.1	Lime rock base course per **[** `square yard (square meter)` **|** `cubic yard (cubic meter)` **]**
[`Item P-211-5.2`	`Separation geotextile per` **[** `square yard` **|** `square meter` **]]**

211-6 REFERENCES

211-6.1 This list of publications forms 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 C136	*Standard Test Method for Sieve or Screen 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 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 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 D4751	*Standard Test Methods for Determining Apparent Opening Size of a Geotextile*
ASTM D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil By Direct Heating*

ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

American Association of State Highway and Transportation Officials (AASHTO)

M288	*Standard Specification for Geosynthetic Specification for Highway Applications*

END OF ITEM P-211

Item P-212 Shell Base Course

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Item P-212 may be used under flexible and rigid pavements when pavement loads are 60,000 lbs (27,200 kg) or less, or when used under stabilized bases. The Engineer may specify this item if the FAA approved and the material is readily available.

****

212-1 DESCRIPTION

212-1.1 General.

This item consists of a base course, per these specifications, composed of shell and binder constructed on a prepared underlying course to the dimensions and typical cross-section shown on the plans.

212-2 MATERIALS

212-2.1 Shell Base.

The shell must consist of durable particles of oyster or clam shell. The base material consists of oyster shell, together with an approved binder or filler material, blended or processed to produce a uniform mixture complying with the specifications for gradation, soil constants, and compaction capability. Clam shell may be used only in combination with oyster shell in the proportion up to and including 50%.c The shell must be reasonably clean and free from excess amounts of clay or organic matter such as leaves, grass, roots, and other objectionable foreign material. The gradation of the blended or processed material must meet the requirements of the gradation given in the following table, when tested per ASTM C136.

Table 212-2.1: Shell Base Coarse Gradation

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
3 inch (75 mm)	100
¾ inch (19.0 mm)	60-90
No. 4 (4.75 mm)	15-55
No. 200 (75 µm)	0-15

Soil binder is the portion of the material, including the blended filler, passing a No. 40 (425 µm) mesh sieve. The soil binder must have a liquid limit of not more than 25 and a plasticity index (PI) of not more than eight as determined by ASTM D4318. The Contractor blends or combines materials so that the final processed material meets all the specifications. The Contractor makes modifications in materials and methods necessary to produce a material can be compacted into a dense, well-bonded base without an excess of soil binder.

212-2.2 Filler for Blending.

If filler, in addition to that naturally present in the base course material, is necessary for satisfactory bonding of the material, or for changing the soil constants of the material passing the No. 40 (425 µm) mesh sieve, or for correcting the gradation, blend it uniformly with the base course material on the pavement or at the plant. Obtain the material from sources approved by the Resident Project Representative (RPR).

212-2.3 Sampling and Testing.

212-2.3.1 Aggregate Base Materials.

The Contractor takes samples of the aggregate base according to ASTM D75 to verify initial aggregate base requirements and gradation. Material must meet the requirements in paragraphs 212-2.1 and 212-2.2. As a minimum, test material for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons. This sampling and testing is the basis for approval of the aggregate base quality requirements. **[__]**

212-2.3.2 Gradation Requirements.

The Contractor must take at least **[** two **]** aggregate base samples, per day, in the RPR's presence to check the final gradation. Sampling is per ASTM D75. Material must meet the requirements in paragraphs 212-2.1 and 212-2.2. Take the samples from the in-place, un-compacted material at sampling points and intervals the RPR designated.

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The Engineer may require additional sampling points for quality requirements. The Engineer defines when additional sampling points are needed in the above paragraph.

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212-2.4 Separation Geotextile.

[Not used. **]** Separation Geotextile must 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. **]**

****

The use of a geotextile to prevent mixing of a subgrade soil and an aggregate subbase/base is appropriate for pavement structures constructed over soils with a California Bearing Ratio greater than 3.

Generally, on airport projects, a Class 2 geotextile with a permittivity of 0.02 and AOS of 0.6 mm is sufficient.

See AASHTO M288 for additional notes regarding separation geotextiles.

****

212-3 CONSTRUCTION METHODS

212-3.1 Control Strip.

Consider the first half-day of construction the control strip. The Contractor must demonstrate, in the RPR's presence, that the materials, equipment, and construction processes meet the requirements of this specification. The control strip establishes the equipment and methods to place and spread the material, the lift thickness, the moisture content, and the sequence and manner of compaction necessary to obtain specified density requirements for the thickness of material placed. 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.

Rework, recompact, remove, or replace control strips not meeting the specification requirements at the Contractor's expense. Do not continue full operations until the RPR accepts the control strip. The Contractor will use the same equipment, materials, and construction methods for the remainder of construction, unless the RPR approves Contractor adjustments.

212-3.2 Preparing Underlying Course.

Before placing base course, the RPR must check and accept the underlying subgrade and/or subbase. Correct any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, before the base course is placed. To ensure proper drainage, begin spreading the base along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

212-3.3 Placement.

Place and spread the aggregate on the prepared underlying layer by spreader boxes or other devices as the RPR approved, to a uniform thickness and width. The equipment must have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling is not permitted. Hauling over the uncompacted base course is not permitted.

The aggregate must meet gradation and moisture requirements prior to compaction. Construct the subbase course in lifts as established in the control strip, but not less than 4 inches (100 mm) or 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 applies to each lift. No lift is covered by subsequent lifts until tests verify the lift met compaction requirements. The Contractor reworks, re-compacts, and retests any material placed which does not meet the specifications.

212-3.4 Compaction.

Immediately after completion of the spreading operations, thoroughly compact the base course. The number, type, and weight of rollers must be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade. The moisture content of the material at the start of compaction must be within ±2 percentage points of the optimum moisture content as determined by ASTM **[__]**. The field density of the compacted material must be at least **[** `100%` **]** of the maximum density of laboratory specimens prepared from samples of the base material. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer specifies ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

****

210-3.5 Finishing.

Finish the surface of the base course by blading or other approved equipment designed for this purpose. Adding thin layers of material to the top layer of base course to meet grade is not permitted. If the elevation of the top layer is ½-inch (12 mm) or more below grade, scarify the top layer of base to a depth of at least 3 inches (75 mm), new material added, and the layer blended and recompacted to bring it to grade, at the Contractor's expense. If the finished surface is above plan grade, cut it to grade and reroll.

212-3.6 Weather Limitations.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not conduct work on base course when the subgrade or subbase is wet or frozen or the base material contains frozen material.

212-3.7 Maintenance.

Maintain the base course in a condition that meets all specification requirements until the RPR accepts the work. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor must 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 is repaired by the Contractor at the Contractor's expense.

212-3.8 Surface Tolerance – Grade.

The Contractor is responsible to measure the grade and crown on a [50 | 25 | 12.5] foot (15-m) grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full-strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR prior to construction of the next layer.

212-3.9 Acceptance Sampling and Testing.

Shell base course will be accepted based upon density and thickness on the area basis. Make two tests for density and thickness for each [1200 square yds (1000 m²)]. Determine sampling locations on a random basis per ASTM D3665.

212-3.9.1 Density.

The [RPR performs all density tests | Contractor's laboratory performs all density tests in the RPR's presence and provides the test results upon completion to the RPR for acceptance].

Each area is accepted for density when the field density is at least [100%] of the maximum density at ±1-1/2 percentage points of the optimum moisture content of laboratory specimens compacted and tested, per ASTM [D1557 | D698]. The in-place field density is determined per [[ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material. Calibrate The machine according to ASTM D6938] or [ASTM D7830] or [ASTM D8167 for in place density and [ASTM D4959], [ASTM D8153], [ASTM D4643], or [ASTM D4944] for moisture]. 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. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer specifies ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

The Engineer may adjust the testing area as appropriate to the job size.

****

212-3.9.2 Thickness Control.

Make depth tests by test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course must be within +0 and -½ 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 ½-inch (12 mm), the Contractor corrects 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 blending the recompacting the material to grade. The Contractor replaces, at their expense, base material where the Contractor took depth tests.

[The thickness of the base course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course the **[** Contractor **|** RPR **]** will survey the **[** subgrade **|** subbase **]** on a **[** 50 **|** 37.5 **|** 17.5 **|** 12.5 **]** foot grid relative to centerline of base **]**. After placement of the base, the surface of the base is surveyed on the same grid and the thickness of base course determined. **]**

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The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after placement of the base. Base the survey interval on the project's size.

****

212-4 METHOD OF MEASUREMENT

212-4.1 The quantity of shell base course is the number of **[** square yards (square meters) **|** cubic yards (cubic meters) **]** of base course material placed, bonded, and accepted in the completed base course. The quantity of base course material is measured in final position [based upon depth tests or cores taken by the Contractor as the RPR directed. |by means of average end areas on the complete work computed from elevations to the nearest 0.01 foot (3 mm)]. On individual depth measurements, thicknesses more than ½ inch (12 mm) more than that shown on the plans is considered as specified thickness, plus ½ inch (12 mm) in computing the yardage for payment. Do not include base materials in any other excavation quantities.

[**212-4.2** Separation geotextile is measured by the number of [square yards |square meters]of materials placed and the RPR accepted as complying with the plans and specifications excluding seam overlaps and edge anchoring.]

212-5 BASIS OF PAYMENT

212-5.1 Payment is made at the contract unit price per [square yards (square meters) |cubic yard (cubic meter)] for shell base course. This price is full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

[**212-5.2** Payment is made at the contract unit price per [square yard |square meter]for separation geotextile. The price is full compensation for furnishing all labor, equipment, material, anchors, and incidentals necessary.]

Payment is made under:

Item P-212-5.1	Shell Base Course - per [square yards (square meters) |cubic yard (cubic meter)]
[Item P-212-5.2	Separation Geotextile per [square yard |square meter]]

212-6 REFERENCES

212-6.1 This list of publications forms 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 C136	*Standard Test Method for Sieve or Screen Analysis of Fine and Coarse 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 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 D4318	*Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*
ASTM D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

END OF ITEM P-212

Item P-215 Rubblized Concrete Pavement Base Course

215-1 DESCRIPTION

215-1.1 General Description.

This work consists of a rubblized concrete pavement base course resulting from the in-place rubbilization and compaction of an existing cement concrete pavement. The work must be accomplished according to the standard specifications and details shown in the plans.

215-2 MATERIALS

215-2.2 Asphalt Mix Pavement.

Asphalt Mix for patching is as described in Item P-401.

215-2.3 Crushed Aggregate Base.

Crushed aggregate base course for patching is as described in Item P-209.

215-2.4 Unclassified Excavation.

Unclassified excavation for patching is the volume of materials removed according to Item P-152. The volume of material is determined according to Item P-152.

215-3 CONSTRUCTION METHODS

215-3.1 Control Strip.

215-3.8.1 Before the rubblization operations begin, the RPR designates a test section of approximately 150 feet by 12 feet (50 meters by 3.6 meters). The Contractor must demonstrate the equipment and process to be used to break, rubblize, seat, compact, and finish the rubblization of the concrete slab, eliminating all slab action. It may be necessary to use varying degrees of energy and/or various striking heights to establish a rubblization procedure that meets the requirements of this specification (75% of particles less than 3 inches (76 mm) on the surface and no particles larger than 1.25 times the slab thickness in the bottom half.)

215-3.8.2 Test Pit.

Excavate a 4-foot (1.2-meter) square test pit in the middle of the test strip, at a location the RPR selected, to determine that the breaker is producing particles that meet the specifications. Check the rubblized particle sizes throughout the entire depth of the pavement. Fill the test pit with coarse aggregate or other material, as approved by the RPR. The Contractor places and properly compacts the replacement material.

215-3.8.3 Project Rubblization Procedure.

The RPR and Contractor mutually agree upon the rubblization procedure with the control strip. Use the established procedure to rubblize the remainder of the pavement. The Contractor continuously monitors the rubblization operation, and makes minor adjustments in the striking pattern, striking energy, number of passes, and other factors necessary to continually achieve acceptable breaking throughout the project. The Contractor informs the RPR of any major adjustments required in the process to provide rubblized pavement conforming to the specification requirements. The RPR may require additional test pits to confirm that the PCC pavement is adequately rubblized.

215-3.2 Rubblization and Seating Equipment.

Accomplish rubblization by using a pavement breaker machine capable of delivering sufficient energy to rubblize the pavement full depth in a manner that eliminates all slab action. Seating equipment must be used to settle and seat the rubblized concrete and to provide a smooth surface for the wearing surface. The type of rubblization machine and the types of associated rolling equipment used in the rubblization process must be either the resonant breaker process or the multi-head breaker process. The Contractor may pre-fracture with a guillotine breaking device.

Rubblization machines and rollers of other design that accomplishes similar results may be used with the RPR's approval. All rubblization and seating equipment necessary to perform the work is considered essential to the completion of the project and is not paid for separately.

215-3.3 Resonant Breaker Process.

215-3.3.1 Resonant Breaker Machine.

This is a self-contained, self-propelled, resonant frequency breaker specifically designed for the purpose of rubblizing PCC pavement. The machine must be able to produce low amplitude blows of approximately 2000 lbs (8.9 kilonewtons) force and delivering blows to the existing concrete surface at a rate of not less than 44 cycles per second. If necessary, the breaker must be equipped with a screen to protect nearby structures, vehicles, or aircraft from flying chips during the fracturing process.

215-3.3.2 Resonant Breaker Seating Equipment.

The Contractor provides and uses a vibratory steel drum roller. The roller must have a gross weight of at least [`10 tons (9.1 metric tons)`] and be operated in vibratory mode, to settle and seat the rubblized pavement and provide a smooth surface for the next pavement layer.

215-3.4 Multi-head Breaker Process.

215-3.4.1 Multi-Head Breaker Machine.

This is a self-contained, self-propelled, multi-head breaker specifically designed for the purpose of rubblizing PCC pavement. The machine must be able to rubblize the pavement a minimum width of 13 feet (3.9 meters) per pass. Pavement- breaking hammers must be mounted laterally in pairs, with half the hammers in a forward row and the remainder diagonally offset in a rear row so there is continuous breakage from side to side. The lift height of the hammers must be independently adjustable.

215-3.4.2 Multi-Head Breaker Seating Equipment.

The Contractor provides and uses the following seating equipment.

215-3.4.3 Z-Grid Roller.

This is a vibratory steel drum roller fitted with a "Z" pattern grid on the drum face. The roller must have a gross weight of at least 10 tons (9.1 metric tons), as operated in the vibratory mode, to further fracture particles at the surface and to settle and seat the rubblized pavement, and provide a smooth surface for the bituminous concrete overlay.

215-3.4.4 Pneumatic-Tire Roller.

A pneumatic-tire roller with a gross weight of at least **[** `25 tons (22.7 metric tons)` **]** must be used after the Z-grid roller to further settle and seat the rubblized pavement.

****

A 10-ton pneumatic roller is typically specified for PCC pavements with thicknesses ranging from eight to twelve inches. A larger roller, up to 25 tons (22.7 metric tons), may be required to properly seat rubblized material resulting from very thick pavements. A smaller pneumatic tire roller may be necessary for use on light duty pavements or pavement with very poor subgrades.

****

215-3.4.5 Smooth Steel Drum Vibratory Roller.

The Contractor provides and uses a smooth steel drum vibratory roller. The roller must have a gross weight of at least 10 tons (9.1 metric tons) as operated in the vibratory mode, to settle and seat the rubblized pavement and provide a smooth surface for the bituminous concrete overlay.

215-3.5 Construction Requirements.

215-3.5.1 Drainage System Installation.

Prior to rubblization operations, install drainage systems as specified on the plans. Drainage systems must properly function for a minimum of two weeks prior to rubblization.

215-3.5.2 Removal of Existing Asphalt Surfaces.

Prior to the rubblization operations, remove existing asphalt overlays and patches from the PCC pavement surfaces to be rubblized. Existing full-depth asphalt patches remain in place unless the RPR directed removal.

215-3.5.3 Saw-Cut Joints.

Make a new full-depth saw-cut joint along an existing joint at all pavements where rubblized PCC abuts pavement to remain in place. Sever all load transfer devices between the planned rubblization and PCC pavement remaining in place.

215-3.5.4 Shouldering.

Complete shoulder adjustments and/or any pavement widening up to the elevation of the existing pavement grade prior to beginning the rubblization operations. These areas can be used to support the rubblization machines while the existing PCC pavement is being rubblized.

215-3.6 Rubblization Criteria.

215-3.6.1 Rubblize the concrete pavement into particles with at least 75% smaller than: 3 inches (75 mm) at surface, based on visual observation, and no particles larger than 1.25 times the slab thickness.

215-3.6.2 For reinforced reinforced concrete pavement, reinforcing steel must be substantially de-bonded from the concrete. Steel may be left in place, unless protruding above the surface. Reduce concrete pieces below the reinforcing steel to the greatest possible extent, individual pieces must not exceed 1.25 times the slab thickness, but not more than 15 inches (380 mm).

215-3.7 Rubblization Procedures.

215-3.7.1 Rubblize in partial widths when necessary to maintain traffic, as shown on the plans, and contained in the contract documents. When the rubblization process is adjacent to active pavement, take measures to prevent debris from entering the active pavement. In areas where the pavement is to be overlayed prior to completion of the rubblization, extend the initial rubblization a minimum of 2 feet (600 mm) beyond the width of the pavement to be overlayed.

215-3.7.2 For the resonant breaker process, begin rubblizing at a free edge or previously broken edge and progress toward the opposite shoulder or longitudinal centerline of the pavement until the entire concrete pavement surface has been rubbilized. Additional passes of the resonant breaker machine are required if larger concrete pieces remain above the reinforcement.

215-3.7.3 Dust Control.

The Contractor must control the dust from the rubblization operation until the rubblized surface is overlayed with bituminous concrete.

215-3.7.4 Damage to Base and Underlying Infrastructure.

Operate the rubblization machine and rollers in a manner that avoids damaging the base, underlying structures, utilities, drainage facilities, bridge approach slabs, bridge decks, and other facilities on the project. If any damage occurs, the Contractor immediately ceases operations, notifies the Engineer, and repairs the damage at the Engineer's direction. The Contractor must make timely repairs at their expense.

215-3.7.5 Removal of Exposed Reinforcing Steel.

Cut reinforcing steel that is exposed flush or slightly below the rubblized surface and remove the project.

215-3.7.6 Removal of Joint Filler and Other Loose Items.

The Contractor removes any loose joint filler, expansion materials, or other similar items.

215-3.7.7 Seating.

Seating of rubblized concrete as specified in paragraph 215-3.9.

215-3.7.8 Patching Unstable Areas.

Patch unstable areas and/or areas of poor subgrade support as identified during the rubblization and seating process at the direction of the RPR. Typically, the rubblized pavement, base course, and subgrade material are removed from unstable areas. Replace the material with aggregate base course or hot mix asphalt as directed by the RPR. Patching procedures must conform to the standard specifications and be completed prior to placing the final surface.

215-3.7.9 Leveling Course

Add a P-209 aggregate leveling course to correct rough or uneven surface as directed by the RPR.

215-3.7.10 Finishing.

Finish the surface of the base course by blading or other approved equipment designed for this purpose. If the elevation of the top layer is ½ inch (12 mm) or more below grade, scarify the top layer of base to a depth of at least 3 inches (75 mm), new material added, and the layer blended and recompacted to bring it to grade, at the Contractor's expense. If the finished surface is above plan grade, cut it to grade and reroll. A milling machine may be used to trim the surface to grade.

215-3.9 Seating Procedures.

The Contractor must use the rolling equipment contained in these specifications. Roll the surface until the rubblized material is compact and the surface is smooth. Additional rolling at the direction of the RPR is considered incidental to the work and is not paid for separately. Do not perform rolling in wet conditions.

215-3.9.1 Resonant Breaker Process.

Roll the rubblized PCC pavement with a minimum of three passes over the entire width of the pavement with a vibratory steel drum roller. For this operation, a pass is defined as forward and back over the entire surface area. The RPR may require additional passes to satisfactorily seat the rubblized pavement and provide a smooth surface that is ready for the bituminous concrete overlay. Do not operate the roller at a speed not to exceed 6 feet (1.8 meters) per second.

215-3.9.2 Multi-Head Breaker Process.

1. Prior to placing the next pavement layer, roll the entire width of the pavement by vibratory and pneumatic-tire rollers following the sequence contained herein. For this operation, a pass is defined as forward and back over the entire surface area.
2. After rubblizing, a minimum of two passes with the Z-grid roller must follow the multi-head breaker machine, followed by a minimum of one pass with the pneumatic-tire roller.
3. Immediately prior to placement of next pavement layer, roll a minimum of one pass with the vibratory steel drum roller.

215-3.10 Progress of the Work

If rain occurs prior to paving, sufficient time must be allowed for the rubblized pavement to dry and become stable. Paving over the rubblized base course must not begin until approved by the RPR.

215-4 METHOD OF MEASUREMENT

215-4.1 Rubblization of concrete pavement is measured by the square yard. Minimize construction traffic on the rubblized material while waiting for the final surface to be placed.

215-4.2 Asphalt mix patching is measured by the ton.

215-4.3 Aggregate patching is measured by the ton.

215-4.4 Drainage system **[** `measured by the linear foot` **|**`not used` **]**.

215-5 BASIS OF PAYMENT

215-5.1 Rubblized Concrete Pavement Base Course.

This item includes full compensation for all labor, equipment, tools, and incidentals necessary to rubblize the existing PCC pavement including:

- Saw cutting
- Breaking
- Rubblizing the existing PCC pavement
- Cutting and removal of reinforcing steel
- Furnish and apply water for dust control
- Provide test sections and test pits
- Saw cut joints
- Cut and remove exposed reinforcing material
- Remove joint filler and other debris
- Cleanup, remove and dispose waste
- Prepare surface prior to placement of next pavement layer

In addition, this item includes full compensation for all labor, equipment, tools, and incidentals necessary to furnish and apply water for dust control, provide test sections and test pits, saw-cut joints, cut and remove exposed concrete reinforcing material, remove joint filler and other debris, cleanup, waste removal and disposal, and preparation of the rubblized surface prior to the bituminous concrete overlay.

Payment is made under:

Item P-215-5.1	Rubblization - per square yard
Item P-215-5.2	Asphalt Mix Patching Material per ton
Item P-215-5.3	Aggregate Patching Material per ton

Item P-215-5.4 Drainage System per liner foot

215-6 REFERENCES

END OF ITEM P-215

Item P-217 Aggregate-Turf Pavement

****

Item P-217 may be used for general aviation taxiways, shoulders, or aprons adjacent to runways accommodating ADG-I and ADG-II aircraft.

****

217-1 DESCRIPTION

217-1.1 This item consists of an aggregate-turf course of soil-bound crushed stone, soil-bound gravel, or soil-bound sand, and a seedbed of suitable soil or combination of soil and aggregate, constructed on a prepared subgrade or a previously constructed underlying course per these specifications.

This item may include the furnishing and applying of fertilizer, lime, top-soil, or other plant nutrients; the furnishing and planting of seed; and the furnishing and spreading of mulch. When any turfing materials are required, the quality, quantity, and construction methods must be per paragraph 217-3.10, Turf. When turf is to be established, the seedbed soil or topsoil must be a natural friable soil, possessing characteristics of the best locally obtainable soils, which can produce a heavy growth of crops, grass, or other vegetation.

The prepared composite mixture of aggregates used for the soil-aggregate course is **[** `Type A, B, or C, of the Table 217-2.1a.` **|**`stabilizer aggregate of the Table 217-2.1a) mixed with in-place materials` **]**.

217-2 MATERIALS

217-2.1 **Soil-Aggregate Mixes.**

The designated soil-aggregate course mixtures must conform to the following requirements.

[`Type A – The materials must be natural or artificial mixtures of clay or soil binder and gravel, stone, or sand, as screenings proportioned to meet the requirements specified.` **]**

[`Type B or C – The materials must be natural or artificial mixtures of gravel, stone, or slag and soil so proportioned to meet the requirement specified. The aggregate must consist of clean, hard durable particles` `of crushed or uncrushed gravel, stone, or slag, and is free from soft, thin, elongated, or laminated pieces, and vegetable or other deleterious substances. ]`

The prepared composite mixture used must meet the applicable gradation requirements as follows when tested per ASTM C136.

Table 217-2.1a: Gradation of Mixture

Sieve Designation (square openings)	Design Mix % by weight passing sieves	Contractors Final Gradation % weight passing	Job Control Tolerances
	[*]		
2 inch (50 mm)	*		0
1inch (25.0 mm)	*		±5%
¾ inch (19.0 mm)	*		±8%
No. 4 (4.75 mm)	*		±8%
No. 10 (2.00 mm)	*		±5%
No. 20 (850 µm)	*		±5%
No. 40 (425 µm)	*		±5%
No. 200 (75 µm)	*		±3%

****

The Engineer selects the gradation from Table 217-2.1b to populate Table 217-2.1a titled “Gradation of Mixture.”

Table 217-2.1b: Gradation of Mixture

Sieve Designation (square openings)	Percentage by weight passing sieves		
	A	B	C
2 inch (50 mm)			100
1 inch (25.0 mm)	100	100	70-95
¾ inch (19.0 mm)		70-100	
No. 4 (4.75 mm)		40-70	
No. 10 (2.00 mm)	60-100	40-70	32-60
No. 20 (850 µm)	50-90		
No. 40 (425 µm)	40-75	20-45	20-40
No. 200 (75 µm)	12-30	10-20	10-20

****

The fraction passing the No. 40 (425 µm) mesh sieve must have a liquid limit not greater than 30 and a PI not greater than eight when tested, per ASTM D4318.

217-2.2 Stabilizer Aggregate.

Place stabilizer aggregate, gradation as specified below upon the existing soil or base course in the specified quantity per square yard (square meter). Blend the aggregate uniformly with the soil or base course material to the depth as shown on the plans. The aggregate must consist of crushed stone, crushed or uncrushed gravel, or crushed slag, and have a percent of wear not more than 60 at 500 revolutions as determined by ASTM C131. The aggregate must be free from soft, thin, elongated, or laminated pieces, disintegrated material, or other deleterious substances. Where sand, as existing subgrade or base, requires modification, modify it by the addition of clay or lime rock. Handle the operation of spreading and mixing as stated under construction methods.

Table 217-2.2a: Gradation of Stabilizer Aggregate

Sieve Designation (Square Openings)	Percentage by Weight Passing Sieves	Contractors Final Gradation % Weight Passing	Job Control Tolerances
	[*]		
2 inch (50 mm)	*		±0%
1½ inch (37.5 mm)	*		±0%
1 inch (25.0 mm)	*		±5%
½ inch (12.5 mm)	*		±5%
No. 4 (4.75 mm)	*		±10%
No. 10 (2.00 mm)	*		±10%
No. 100 (150 µm)	*		±5%

****

The Engineer must select the appropriate gradation(s) from Table 217-2.2b.

Table 217-2.2b: Gradation of Stabilizer Aggregate

Sieve designation (square openings)	Percentage by weight passing sieves		
	D	E	F
2 inch (50 mm)		100	
1-1/2 inch (37.5 mm)	100		
1 inch (25.0 mm)	90-100		
1/2 inch (12.5 mm)		0-15	100
No. 4 (4.75 mm)	20-50		85-100
No. 10 (2.00 mm)	0-10		
No. 100 (150 µm)			0-30

****

217-2.3 Sampling and Testing.

217-2.3.1 Aggregate Base Materials.

The Contractor takes samples of the aggregate according to ASTM D75 to verify initial aggregate base requirements and gradation. Material must meet the requirements in paragraph 217-2.1. This sampling and testing is the basis for approval of the aggregate base quality requirements. **[__]**

217-2.3.2 Gradation Requirements.

The Contractor must take at least **[** `two` **]** aggregate samples per day in the presence of the Resident Project Representative (RPR) to check the final gradation. Sampling is per ASTM D75. Material must meet the requirements in paragraph 217-2.2. The samples must be taken from the in-place, un-compacted material at sampling points and intervals designated by the RPR.

****

The Engineer may require additional sampling points for quality requirements. The Engineer defines when additional sampling points are needed in the above paragraph.

****

217-2.4 Separation Geotextile.

[`Not used.` **|** `Separation Geotextile is` **[** `Class 2` **]**, **[** `0.02 sec`$^{-1}$ **]** `permittivity per ASTM D4491, Apparent opening size per ASTM D4751 with` **[** `0.60 mm` **]** `maximum average roll value.` **]**

****

The use of a geotextile to prevent mixing of a subgrade soil and an aggregate subbase/base is appropriate for pavement structures constructed over soils with a California Bearing Ratio greater than 3.

Generally, on airport projects, a Class 2 geotextile with a permittivity of 0.02 and AOS of 0.60 mm is sufficient.

See AASHTO M288 for additional notes regarding separation geotextiles.

****

217-3 CONSTRUCTION METHODS

217-3.1 Control Strip.

The first half-day of construction is considered 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 control strip establishes the equipment and methods to place and spread the material; the lift thickness, moisture content; and the sequence and manner of compaction necessary to obtain specified density requirements. The maximum compacted thickness may be increased upon demonstration that the approved equipment and operations will uniformly compact the lift to the specified density. The RPR must approve the material, equipment, and procedures prior to proceeding to full production.

Control strips not meeting the specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor’s expense. Do not begin full operations until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve any adjustments made by the Contractor to material, equipment, or procedures.

217-3.2 Preparing Underlying Course.

The RPR must check and accept the underlying course before placing and spreading operations begin. Correct any ruts or soft, yielding places caused by improper drainage conditions, hauling, or any other cause, before the base course is placed. To protect the underlying course and to ensure proper drainage, begin the spreading along the centerline of the pavement on a crowned section, or on the high side of the pavement with a one-way slope. Do not place material on frozen subgrade or subbase.

217-3.3 Placement.

Place and spread the material on the prepared underlying layer by spreader boxes or other devices as the RPR approved, to a uniform thickness and width. Thoroughly pulverize and mix the material to produce a homogeneous mass forming a layer. The equipment must have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles requiring re-handling is not permitted. Hauling over the uncompacted base course is not permitted. The material must meet gradation and moisture requirements prior to compaction. The layer must be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) or 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 applies to each lift. Do not cover any lift by subsequent lifts until tests verify that compaction meets requirements. The Contractor reworks, re-compacts, and retests any material placed which does not meet specifications.

217-3.5 Compaction.

Immediately upon completion of the spreading operations, compact each layer of the soil-aggregate course, as specified, with approved compaction equipment. The number, type, and weight of rollers must 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 must be at least **[** `90%` **]** of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. The moisture content of the material during placing operations must be within ±2 percentage points of the optimum moisture content as determined by ASTM **[** `D698` **]**. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

217-3.6 Finishing.

Finish the surface of the soil-aggregate course by blading or other approved equipment designed for this purpose. Adding thin layers of material to the top layer of soil-aggregate course to meet grade is not permitted. If the elevation of the top layer is ½ inch (12 mm) or more below grade, scarify the top layer of base to a depth of at least 3 inches (75 mm), new material added, and the layer blended and recompacted to bring it to grade at the Contractor’s expense. If the finished surface is above plan grade, cut surface to grade and reroll.

217-3.7 Weather Limitations.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not work on base course when the subgrade or subbase is wet or frozen or the soil-aggregate material contains frozen material.

217-3.8 Maintenance.

Maintain the layer in a condition that will meet all specification requirements until the work is accepted. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor must 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 soil-aggregate course. Damage to the soil-aggregate course from routing equipment over the base course must be repaired by the Contractor at their expense.

217-3.9 Surface Tolerance – Grade.

The Contractor is responsible for measuring the grade and crown on a [50 | 25 | 12.5] foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full strength pavement, and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in the areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR.

217-3.10 Acceptance Sampling and Testing.

Soil-aggregate course will be accepted for density and thickness on an area basis. Make two tests for density and thickness for each [1200 square yds (1000 m2)]. Determine sampling locations on a random basis per ASTM D3665.

217-3.10.1 Density.

The [RPR performs all density tests | Contractor’s laboratory performs all density tests in the RPR’s presence and provides the test results upon completion to the RPR for acceptance].

Each area is accepted for density when the field density is at least [90%] of the maximum density of laboratory specimens compacted and tested per ASTM [D1557 | D698]. The in-place moisture content is determined according to ASTM D4959. The in-place field density is determined per [[ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 is used to determine the moisture content of the material. Calibrate the machine according to ASTM D6938] or [ASTM D7830] or [ASTM D8167 for in place density and [ASTM D4959], [ASTM D8153], [ASTM D4643], or [ASTM D4944] for moisture]. Perform in-place density test immediately after completion of compaction to determine compaction. If the material fails to meet the density requirements, continue compaction. Remove, replace, and recompact areas not meeting compaction requirements. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer may adjust the testing area as appropriate to the job size.

Specify ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). Specify ASTM D1557 for

areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

****

217-3.10.2 Thickness.

Make depth tests by test holes or cores at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each area. Where the thickness is deficient by more than ½-inch (12 mm), the Contractor must 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 blended and recompacted to grade. The Contractor must replace, at their expense, base material where depth tests have been taken.

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after placement of the base. Base the survey interval on the project's size.

****

217-3.11 Seeding.

Seeding **[** `and topsoiling` **]** is according to Item T-901, Seeding **[** `and T-905, Topsoiling` **]**.

217-4 METHOD OF MEASUREMENT

217-4.1 Measure soil-aggregate course by the number of **[** `square yard (square meter)` **|** `cubic yards (cubic meters)` **]** of base course material placed, bonded, and accepted in the completed base course. Measure in final position based on **[** `depth tests or cores` **|** `, by means of average end areas on the completed work` **]**.

217-4.2 Measure stabilizer aggregate by the number of **[** `square yard (square meter)` **|** `cubic yards (cubic meters)` **]** of aggregate furnished, placed, and accepted in the completed base course.

217-4.3 When approved materials in-place are used in the base course, the preparation and incorporation of other materials in the base mixture is measured as a conditioning and mixing operation measured by the number of square yards (square meters) of such material prepared and incorporated in the mix and accepted.

[217-4.4 `Measure separation geotextile by the number of` **[** `square yards` **|** `square meters` **]** `of materials placed and the RPR accepted as complying with the plans and specifications excluding seam overlaps and edge anchoring.` **]**

****

Topsoil, lime, fertilizer, seeding, and mulching is paid under the applicable T-specs.

****

217-5 BASIS OF PAYMENT

217-5.1 Payment is made at the contract unit price per **[** `square yard (square meter)` **|** `cubic yard (cubic meter)` **]** for soil-aggregate base course. These prices are full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

217-5.2 Payment is made at the contract unit price per **[** `square yard (square meter)` **|** `cubic yard (cubic meter)` **]** for stabilizer aggregate. These prices are full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

217-5.3 Payment is made at the contract unit price per square yard (square meter) for conditioning operation. These prices are full compensation for furnishing all materials and for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

[217-5.4 `Separation geotextile is measured by the number of` **[** `square yards` **|** `square meters` **]** `of materials placed and accepted by the RPR as complying with the plans and specifications excluding seam overlaps and edge anchoring.` **]**

Payment is made under:

Item P-217-5.1	Soil Aggregate Base Course - per **[** `square yard (square meter)` **|** `cubic yard (cubic meter)` **]**
Item P-217-5.2	Stabilizer Aggregate - per **[** `square yard (square meter)` **|** `cubic yard (cubic meter)` **]**

Item P-217-5.3	Conditioning Operation - per square yard (square meter)
[Item P-217-5.4	Separation Geotextile per [square yard | square meter]]

****

The Engineer only includes those items shown in the bid schedule.

****

217-6 REFERENCES

217-6.1 This list of publications forms 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 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 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 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 D4751	*Standard Test Methods for Determining Apparent Opening Size of a Geotextile*
ASTM D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*

ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

American Association of State Highway and Transportation Officials (AASHTO)

M288	*Standard Specification for Geosynthetic Specification for Highway Applications*

END OF ITEM P-217

Item P-219 Recycled Concrete Base Course

****

- **Item P-219 can be used under flexible and rigid pavement.**
- **The quality of the recycled aggregate base course is directly related to the quality of the source material it is produced from and how it is processed and stored.**
- **Geotechnical laboratory testing is required to establish the quality of the P-219 material.**
- **Material that exhibits a CBR of 20 may be used as a subbase as a substitution for P-204.**
- **-Material that exhibits a CBR of 80 may be used as a base as a substitution for P-209.**
- **-Material that exhibits a CBR of 100 may be used as a stabilized base.**

****

219-1 DESCRIPTION

219-1.1 This item consists of a base course composed of recycled concrete, crushed to meet a particular gradation, constructed on a prepared course per these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

219-2 MATERIALS

219-2.1 Aggregate.

The recycled concrete material must be free of reinforcing steel and expansion material. Any existing asphalt overlays must be removed from the concrete surface prior to removal and crushing. Recycled concrete must consist of at least 90%, by weight, cement concrete; virgin aggregates may be added to meet the 90% minimum concrete requirement. The remaining 10% may consist of the materials in Table 219-2.1a.

Table 219-2.1a: Deleterious Materials

Material	Quantity
Wood	0.1% maximum
Brick, mica, schist, or other friable materials	4% maximum
Asphalt concrete	10% maximum
Total	10% maximum

Table 219-2.1b: Recycled Concrete Base Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate		
Resistance to degradation	Loss: 45% maximum	ASTM C131
Flat Particles, Elongated Particles, or Flat and Elongated Particles[1]	10% maximum, by weight, for fraction retained on the ½ inch (12.5mm) sieve and 20% maximum, by weight, for the fraction passing the ½-inch (12.5 mm) sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Fine Aggregate Portion		
Liquid limit	Less than or equal to 25	ASTM D4318
Plasticity Index (PI)	Not more than four	ASTM D4318

[1] A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three.

Produce the fine aggregate by crushing stone, gravel, slag, or recycled concrete meeting the requirements for wear and soundness specified for coarse aggregate. Fine aggregate may be added to produce the correct gradation. Each source of recycled concrete aggregate must meet the above requirements.

Recycled concrete aggregate shape depends on the characteristics of the recycled concrete, plant type, and plant operation speed. This may require multiple trial batches before crushed recycled concrete aggregate meeting the shape and gradation requirements can be produced.

****

Concrete that has deteriorated from alkali-silica reaction (ASR) may be used for recycled base course with appropriate analysis. See IPRF 03-05.

Recycled concrete aggregate must not be used in locations with high sulfate content soils (no more than 0.5%).

Recycled concrete aggregate shape depends on the characteristics of the recycled concrete, plant type, and plant operation speed.

****

219-2.2 Gradation Requirements.

The gradation (job mix) of the final mixture must fall within the design range indicated in the following table, when tested per ASTM C117 and ASTM C136. The final gradation must continuously be graded from coarse to fine and must not vary from the low limit on one sieve to the high limit on an adjacent sieve or vice versa.

Table 219-2.2: Gradation of Recycled Concrete Aggregate Base

Sieve Size	Percentage by Weight Passing Sieves		Contractors Final Gradation % Weight Passing	Job Mix Tolerances Percent
	Subbase	**Base**		
2 inch (50 mm)		100		--
1½ inch (37.5 mm)	100	95 - 100		±5
1 inch (25.0 mm)		70 - 95		±6
¾ inch (19.0 mm)	70-100	55 - 85		±6
No. 4 (4.75 mm)		30 - 60		±6
No. 10	20-100			
No. 30 (600 µm)	12-30	12 - 30		±4
No. 40	5-60			
No. 200 (75 µm)	0-15	0 - 10		±2

Apply the job mix tolerances in Table 219-2.2 to the job mix gradation to establish a job control gradation band. The full tolerance still applies if application of the tolerances results in a job control gradation band outside the design range.

219-2.3 Sampling and Testing.

219-2.3.1 Aggregate Base Materials.

The Contractor must take samples of the aggregate base according to ASTM D75 to verify initial aggregate base requirements and gradation. Material must meet the requirements in paragraphs 219-2.1 and 219-2.2. As a minimum, test material for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons. This sampling and testing is the basis for approval of the aggregate base quality requirements. **[__]**

219-2.3.2 Gradation Requirements.

The Contractor must take at least **[** `two` **]** aggregate base samples per day in the presence of the Resident Project Representative (RPR) to check the final gradation. Sampling must be per ASTM D75. Material must meet the requirements in paragraph 219-2.2. The samples must be taken from the in-place, un-compacted material at sampling points and intervals the RPR designated.

****

The Engineer may require additional sampling points for quality requirements. The Engineer defines when additional sampling points are needed in the above paragraph.

****

219-2.4 Separation Geotextile.

[Not used.][Separation Geotextile must be [Class 2], [0.05 sec^{-1}] permittivity per ASTM D4491, Apparent opening size per ASTM D4751 with [0.60 mm] maximum average roll value.]

****

The use of a geotextile to prevent mixing of a subgrade soil and an aggregate subbase/base is appropriate for pavement structures constructed over soils with a California Bearing Ratio greater than 3.

Generally, on airport projects, a Class 2 geotextile with a permittivity of 0.02 and AOS of 0.6 mm is sufficient.

See AASHTO M288 for additional notes regarding separation geotextiles.

****

219-3 CONSTRUCTION METHODS

219-3.1 Control Strip.

Consider the first half-day of construction the control strip. The Contractor must demonstrate, in the RPR's presence, that the materials, equipment, and construction processes meet the requirements of this specification. The control strip establishes the equipment and methods to place and spread the material, the lift thickness, the moisture content, and the sequence and manner of compaction necessary to obtain specified density requirements for the thickness of material placed. The maximum compacted thickness may be increased 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 not meeting the specification requirements must be reworked, recompacted, or removed and replaced at the Contractor's expense. Full operations must not begin until the RPR accepts the control strip. The RPR must approve, in advance, any adjustments made by the Contractor to material, equipment, or procedures.

219-3.2 Preparing Underlying Course.

Before placing base course, the RPR must check and accept the underlying subgrade and/or subbase. Correct any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, before the base course is placed. To ensure proper drainage, begin the spreading of the base along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

219-3.3 Placement.

Place and spread the aggregate on the prepared underlying layer by spreader boxes or other devices as the RPR approved, to a uniform thickness and width. The equipment must have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling is not permitted. Hauling over the uncompacted base course is not permitted.

The aggregate must meet gradation and moisture requirements prior to compaction. Construct the subbase course in lifts as established in the control strip, but not less than 4 inches (100 mm) or 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 applies to each lift. Do not cover any lift by subsequent lifts until tests verify that compaction meets requirements. The Contractor must rework, re-compact, and retest any material placed which does not meet the specifications.

219-3.4 Compaction.

Immediately upon 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 must 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 must be at least **[** `100%` **]** of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. Compact and test the laboratory specimens according to **[** `ASTM D1557` **]**. The moisture content of the material during placing operations must 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.

****

Material meeting the requirements of Item P-219 may be free-draining and to achieve compaction may need to be compacted on the wet-side of optimum.

The Engineer specifies ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or less and ASTM D1557 for areas designated for aircraft with gross weights greater than 60,000 lbs (27,200 kg).

****

219-3.5 Weather Limitations.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not work on base course when the subgrade or subbase is wet or frozen or the base material contains frozen material.

219-3.6 Maintenance.

Maintain the base course in a condition that meets all specification requirements. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor must 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 must be repaired by the Contractor at their expense.

219-3.7 Surface Tolerance – Grade.

The Contractor is responsible to measure the grade and crown on a **[** `50` **|** `25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide final grade checks to the RPR prior to construction of the next pavement layer.

219-3.8 Acceptance Sampling and Testing for Density.

Recycled concrete aggregate base course will be accepted on an area basis for density and thickness. Make two tests for density and thickness for each **[** `1200 square yds (1000 m2)` **]**. Determine sampling locations on a random basis per ASTM D3665.

219-3.8.1 Density.

The **[** `RPR performs all density tests` **|** `The Contractor’s laboratory performs all density tests in the RPR’s presence and provide the test results upon completion to the RPR for acceptance` **]**.

Each area is acceptable for density when the field density is at least [100%] of the maximum density of laboratory specimens compacted at ±2% of optimum moisture and tested per ASTM [D1557 | D698]. Determine the in-place field density per [[ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material. Calibrate the machine according to ASTM D6938.] or [ASTM D7830] or [ASTM D8167 for in place density and [ASTM D4959], [ASTM D8153], [ASTM D4643], or [ASTM D4944] for moisture]. If the specified density is not attained, the entire area must be reworked and/or recompacted and two additional random tests made. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified

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The Engineer specifies ASTM D698 or ASTM D1557 for areas designated for aircraft with gross weights of less than 60,000 lbs (27,200 kg). The Engineer specifies ASTM D1557 for areas designated for aircraft with gross weights of 60,000 lbs (27,200 kg) or greater.

The Engineer may adjust the testing area as appropriate to the job size.

****

219-3.8.2 Thickness.

Make depth tests in test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each area. Where the thickness is deficient by more than ½-inch (12 mm), the Contractor must 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 blending and recompacting the material to grade. The Contractor replaces, at their expense, base material where depth tests have been taken.

[[The thickness of the base course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course the [Contractor | RPR]surveys the [subgrade | subbase] on a [50 | 37.5 | 17.5 | 12.5] foot grid relative to centerline of base.] After placing the base, the surface is surveyed on the same grid and the thickness of base course determined. **]**

****

The Engineer may modify the above thickness control paragraph to permit the thickness determination by survey. A survey is required before and after placement of the base. The survey interval should be specified based on the project's size.

****

219-4 METHOD OF MEASUREMENT

219-4.1 The quantity of recycled concrete aggregate base course is determined by measurement of the number of square yards (square meters) of material, actually constructed and accepted as complying with the plans and specifications.

[219-4.2 Separation geotextile is measured by the number of **[** square yards **|** square meters **]** of materials placed and accepted by the RPR as complying with the plans and specifications excluding seam overlaps and edge anchoring. **]**

219-5 BASIS OF PAYMENT

219-5.1 Payment is made at the contract unit price per square yard (square meter) for recycled concrete aggregate base course. This price is 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.

[219-5.2 Payment is made at the contract unit price per **[** square yard **|** square meter **]** for separation geotextile. The price is full compensation for furnishing all labor, equipment, material, anchors, and incidentals necessary. **]**

Payment is made under:

Item P-219-5.1	Recycled Concrete Aggregate Base Course per square yard (square meter)
[Item P-219-5.2	Separation Geotextile per **[** square yard **|** square meter **]]**

219-6 REFERENCES

219-6.1 This list of publications forms 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 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 Aggregate*
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 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 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 D4643	*Standard Test Method for Determination of Water Content of Soil by Microwave Oven Heating*
ASTM D4791	*Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated 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)*

END OF ITEM P-219

Item P-220 Cement Treated Soil Base Course

****

When Item P-220 is used as a stabilized base course, the layer must be a minimum 12-inches (300 mm) thick. Use of Item P-220 as a stabilized base course is not recommended where frost penetration into the subbase is anticipated. When used as a base course, typically 6-8% cement is mixed with the soil. If soil treatment is needed to create a stable working platform. See Item P-157.

Prior to specifying Item P-220 the Geotechnical Engineer must do sufficient testing to ensure that the soil is appropriate for a cement treated base course. Cement stabilization works best with granular soils combined with granular pavement material. Coarse grained soils which conform to ASTM D2487 classified as GW, GP, GM, GC, SW, SM, SC, SP, and/or combination(s), generally may be cement stabilized.

The Engineer must check the soluble sulfate contents of the soils during design to determine if stabilization can react and induce heave. Sulfate reaction with either the soil to be stabilized or mixing water used in the stabilization process may be detrimental to the finished product due to the expansive nature of the sulfate reaction. During the Design Phase, test the soils and water anticipated for inclusion in the stabilized material for the potential to cause an adverse expansion reaction.

****

220-1 DESCRIPTION

220-1.1 This item consists of constructing a base course by uniformly mixing soil, cement, and water. Spread, shape, and compact the mixed material according to these specifications and to the dimensions and typical cross-section shown on the plans. Build runway, taxiway, or apron pavements in a series of parallel lanes using a plan that reduces the number of longitudinal and transverse joints to a minimum.

220-2 MATERIALS

220-2.1 Cement.

Cement must conform to the requirements of ASTM C150, Type I, II, or V or ASTM C595, Type IS, IP, IL, IT, or ASTM C989.

220-2.2 Water.

Water from a drinking water source is suitable for mixing and curing. If water is taken from other sources, it must meet the requirements of ASTM C1602.

220-2.3 Soil.

The soil for this work consists of on-site materials and must be free of roots, sod, weeds, and stones larger than 2½ inches (60 mm) with a sulfate content of less than 0.3%.

220-2.4 Asphalt Material.

The types, grades, controlling specifications, and application temperatures for the asphalt materials used for curing the soil-cement is **[__]**.

220-3 MIX DESIGN

220-3.1 Proportions.

Before the start of base course construction, tests must be made by the **[** Contractor **|** RPR **]** on the soil or soil-aggregate material to determine the quantity of cement required for the mix design. Each different soil type requires a separate mix design. Compact test specimens containing various amounts of cement per ASTM D558 and determine the optimum moisture for each test specimen. Test samples prepared at the optimum moisture to the wet-dry and the freeze-thaw test according to ASTM D559 and ASTM D560, respectively. Add cement at an application rate of **[** 3 **|** 6 **|** 8 **]** percent of dry unit weight of soil.

****

The Engineer must, based on the results of the Geotechnical Report, specify the application rate of cement to achieve the desired properties for the treated material.

When the cement treated material is used as a structural layer, add cement until a minimum California Bearing Ration (CBR) of 100 or a seven-day compressive strength of 300 to 800 psi (2068 to 5516 kPa) per ASTM C1633 is achieved.

****

220-4 CONSTRUCTION METHODS

220-4.1 Control Strip.

The first half-day of construction is considered 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 control strip establishes the equipment and methods to place and spread the material; the lift thickness, the moisture content; and the sequence and manner of mixing and compaction necessary to obtain specified density requirements. The maximum compacted thickness may be increased upon demonstration that the approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness construction of the control strip and approve the material, equipment, and procedures prior to proceeding to full production.

Control strips not meeting the specification requirements must be reworked, recompacted, or removed and replaced at the Contractor’s expense. Do not begin full operations until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve, in advance, any adjustments made by the Contractor to materials, equipment, or procedures.

220-4.2 Weather Limitations.

Do not place material unless the ambient air temperature is at least 40°F (4°C) and rising. Do not work on base course when the subgrade or subbase is wet or frozen or the base material contains frozen material.

220-4.3 Maintenance.

Maintain the layer in a condition that meets all specification requirements until the work is accepted. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, the Contractor must verify that materials still meet all specification requirements prior to placement of additional material. 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 must be repaired by the Contractor at their expense.

220-4.4 Equipment.

Construct the course with any equipment that meets the requirements for soil pulverization, cement application, mixing, water application, incorporation of materials, compaction, finishing, and curing specified here.

220-4.5 Preparation.

Grade and shape areas to be stabilized to the lines, grades, and cross-section shown on the plans. Remove any soft or yielding areas in the subgrade and replace with acceptable soil and compact to the specified density.

220-4.6 Pulverization.

After completion of moist-mixing, the soil for the base course must be pulverized so that 100% by dry weight passes a 1-inch (25.0 mm) sieve and a minimum of 80% passes a No. 4 (4.75 mm) sieve.

220-4.7 Cement Application, Mixing, and Finishing.

220-4.7.1 Mixing in Place.

[Not used. |Mixing of the soil, cement, and water is accomplished by the mixed-in-place method. Shape pulverized material to the cross-section indicated. Apply cement so that when uniformly mixed with the soil, the specified cement content is obtained, and enough cement-treated soil is produced to construct a compacted cement-treated course conforming to the lines, grades, and cross-section indicated. Immediately after the cement has been distributed, it must be mixed with the soil.

Do not mix the cement below the required depth. Continue mixing until the cement has been sufficiently blended with the soil to prevent the formation of cement balls when water is applied. Determine moisture content of the mixture immediately after completion of mixing of the soil and cement. Provide water supply and pressure distributing equipment that will permit the application within three hours of all mixing water on the section being processed. Incorporate water in the mix so that water concentration near the surface does not occur.

After all mixing water has been applied, continue mixing until the water is uniformly distributed throughout the full depth of the mixture. Do not apply cement if the soil moisture content exceeds the optimum moisture content specified for the cement-treated mixture. After mixing is complete, the proportions of the mixture must be according to the approved mix design.]

220-4.7.2 Central Plant Mix.

[Not used. |Mixing of the soil, cement, and water is accomplished by the central-plant-mixed method. Mix the soil, cement, and water in either a batch or continuous-flow type pugmill. The plant must be equipped with feeding and metering devices that add the soil, cement, and water into the mixer in the specified quantities. Mix the soil and cement `prior to adding water Continue mixing until a uniform mixture of soil, cement, and water is obtained. Haul the mixture to the project in trucks equipped with protective covers. Place the mixture on the moistened subgrade in a uniform layer by an approved spreader. Dumping of the mixture in piles or windrows on the subgrade is not permitted. Place adjacent lanes of soil-cement within 30 minutes. The layer of soil-cement must be uniform in thickness and surface contour and of sufficient quantity that the completed base conforms to the required line, grade, and cross-section. Start compaction within 60 minutes of the start of moist mixing.` **]**

****

It is acceptable to leave both options for mixing in the specification.

Haul the mixture to the project in trucks equipped with protective covers. Place the mixture on the moistened subgrade in a uniform layer by an approved spreader. No more than 30 minutes must elapse between the placement of soil-cement in adjacent lanes.

The layer of soil-cement must be uniform in thickness and surface contour and of sufficient quantity that the completed base conforms to the required line, grade, and cross-section. Dumping of the mixture in piles or windrows on the subgrade is not permitted.

Not more than 60 minutes may elapse between the start of moist mixing and the start of compaction of soil-cement.

****

220-4.8 Compaction.

Begin compaction of the course within **[** `60` **]** minutes after mixing the cement with the soil. Complete all compaction operations within **[** `two` **]** hours from the start of moist mixing.

The field density of the compacted mixture must be at least **[** `98%` **]** of the maximum density as determined by ASTM **[** `D558` **]**. Determine the in-place moisture content according to ASTM D2216. The moisture content of the mixture at the start of compaction must be within ±2 percentage points of the optimum moisture content. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

May be modified as appropriate to comply with the Geotechnical Engineer's recommendations and/or requirements to achieve a specified strength, etc.

Test frequency should reflect typical day's placement. Recommend not less than one test per 1,000 square yards (840 m^2) or a minimum of four tests per day.

****

220-4.9 Finishing and Curing.

After the final lift or course of treated subgrade has been compacted, trim the surface to the lines and grades as shown on the project plans and typical sections. Protect the finished portions of treated subgrade from damage from equipment.

Within 24 hours after completion of final finishing, cure the surface **[** `by keeping the surface continuously moist for a period of seven days with a fog-type water spray` **|** `with an application of an emulsified asphalt uniformly applied at the rate of approximately 0.2 gallons per square yard (0.91 l/m2)` **]**. The curing material must be maintained and applied as needed by the Contractor during the 7-day protection period. Protect the layer from freezing for at least for at least seven days after its construction.

220-4.10 Construction Limitations.

Form a straight transverse construction joint using a formed header or by cutting back into the compacted material to form a vertical face at the end of each day's construction and/or when operations after application of the cement are interrupted for more than 30 minutes. Completed portions may be opened to light traffic, if the RPR approved, and provided the curing is not impaired.

220-4.11 Surface Tolerance.

220-4.11.1 Grade.

The Contractor is responsible for measuring the grade and crown on a **[** `50` **|** `25` **|** `12.5` **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by scarifying to a depth of at least 3 inches, reshaping and recompacting. The Contractor must provide the final grade checks to the RPR prior to construction of the next pavement layer.

220-4.11.2 Smoothness.

The final surface must not vary more than +0 to –⅜ inch (9mm) when tested with a 12-foot (3.7 m) straightedge applied parallel to and at right angles to the centerline. Move the straight edge continuously forward at half the length of the straight edge for the full length of each line on a **[** 25 **|** 50 **]** foot grid.

220-4.12 Acceptance Sampling and Testing.

Cement Treated Solid Base course is acceptable for density and thickness on an area basis. Two tests are made for density and thickness for each **[** 1200 square yards (1000 square meters) **]**, but not less than four tests per day of production. Determine sampling locations on a random basis per ASTM D3665.

220-4.12.1 Density.

The **[** RPR will perform all density tests **|** Contractor's laboratory will perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance **]**.

Each area is accepted for density when the field density is at least **[** 98% **]** of the maximum density of laboratory specimens compacted and tested per ASTM **[** D558 **]**. The in-place moisture content is determined according to ASTM D4959. The in-place field density is determined per **[** **[** ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 is used to determine the moisture content of the material. Calibrate the machine according to ASTM D6938 **]** or **[** ASTM D7830 **]** or **[** ASTM D8167 for in place density and **[** ASTM D4959 **]**, **[** ASTM D8153 **]**, **[** ASTM D4643 **]**, or **[** ASTM D4944 **]** for moisture **]**. Perform in-place density test immediately after completion of compaction to determine compaction. If the material fails to meet the density requirements remove, replace, and recompact areas not meeting compaction requirements. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

****

The Engineer may adjust the testing area as appropriate to the job size.

****

220-4.12.2 Thickness.

Make depth tests by test holes or cores at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course must be within +0 and -½ inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the RPR's presence for each sublot. Where the thickness is deficient by more than ½-inch (12 mm), remove the material to full depth and replace, at Contractor's expense.

[[The thickness of the base course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course the [Contractor | RPR] will survey the [subgrade | subbase] on a [50 | 37.5 | 17.5 | 12.5] foot grid relative to centerline of base]. After placement of the base, the surface of the base is surveyed on the same grid and the thickness of base course determined.]

****

Base the survey interval on the project's size, as well as location on airport. The size and spacing of the grid for survey should be relative to width of paving lanes.

****

220-5 METHOD OF MEASUREMENT

220-5.1 The quantity of cement treated soil base course is the number of square yards (square meter) of completed and accepted base course.

220-5.2 Cement is measured by the ton (kg).

220-6 BASIS OF PAYMENT

220-6.1 Payment is made at the contract unit price per square yard (square meters) for cement treated soil base course. This price is full compensation for furnishing all materials, except cement, and for all preparation, delivering, placing, and mixing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

220-6.2 Payment is made at the contract unit price per ton (kg) for cement. This price is full compensation for furnishing this material and for all delivery, placing, and incorporation of this material, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item P-220-6.1	Cement treated soil Base Course - per square yard (square meter)
Item P-220-6.2	Cement - per ton (kg)

220-7 REFERENCES

220-7.1 This list of publications forms 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 C136	*Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates*
ASTM C150	*Standard Specification for Portland Cement*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM C1632	*Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory*
ASTM C1633	*Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders*
ASTM D558	*Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures*
ASTM D559	*Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures*
ASTM D560	*Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures*
ASTM D977	*Standard Specification for Emulsified Asphalt*
ASTM D2027	*Standard Specification for Cutback Asphalt (Medium-Curing Type)*
ASTM D2028	*Standard Specification for Cutback Asphalt (Rapid-Curing Type)*
ASTM D2397	*Standard Specification for Cationic Emulsified Asphalt*
ASTM D2487	*Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)*

ASTM D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*
ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

END OF ITEM P-220

Part 5 – Stabilized Base Courses

Item P-304 Cement-Treated Base Course (CTB)

****

- **Place Item P-304 with a spreader like an aggregate base.**
- **Microcracking is recommended when used under flexible pavements and is optional under rigid pavements.**

****

304-1 DESCRIPTION

304-1.1 This item consists of a CTB course composed of mineral aggregate and cement, uniformly blended and mixed with water. The mixed material must be spread and shaped with a mechanical spreader and compacted with rollers according to these specifications and in conformance to the lines, grades, dimensions, and cross-sections shown on the plans.

304-2 MATERIALS

304-2.1 Aggregate.

The aggregate must be select granular materials, comprised of crushed or uncrushed gravel and/or stone, or recycled cement concrete. The material must be free of roots, sod, and weeds. The crushed or uncrushed aggregate must consist of hard, durable particles meeting the requirements in Table 304-2.1.

Table 304-2.1: Cement Treated Aggregate Base Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate Portion (retained on the No. 4 (4.75 mm) sieve)		
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate [1]	Loss after five cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88

Material Test	Requirement	Standard
Flat Particles, Elongated Particles, or Flat and Elongated Particles [2]	10% maximum, by weight, for fraction retained on the ½ inch (12.5mm) sieve and 20% maximum, by weight, for the fraction passing the ½-inch (12.5 mm) sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Fine Aggregate Portion (Passing the No. 40 (425µm) sieve)		
Liquid limit	Less than or equal to 25	ASTM D4318
Plasticity Index (PI)	Not more than 6	ASTM D4318

[1] Soundness tests not required when using recycled concrete aggregates.

[2] A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three.

304-2.2 Gradation Requirements.

The aggregate must conform to the gradation(s) shown in Table 304-2.2, per ASTM C136. Select a final aggregate blend that is well graded from coarse to fine within the limits designated in the table and that does not vary from the low limit on one sieve to the high limit on adjacent sieves, or vice versa.

Table 304-2.2: Aggregate Gradation for CTB Material

Sieve Size	Design Range Percentage by Weight Passing	Contractor's Final Gradation	Quality Control Tolerances for Contractor's Final Gradation Percent
2 inch (50 mm)	100		±0
1 inch (25.0 mm)	90-100		±5
No. 4 (4.75 mm)	45-95		±8
No. 10 (2.00 mm)	37-80		±8
No. 40 (425 µm)	15-50		±5
No. 200 (75 µm)	0–15		±3

304-2.3 Cement.

Use any of the following cements: ASTM C150, *Types I, II,* or *V*; ASTM C595, *Types IS*, *IP*, *IL*, or *IT*; ASTM C1157 *Types GU, HS, MS, MH or LH.*

304-2.4 Cementitious Additives.

Coal ash, Pozzolans, or slag cement may be added to the CTB mix. If used, each material must meet the following requirements:

304-2.4.1 Coal Ash or Pozzolan.

Pozzolanic materials must meet the requirements of ASTM C618, Class F, or N except for loss of ignition, where the maximum must be less than 6%. [The supplementary optional physical requirements of Table 3 contained in ASTM C618 apply.]

304-2.4.2 Slag Cement (Ground Granulated Blast Furnace (GGBF) Slag).

Slag must conform to ASTM C989, Grade 100, or 120.

304-2.5 Water.

Water from a drinking water source is suitable for mixing and curing. If water is taken from other sources, it will meet the requirements of ASTM C1602.

304-3 MIXTURE COMPOSITION

304-3.1 General.

The CTB material is a mixture of aggregate, cementitious material, and water. Pozzolanic materials or slag cement may be used as a partial replacement for cement.

304-3.2 Mix Design.

The mix design will use the minimum cement content that, when tested in the laboratory per ASTM D1633, produces a seven day compressive strength between 300 lbs per square inch (2068 kPa) minimum and a maximum of 600 lbs per square inch (3447 kPa). Avoid higher strengths due to potential to cause shrinkage and reflective cracks. Strength is only tested during mix design to establish the cement content of the CTB. Determine the maximum density and optimum moisture for compaction using ASTM D558.

[Perform wet-dry and/or freeze-thaw tests according to ASTM D559 and ASTM D560 respectively. Prepare a minimum of 2 specimens for each trial cement content. The weight loss for each type of test must not exceed 14% after twelve cycles.]

****

In climate zones 1-3 based upon IECC wet-dry and/or freeze-thaw tests generally not required.

Note: that an estimated cement content may be determined from Table 1, Chapter 2, of the *Soil-Cement Laboratory Handbook*, published by the Portland Cement Association (PCA). Typically, 5% cement is adequate.

In designing the mixture, cement contents above and below the initial estimated amount should be tested to determine the minimum quantity of

cement needed to achieve the strength and durability where freeze-thaw resistance is deemed necessary by the Engineer.

****

The mix design must include a complete list of materials, including type, brand, source, and amount of cement, fine aggregate, coarse aggregate, water, and cementitious additives. Changes in the source of aggregate require a new mix design. Changes in the supplier of cementitious material require a new trial batch. If the trial batch is not acceptable a new mix design is required. Minor changes in dosage of admixtures are acceptable. Changes in supplier of admixtures or addition or deletion of an admixture requires a trial batch. If the trial batch is not acceptable, a new mix design is required.

304-3.4 Mix Design Submittals.

At least 30 days prior to the placement of the CTB, the Contractor must submit certified test reports for materials to be used in CTB and the mix design to the Resident Project Representative (RPR). Tests must be of material to be used for production and not be older than one year. The certification must show the ASTM or American Association of State Highway and Transportation Officials (AASHTO) specifications or tests for the material, the name of the company performing the tests, the date of the tests, the test results, and a statement that the material did or did not comply with the applicable specifications. The submittal package must include the following:

1. Source(s) of materials, including aggregate, cement, cementitious additives, curing, and bond-breaking materials.
2. Physical properties of the aggregates, cement, cementitious additives, curing, and bond-breaking materials.
3. Mix design:
    a. Mix identification number
    b. Aggregate gradation
    c. Cement content
    d. Water content
    e. Cementitious materials content
    f. Compaction and strength results
    g. Laboratory compaction characteristics)
    h. Compressive strength at seven days to establish cement content
    i. **[** `Wet-dry and/or freeze-thaw weight loss` **]**

Do not place CTB material until the RPR has approved the submittal in writing. During production, the Contractor must submit batch tickets for each delivered load.

304-4 EQUIPMENT

304-4.1 Mixing.

The mixer must be a batch or continuous-flow type stationary mixer that produces a well-blended, uniform mixture of aggregate, cement, water, and pozzolan. The mixer must be equipped with calibrated metering and feeding devices that introduce the aggregate, cement, water, and cementitious additives (if used) into the mixer in the specified quantities.

The RPR must have free access to the plant at all times for inspection of the plant's equipment and operation and for sampling the CTB mixture.

304-4.2 Hauling.

Transport the CTB material from the plant to the job site in trucks or other hauling equipment having beds that are smooth, clean, and tight. Truck bed covers must be provided and used to protect the CTB from weather. CTB material that becomes wet during transport must be rejected.

304-4.3 Placing.

Place CTB material with a mechanical spreader capable of receiving, spreading, and shaping the mixture without segregation into a uniform layer or lift. The equipment must be equipped with a strike-off plate and end gates capable of being adjusted to the layer thickness and width.

304-5 CONSTRUCTION METHODS

304-5.1 Control Strip.

The first half-day of construction is considered 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 control strip establishes the equipment and methods to mix, place and spread the material; the lift thickness, the moisture content; and the sequence and manner of compaction necessary to obtain specified density requirements. The maximum compacted thickness may be increased upon demonstration that the approved equipment and operations will uniformly compact the lift to the specified density. The RPR must approve the material, equipment, and procedures prior to proceeding to full production.

Control strips not meeting specification requirements must be reworked, re-compacted, or removed and replaced at the Contractor's expense. Do not begin full operations until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve any adjustments made by the Contractor to material, equipment, or procedures.

304-5.2 Sampling and Testing.

304-5.2.1 Aggregate Base Materials.

The Contractor must take samples of the aggregate base stockpile according to ASTM D75 to verify initial aggregate base requirements and gradation. Material must meet the requirements in paragraphs 304-2.1 and 304-2.2.

304-5.2.2 Gradation Requirements.

The Contractor must take at least **[** `two` **]** aggregate base samples per day from the discharge gate of storage bin or from conveyor belt to mixer. As a minimum, test material for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons.

304-5.2.3 Job Mix.

The Contractor's process control must include records of the amount of aggregate, cementitious material, additives, and water.

304-5.3 Weather Limitations.

Do not place CTB on frozen surfaces or when weather conditions will detrimentally affect quality of the finished course. Apply cement when the ambient temperature is a minimum of 40°F (4°C) and rising and aggregate are not frozen or contain frost. If ambient temperature falls below 40°F (4°C), protect completed CTB areas against freezing.

304-5.4 Preparation of Underlying Course.

The RPR must check the underlying course before placing and spreading operations are started. Prior to placing the material, the final grade should be firm, moist, and free of frost. Use of chemicals to eliminate frost is not permitted. Wet the underlying course in advance of placing the CTB layer.

304-5.5 Placing.

Place the CTB mixture on the moistened subgrade or subbase and spread into a uniform layer of specified width and thickness that when compacted and trimmed, conforms to the required line, grade, and cross-section. Locate longitudinal joints so there is **[** `no offset` **|** `a 2-foot (600 mm) minimum offset` **]** from planned joints in any overlying layer. Begin placement of the material along the centerline of the pavement on a crowned section or on the highest elevation contour of a pavement with variable cross slope. Install the CTB layer in single compacted layer no greater than 6 inches (150 mm) thick.

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When concrete surface layer, no longitudinal joint offset. When asphalt surface layer, 2-foot (600 mm) minimum offset, but not more than 12 inches.

Insert CTB thickness per design analysis.

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304-5.6 Compaction and Finishing

Complete all compaction and finishing operations within 2 hours from the start of mixing. Compaction and finishing must produce a smooth, dense surface, free of ruts, cracks, ridges, and loose material. The Contractor must remove and replace material not completed within the 2-hour time limit at the Contractor's expense.

304-5.6.1 Compaction.

The field density of the compacted mixture must be at least **[** 98% **]** of the maximum density according to paragraph 304-3.2. At the start of compaction, the moisture content must be within ±2 percentage points of the specified optimum moisture. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

304-5.6.2 Finishing.

Immediately after compaction, shape the surface of the CTB layer to the specified lines, grades, and cross-section. Keep the surface moist by means of fog-type sprayers during the finishing process.

304-5.7 Construction Joints.

Construct a straight transverse construction joint either formed by a header or by cutting back into the compacted material to form a true vertical face, at the end of each day's construction and when operations are interrupted for more than 30 minutes.

304-5.8 Curing.

Cure the compacted and finished CTB with the approved curing agents as soon as possible, but in no case later than two hours after completion of the finishing operations. Protect the CTB against the loss of moisture for a period of 7 days using one of the following methods. Until the curing material is applied keep the layer moist using a moisture-retaining cover or a light application of water.

304-5.8.1 Asphalt Emulsion.

[Not Used. **|** Spray the entire surface of the CTB layer with an asphalt emulsion at a rate of between 0.15 and 0.30 gallons per square yard (0.7 and 1.4 l/m^2); the exact temperature and rate of application being that required to achieve complete and uniform coverage without runoff. Apply sand at **[__]** lbs per square yard `(kg/m²) to treated surfaces requiring protection from traffic.`]

304-5.8.2 Impervious Membrane.

[`Not used.`][`Spray the surface of the CTB layer with a liquid membrane-forming curing compound at the rate of one gallon (3.8 liters) to not more than 100 square feet (9.3 m²) to obtain a uniform cover over the surface. Hand spraying of odd widths or shapes and CTB surfaces exposed by the removal of forms is permitted.`]

304-5.8.3 White Burlap-polyethylene Sheets.

[`Not used.`][`The surface of the CTB layer must be entirely covered with the sheeting. The sheeting must be placed and weighted to remain in contact with the surface covered, and the covering maintained fully saturated and in position for seven days after the CTB has been placed.`]

304-5.8.4 Water Method.

[`Not used.`][`The entire area must be covered with burlap or other water absorbing material. The material must be of sufficient thickness to retain water for adequate curing without excessive runoff. The material must always be kept wet and maintained for seven days. It is the responsibility of the Contractor to prevent ponding of the curing water on the subbase.`]

304-5.9 Microcracking.

[`Not used.`][`48-72 hours after placement microcrack CTB with two to three passes over entire surface with a` [`12-ton`] `steel wheel vibratory roller operating at maximum amplitude while traveling two to three mph. Monitor the surface of the CTB during microcracking if surface aggregates are being crushed stop vibration and roll in static mode.`]

304-5.10 Maintenance.

Completed portions of the CTB may be opened to local traffic provided that curing process is not impaired. Do not permit heavy equipment or traffic on the CTB until the curing period is complete. After the curing period, completed areas may be opened to construction traffic. The CTB must be protected from freezing until covered by subsequent paving layers.

304-5.11 Construction Traffic.

Completed portions may be opened to light construction traffic provided the curing is not impaired. The Contractor must remove and replace CTB damaged by construction traffic at the Contractor’s expense. Do not permit heavy equipment or traffic on the CTB until the curing period is complete.

304-5.12 Surface Tolerance.

304-5.12.1 Grade.

The Contractor is responsible to measure the grade and crown on a [50 | 25 | 12.5] foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by removal, replacement, reshaping, and recompacting. The Contractor must provide final grade checks to the RPR prior to construction of the next pavement layer.

304-5.12.2 Smoothness.

The final surface must not vary more than +0 to – ⅜ inch (9mm) when tested with a 12-foot (3.7 m) straightedge applied parallel to and at right angles to the centerline. Move the straight edge continuously forward at half the length of the straight edge for the full length of each line on a [25 | 50] foot grid.

304-6 MATERIAL ACCEPTANCE

304-6.1 Acceptance Sampling and Testing.

CTB is acceptable for density and thickness on an area basis. Make two tests for density and thickness for each [1200 square yards (1000 square meters), but not less than four tests per day of production]. Sampling locations is determined on a random basis per ASTM D3665.

304-6.1.1 Density Testing.

Take CTB samples representing the material placed to check density and moisture requirements according to ASTM D558. Take additional CTB samples [daily | weekly | as necessary] to verify density and moisture requirements. The [RPR will perform all density tests | Contractor’s laboratory will perform all density tests in the RPR’s presence and provide the test results upon completion to the RPR for acceptance].

Each area is acceptable for density when the field density is at least [98%] of the maximum density of laboratory specimens compacted and tested per ASTM [D558]. Determine the in-place field density per [[ASTM D6938 using Procedure A, the direct transmission method, and use ASTM D6938 to determine the moisture content of the material. Calibrate the machine according to ASTM D6938.] or [ASTM D7830] or [ASTM D8167 for in place density and [D4959, | D8153, | ASTM D4643,] or [ASTM D4944] for moisture]. If the specified density is not attained, the entire area must be reworked and/or recompacted and two additional random tests made. Follow this procedure until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

304-6.1.2 Thickness.

[Thickness is determined by measuring the depth of core holes in the CTB at random locations, per ASTM D3665. The Contractor fills the resulting core holes with CTB or non-shrink grout.]

[The thickness of the base course is to be within +0 and -½ inch (12 mm) of the specified thickness as determined by survey. Prior to placement of the base course, the [Contractor | RPR] will survey the [subgrade | subbase | base] on a [50 | 37.5 | 17.5 | 12.5] foot grid relative to centerline of base.]. After placement of the base, the surface of the base is surveyed on the same grid and the thickness of base course determined. At the Contractor's expense, remove and replace the area represented by the tests when the thickness measurement is deficient by more than ½ inch (12 mm).

****

The Engineer selects the method used to determine the thickness of the CTB. If thickness is determined by survey, the Engineer specifies the minimum survey grid.

****

304-7 METHOD OF MEASUREMENT

304-7.1 Cement-treated Base Course.

The quantity of cement-treated base course is determined by measurement of the number of square yards (square meters) of CTB actually constructed and the RPR accepted, as complying with the plans and specifications.

304-8 BASIS OF PAYMENT

304-8.1 Cement-treated Base Course.

Make payment at the contract unit price per square yard (square meters) for cement-treated base course. This price is compensation for furnishing all materials, including cement; for all preparation, manipulation, placing, and curing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Item P-304-8.1	Payment is made for cement-treated base course – per **[** `square yard (square meters)` **].**

304-9 REFERENCES

304-9.1 This list of publications forms 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 C88	*Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate*
ASTM C150	*Standard Specification for Portland Cement*
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 Aggregate*
ASTM C174	*Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores*
ASTM C309	*Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete*
ASTM C595	*Standard Specification for Blended Hydraulic Cements*

ASTM C618	*Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*
ASTM C989	*Standard Specification for Slag Cement for Use in Concrete and Mortars*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D75	*Standard Practice for Sampling Aggregates*
ASTM D558	*Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures*
ASTM D559	*Standard Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures*
ASTM D560	*Standard Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures*
ASTM D977	*Standard Specification for Emulsified Asphalt*
ASTM D1633	*Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders*
ASTM D2397	*Standard Specification for Cationic Emulsified Asphalt*
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 D4643	*Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating*
ASTM D4944	*Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester*
ASTM D4959	*Determination of Water Content of Soil By Direct Heating*
ASTM D6938	*Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*
ASTM D7830	*In-Place Density (Unit Weight) and Water Content of Soil Using an Electromagnetic Soil Density Gauge*
ASTM D8153	*Determination of Soil Water Content Using a Dielectric Permittivity Probe*

ASTM D8167	*In-Place Bulk Density of Soil and Soil Aggregate by a Low Activity Nuclear Method (Shallow Depth)*

END OF ITEM P-304

Item P-306 Lean Concrete Base Course

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- **Item P-306 is placed with a concrete paver.**
- **Bond-breaker required when used under rigid pavements.**
- **Due to the potential for reflective cracking, do not use P-306 under flexible pavement.**

****

P-306-1 DESCRIPTION

306-1.1 This item consists of a lean concrete base course material that is composed of aggregate and cement uniformly blended and mixed with water. The mixture may also include approved cementitious additives, in the form of coal ash or slag, and chemical admixtures. The plant mixed lean concrete base material is spread, shaped, and consolidated using concrete paving equipment to the lines, grades, dimensions, and typical cross-sections shown on the plans.

P-306-2 MATERIALS

306-2.1 Aggregate.

The coarse aggregate fraction must be of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, recycled cement concrete, or a combination of aggregates. The fine aggregate fraction may be part of the natural aggregate blend as obtained from the borrow source or it may be natural sand that is added at the time of mixing. The aggregate must meet the gradation and material requirements in the following tables.

Table 306-2.1a: Coarse and Fine Aggregate Requirements

Material Test	Requirement	Standard
Coarse Aggregate Portion (retained on the No. 4 (4.75 mm) sieve)		
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate[1]	Loss after five cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88

Material Test	Requirement	Standard
Flat Particles, Elongated Particles, or Flat and Elongated Particles2	10% maximum, by weight, for fraction retained on the ½ inch (12.5mm) sieve and 20% maximum, by weight, for the fraction passing the ½-inch (12.5 mm) sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Fine Aggregate Portion (passing the No. 40 (425µm) sieve)		
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
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

[1] Soundness tests not required for recycled concrete aggregates.

[2] A flat particle is one having a ratio of width to thickness greater than three; an elongated particle is one having a ratio of length to width greater than three.

Table 306-2.1b: Aggregate Gradation for Lean Concrete

Sieve Size (square openings)	Percentage by Weight Passing Sieves	Contractors Gradation Percent Passing by Weight
	Gradation [*]	
1½ inch (37.5 mm)	*	
1 inch (25.0 mm)	*	
¾ inch (19.0 mm)	*	
No. 4 (4.75 mm)	*	
No. 40 (425 µm)	*	
No. 200 (75 µm)	*	

****

The Engineer selects the specified gradation from Table 306-2.1c. When deciding which gradation to use, the Engineer should consider aggregates size(s) which are locally available. Gradation may be modified to suit locally available aggregate or recycled concrete pavement, provided the strength requirements are met.

Table 306-2.1c: Aggregate Gradation for Lean Concrete

Sieve Size (square openings)	Percentage by Weight Passing Sieves	
	Gradation A	Gradation B
1-1/2 inch (37.5 mm)	100	--
1 inch (25.0 mm)	70 - 95	100
3/4 inch (19.0 mm)	55 - 85	70 - 100
No. 4 (4.75 mm)	30 - 60	35 - 65
No. 40 (425 µm)	10 - 30	15 - 30
No. 200 (75 µm)	0 - 15	0 - 15

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306-2.3 Cement.

Use any of the following cements: ASTM C150, *Types I, II,* or *V*; ASTM C595, *Types IS*, *IP*, *IL*, or *IT*; ASTM C1157 *Types GU, HS, MS, MH, or LH.*

306-2.4 Cementitious Additives.

Coal ash, Pozzolans, and slag cement may be added to the lean concrete mix. If used, each material must meet the following requirements.

306-2.4.1 Pozzolan.

Pozzolanic materials must meet the requirements of ASTM C618, Class F, or N except for loss of ignition, where the maximum must be less than 6%. **[** `The supplementary optional physical requirements of Table 3 contained in ASTM C618 applies.` **]**

306-2.4.2 Slag Cement (Ground Granulated blast Furnace (GGBF) Slag).

Slag must conform to ASTM C989, Grade 100 or 120.

306-2.5 Chemical Admixtures.

The Contractor must submit certificates indicating that the furnished material meets all the requirements listed below. In addition, the RPR may require the Contractor to submit complete test data showing that the furnished material meets all requirements of the cited specification.

306-2.5.1 Air-entraining Admixtures.

Air-entraining admixtures must meet the requirements of ASTM C260.

306-2.5.2 Water-reducing Admixtures.

Water-reducing, set-controlling, admixtures must meet the requirements of ASTM C494, Type A, D, E, F, or G. Add water-reducing admixtures at the mixer separately from air-entraining admixtures according to the manufacturer's printed instructions. The air entrainment agent and the water-reducing admixture must be compatible.

306-2.5.3 Retarding Admixtures.

Retarding admixtures must meet the requirements of ASTM C494, Type B or D.

306-2.5.4 Accelerating Admixtures.

Accelerating admixtures must meet the requirements of ASTM C494, Type C.

306-2.6 Water.

Water from a drinking water source is suitable for mixing and curing. If water is taken from other sources, it must meet the requirements of ASTM C1602.

306-2.7 Curing Materials.

For curing lean concrete, use white-pigmented, liquid membrane-forming compound conforming to ASTM C309, Type 2, Class B, or clear or translucent Type 1-D, Class B with white fugitive dye. **[__]**

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The Engineer may add additional curing materials. Modify paragraph 306-2.7 accordingly.

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P-306-3 MIXTURE COMPOSITION

306-3.1 Mix Design.

The lean concrete mix design must be based on trial batch results conducted in the laboratory which meet the criteria of this section. Seven-day compressive strength must not be less than 500 lbs per square inch (3,445 kPa) or greater than 800 lbs per square inch (5,516 kPa). Take compressive strengths as the average of two compressive strength test results. Prepare and test all compressive strength specimens according to ASTM C192 and ASTM C39. Note, maximum strength is only tested during mix design, acceptance based upon minimum compressive strength.

The percentage of air entrainment is **[** 6% **]**, ±½%. Air content is determined by testing, according to ASTM C231, for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate. The mix design must include a complete list of materials, including type, brand, source, and amount of cement, fine aggregate, coarse aggregate, water, and cementitious additives.

Changes in the source of aggregate require a new mix design. Changes in supplier of cementitious material require a new trial batch, if trial batch is not acceptable a new mix design is required. Minor changes in dosage of admixtures are acceptable.

Changes in supplier of admixtures or addition or deletion of an admixture requires a trial batch. If the trial batch is not acceptable, a new mix design is required.

306-3.2 Mix Design Submittals.

At least **[** `30 days` **]** prior to the placement of the lean concrete, the Contractor must submit certified test reports to the Resident Project Representative (RPR) for those materials proposed for use during construction, as well as the mix design for the lean concrete material. The certifications must identify the specifications and test standard, the name of the testing laboratory, the test dates, and a statement that the materials comply with the applicable specifications. Tests must be of material to be used for production and less one year old. The submittal package must include the following:

1. Sources of materials, including aggregate, cement, admixtures, and curing and bond breaking materials.
2. Physical properties of the aggregates, cement, admixtures, curing and bond breaking materials.
3. Mix design:
    a. Mix identification number
    b. Weight of saturated surface-dry aggregates (fine and coarse)
    c. Combined aggregate gradation
    d. Cement factor
    e. Water content
    f. Water-cementitious material ratio (by weight)
    g. Volume of admixtures and yield for one cubic yard (cubic meter) of lean concrete
4. Laboratory test results:
    a. Slump
    b. Unit weight
    c. Air content
    d. Compressive strength at 3, 7, and 28 days (average values)
    e. **[** `Wet-dry and/or Freeze-thaw weight loss` **]**

During production, the Contractor submits batch tickets to the RPR for each load delivered.

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A control strip is not required on jobs less than 3000 square yards.

Freeze-thaw testing is not required in areas that do not get multiple freeze-thaw cycles. Generally testing is not required in International Institute for Energy Conversation (IECC) Climate Zones 1-3. Areas on the fringe of Zones 3 and 4 should be tested.

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P-306-4 EQUIPMENT

306-4.1 The Contractor must provide certification that all equipment conforms to the requirements of ASTM C94. The Contractor must furnish all equipment necessary to mix, transport, place, compact, and finish the lean concrete material.

306-4.2 Forms.

Use steel straight side forms furnished in sections not less than 10 feet (3 m) in length. Forms must have a depth equal to the pavement thickness at the edge. Use flexible or curved forms of proper radius for curves of 100 feet (30 m) radius or less. Secure forms so that when in place they withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Do not use forms with battered top surfaces and bent, twisted or broken forms. Do not use built-up forms except as the RPR approved. The forms must contain provisions for locking the ends of abutting sections together tightly for secure setting. When the RPR approves, wood forms may be used under special conditions.

306-4.3 Concrete Pavers.

A fixed form or slip-form concrete paver may be used to place lean concrete. The paver must be fully energized, self-propelled, and capable of spreading, consolidating, and finishing the lean concrete material, true to grade, tolerances, and cross-sections. The paver must be of sufficient weight and power to construct the maximum specified concrete paving lane width, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. Slip-form pavers must be equipped with electronic or hydraulic horizontal and vertical control devises. Bridge deck pavers are approved as paver-finishing machines for lean concrete, provided they can handle the amount of lean concrete required for the full-lane width specified, and capable of spreading, consolidating, and finishing the lean concrete material, true to grade, tolerances, and cross-sections.

306-4.4 Vibrators.

For fixed-form construction, vibrators may be either the surface pan type or internal type with either immersed tube or multiple spuds for the full width of the slab. They may be attached to the spreader, the finishing machine, or mounted on a separate carriage. They must not contact the subgrade or forms. For slip-form construction, the paver must have internal vibrators for the full width and depth of the pavement being placed. The number, spacing, frequency, and eccentric weight of vibrators must be sufficient to achieve consolidation without segregation and voids. Internal vibrators may be supplemented by vibrating screeds operating on the surface of the lean concrete. Vibrators and screeds must automatically stop operation when forward motion ceases. Hand-held vibrators may only be used in irregular areas where the paver cannot operate.

306-4.5 Joint Saws.

The Contractor must provide enough saws with adequate power to cut contraction or construction joints to the required dimensions as shown on the plans. The Contractor must provide at least one standby saw in good working order.

P-306-5 CONSTRUCTION METHODS

306-5.1 Control Strip.

****

A control strip is not required on jobs less than 3000 square yards.

****

[Not Required.][The first half-day of construction is considered 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 control strip establishes the equipment and methods to mix, place, consolidate and finish the material. The RPR must witness construction of the control strip and approve the material, equipment, and procedures prior to proceeding to full production.

Control strips not meeting specification requirements must be removed and replaced at the Contractor’s expense. Do not begin full operations until the RPR accepts the control strip. The Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve, in advance, any adjustments made by the Contractor to material, equipment, or procedures.]

306-5.2 Weather Limitations.

306-5.2.1 Cold Weather.

The Contractor must follow the recommended practices in American Concrete Institute (ACI) 306R, Guide to Cold Weather Concreting**.** The temperature of the mixed lean concrete must not be less than 50°F (10°C) at the time of placement. Do not place the lean concrete when the ambient temperature is below 40°F (4°C) or when conditions indicate that the temperature may fall below 35°F (2°C) within 24 hours. Do not place lean concrete on frozen underlying courses.

306-5.2.2 Hot Weather.

The Contractor must follow the recommended practices in ACI 305R, Guide to Hot Weather Concreting. The lean concrete temperature from initial mixing through final cure must not exceed 90°F (32°C). When the maximum daily air temperature exceeds 85°F (30°C), sprinkle the forms and/or the underlying material with water before placing the lean concrete.

306-5.2.3 Rain.

The Contractor should stop operations prior to and must stop during rain to cover and protect any plastic lean concrete. If pavement gets rained on prior to placement of protection, remove any excess water with dry burlap or similar material. If initial set has not occurred, the surface may be finished after removing excess water. The Contractor, at their expense, must remove and replace if more than ¼ inch of paste was removed exposing aggregate. In order not to remove pavement damage by rain, the Contractor must hire a petrographer to perform an analysis to document the depth and extent of damage. Pavement must be able to meet all acceptance criteria for smoothness, thickness, grade, air, and strength. If rain occurs within three hours of application of curing compound, apply an additional coat of curing compound.

306-5.4 Form Setting.

Tightly lock and ensure form sections are free from play or movement in any direction. Forms must not deviate from true line by more than ¼ inch (6 mm) at any joint. The top face of the form must not vary from a true plane more than ⅛ inch (3 mm) in 10 feet (3 m), and the upstanding leg must not vary more than ¼ inch (6 mm). Clean and oil forms prior to the placing of lean concrete. Wood forms may be used under special conditions and as the base form to adjust for variations in grade. Forms must extend the full depth of the pavement section, except shims less than 1 inch, are permitted to correct for variations in grade.

306-5.5 Preparation of Underlying Course.

The RPR must check and accept the underlying course before placing operations begin. Prior to placing the material, the final grade must be firm, moist, and free of frost. Use of chemicals to eliminate frost is not permitted. Wet the underlying course in advance of placing the lean concrete base course.

306-5.6 Grade Control.

Grade control must be as necessary to construct the layer to the profile and cross-sections as shown on the plans.

306-5.7 Mixing.

The batch plant site, layout, equipment, and provisions for transporting material must ensure a continuous supply of material to the work. Construct stockpiles in a manner that prevents segregation and intermixing of deleterious materials. Mix and deliver lean concrete to the site per the requirements of ASTM C94 or ASTM C685. The mixing time must be adequate to produce lean concrete that is uniform in appearance with all ingredients evenly distributed. Measure mixing time from the time all materials are emptied into the drum and until the discharge chute is opened to deliver the lean concrete. Add water in first one fourth of mixing time.

The elapsed time from the addition of cementitious material to the mix until the lean concrete is deposited in place at the worksite must not exceed 60 minutes when the concrete is hauled in non-agitating trucks, or 90 minutes when it is hauled in truck mixers or truck agitators. Re-tempering lean concrete is not permitted, except when delivered in truck mixers. With truck mixers, additional water may only be added to the batch materials if the addition of water is added within 45 minutes after the initial mixing operations and the water/cement ratio specified in the mix design is not exceeded.

306-5.8 Placing.

Place the lean concrete material continuously at a uniform rate on the underlying course minimizing segregation and handling of the mix. Rakes are not permitted for spreading the lean concrete.

306-5.9 Finishing.

Shape the finished surface of the lean concrete base layer to the specified lines, grades, and cross-section. Hand finishing is not permitted except in areas where the mechanical finisher cannot operate.

[`The surface of the lean concrete must not be textured.` **|** `The surface of the lean concrete must have a coarse texture.` **]**

****

If a concrete overlay is required, select the no texture option. If an asphalt overlay is required, select the coarse texture option.

****

306-5.10 Construction Limitations.

Complete all placement and finishing operations within two hours from the start of mixing. Material placed and not finished within the 2-hour time limit must be removed and replaced at the Contractor’s expense. Form a straight transverse construction joint at the end of each day’s construction and/or when operations are interrupted for more than 30 minutes, by a header or by cutting back into the compacted material to form a true vertical face.

306-5.11 Joints.

Locate all longitudinal and transverse joints as shown on the plans. Longitudinal joints must be within 6 inches (150 mm) of planned joints in the overlaying concrete pavement and transverse joints must be within 3 inches (75 mm) the planned joints of the overlying concrete surface. Saw joints as soon as the base can support the saws without damage to the lean concrete base. Construct joints by sawing the hardened lean concrete to a depth of at least one-third the thickness of the lean concrete base, or one-fifth the depth of the lean concrete base when using early entry saws.

306-5.12 Curing.

Immediately after finishing operations are completed and bleed water is gone from the surface, all exposed surfaces of the newly placed concrete must be cured for a seven day cure period according to one of the methods below. Note, not all mixes have bleed water, and in areas of low humidity there may not be any bleed water. The concrete must not be left exposed for more than ½ hour during the curing period.

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The Engineer deletes cure types that may not be feasible in operating areas subject to aircraft jet blast.

The use of supplementary cementitious materials (for example, coal ash, slag cement) or set-retarding admixtures may delay the occurrence of bleed water.

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306-5.12.1 Impervious Membrane Method.

After bleed and surface moisture has evaporated curing with liquid membrane compounds. All exposed surfaces of the pavement must be sprayed with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. Do not apply curing compound during rainfall. Apply curing compound with mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 square feet (14 square meters). Use fully atomizing type spraying equipment equipped with a tank agitator. At the time of use, the compound must be in a thoroughly mixed condition with the pigment dispersed throughout the vehicle. During application, the compound must be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms is permitted. When the RPR approved hand spraying, use a double application rate to ensure coverage. If the film become damaged from any cause, including sawing operations, within the required curing period, repair the damaged portions immediately with additional compound or other approved means. Upon removal of side forms, immediately protect the sides of the exposed slabs to provide a curing treatment equal to that provided for the surface.

306-5.12.2 White Burlap-polyethylene Sheets.

The surface of the pavement must be entirely covered with the sheeting. The sheeting used will be such length (or width) to extend at least twice the thickness of the pavement beyond the edges of the slab. Place the sheeting so that the entire surface and both edges of the slab are completely covered. Place and weight the sheeting to remain in contact with the surface covered, and the covering maintained fully saturated and in position for seven days after the concrete has been placed.

306-5.12.3 Water Method.

The entire area must be covered with burlap or other water absorbing material. The material must be of sufficient thickness to retain water for adequate curing without excessive runoff. The material must always be kept wet and maintained for seven days. When the forms are stripped, the vertical walls must also be kept moist. It is the responsibility of the Contractor to prevent ponding of the curing water on the lean concrete base.

306-5.12.4 Concrete Protection for Cold Weather.

Maintain the concrete at a temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the seven-day curing period. The Contractor is responsible for the quality and strength of the concrete placed during cold weather; any concrete damaged is removed and replaced at the Contractor’s expense.

306-5.12.5 Concrete Protection for Hot Weather.

Concrete should be continuous moisture cured for the entire curing period, must commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, protect the concrete surface from drying with application of a liquid membrane-forming curing compound while surfaces are still damp and apply a second application 24 hours after the first. The RPR may approve other curing methods.

306-5.13 Maintenance.

The Contractor must protect the lean concrete from damage due to environment or construction traffic. Traffic is not permitted on the pavement until test specimens made per ASTM C31 have attained a compressive strength of 500 psi (3445 kPa) when tested per ASTM C39. The Contractor must maintain the applied curing method for the entire curing period.

306-5.14 Sampling and Testing.

306-5.14.1 Aggregate base materials.

The Contractor must take samples of the aggregate according to ASTM D75 to verify aggregate quality and gradation. Material must meet the requirements in paragraph 306-2.1. As a minimum, material must be tested for quality prior to the start of construction and prior to the restart of construction for projects that span multiple construction seasons. **[__]**

306-5.14.2 Gradation requirements.

The Contractor must take at least **[** two **]** aggregate samples, per day, ASTM D75 in the presence of the RPR to check the gradation.

306-5.15 Surface Tolerance.

306-5.15.1 Grade.

The Contractor is responsible for measuring the grade and crown on a **[** 50 **|** 25 **|** 12.5 **]** foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within + 0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by removing and replacing. The Contractor must provide the final grade checks to the RPR prior to construction of the next pavement layer.

306-5.15.2 Smoothness.

The final surface must not vary more than +0 to – ⅜ inch (9mm) when tested with a 12-foot (3.7 m) straightedge applied parallel to and at right angles to the centerline. Move the straight edge continuously forward at half the length of the straight edge for the full length of each line on a **[** 25 **|** 50 **]** foot grid.

P-306-6 MATERIAL ACCEPTANCE

306-6.1 Acceptance Sampling and Testing.

The RPR performs acceptance sampling and testing to determine conformance with the requirements specified in this section for each **[** 1200 square yards (1000 square meters) **]**. The RPR determines sampling locations on a random basis per ASTM D3665.

306-6.1.1 Compressive Strength.

Take one sample of freshly delivered lean concrete for compressive strength and air content for each **[** 1200 square yards (1000 square meters) **]** according to ASTM C172, and air content tests according to ASTM C231. Make and cure two test cylinders from the sample, per ASTM C31, and determine the seven-day compressive strength of each cylinder, per ASTM C39. The compressive strength is the average of the two, seven day compressive strengths. The Contractor provides for the initial curing of cylinders according to ASTM C31 during the 24 hours after molding.

306-6.1.2 Thickness.

[The Contractor drills cores at two different sampling locations for thickness determination for each **[** 1200 square yards (1000 square meters). **]** Determine thickness by measuring the depth of core holes and computed by averaging the thickness determination of the two locations.

The Contractor fills core holes with lean concrete base or non-shrink grout. **]**

[[A survey determines if the thickness of the base course is within +0 and -½ inch (12 mm) of the specified thickness. Prior to placement of the base course, the **[** Contractor | RPR **]** surveys the **[** subgrade | subbase **]** on a **[** 50 | 37.5 | 17.5 | 12.5 **]** foot grid relative to centerline of base **]**. After placement of the base, survey the surface base on the same grid and the thickness of base course determined. **]**

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The Engineer may change sampling frequency to compensate for project size and anticipated production.

The Engineer must select the method to determine the thickness and delete the other option. When the survey method is selected, the Engineer must specify the minimum survey grid. The size of grid must be relative to the width of placement and width of pavement.

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306-6.2 Acceptance.

306-6.2.1 Strength.

If the lean concrete fails to meet the minimum compressive strength requirements, the Contractor must remove and replace the material at the Contractor’s expense.

306-6.2.2 Thickness.

Full payment is made if the average thickness is not deficient by more than ½ inch (12 mm) from the plan thickness. When such measurement is deficient by more than ½ inch (12 mm) but less than 1-inch (25 mm) from the plan thickness, the Contractor must remove and replace the area represented by the test at the Contractor’s expense, or be permitted to remain in-place at an adjusted payment of 75% of the contract unit price.

P-306-7 METHOD OF MEASUREMENT

306-7.1 Measurement.

The quantity of lean concrete base course is determined by the number of square yard (square meters) of lean concrete actually constructed and the RPR accepted as complying with the plans and specifications.

P-306-8 BASIS OF PAYMENT

306-8.1 Payment.

The accepted quantities of lean concrete are paid for at the contract unit price per square yard (square meters) for lean concrete base. The price and payment is full compensation for furnishing and placing all materials, provided; however, for any pavement found deficient in thickness as specified in paragraph 306-6.2.2, the reduced unit price is paid.

Item P-306-8.1 Payment is made for lean concrete base course - per **[** `square yard (`square meters`)` **]**.

P-306-9 REFERENCES

306-9.1 This list of publications forms 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 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 C150	*Standard Specification for Portland Cement*
ASTM C172	*Standard Practice for Sampling Freshly Mixed Concrete*
ASTM C173	*Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method*
ASTM C174	*Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores*
ASTM C192	*Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory*
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 C1260	*Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)*
ASTM C309	*Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete*
ASTM C494	*Standard Specification for Chemical Admixtures for Concrete*
ASTM C595	*Standard Specification for Blended Hydraulic Cements*
ASTM C618	*Specification for Coal Fly Ash and Raw and Calcined Natural Pozzolans for Use in Concrete*
ASTM C989	*Standard Specification for Slag Cement for Use in Concrete and Mortars*

ASTM C1567	*Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregates (Accelerated Mortar-Bar Method)*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T136	*Standard Method of Test for Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures*
ASTM D3665	*Standard Practice for Random Sampling of Construction Materials*

American Concrete Institute (ACI)

ACI 305R	*Guide to Hot Weather Concreting*
ACI 306R	*Guide to Cold Weather Concreting*

END OF ITEM P-306

Item P-307 Stabilized Drainable Base Course (SDBC)

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- **Item P-307 can be used as a stabilized base course under flexible and rigid pavements. Stabilize it with either asphalt or cement. To be considered a drainable base, material needs to have a permeability of 500-1500 ft/day (150-455 m/day).**
- **See Advisory Circular (AC) 150/5320-6 for where the drainable base is placed.**
- **Size 78 gradation may have better stability under construction loads and has been found to take less compactive effort than Size 57.**
- **Some fines will need to be added to the Size 57 and Size 67 stone to increase stability.**

****

307-1 DESCRIPTION

307-1.1 This item consists of drainable (permeable) base stabilized with either asphalt or cement. The stabilized drainable base course (drainage layer) is composed of mineral aggregate, and asphalt or cement mixed in a central mixing plant and placed on a prepared subgrade or base course according to these specifications conforming to the lines, grades, thickness, and typical cross sections shown in the plans.

307-2 MATERIALS

307-2.1 Aggregate.

Use aggregate consisting of clean, sound, hard, durable, angular particles of crushed gravel, crushed stone, or recycled cement concrete meeting the gradation requirements of **[** `ASTM D448 Size 78` **|**`ASTM C33 Size 67` **|**`or` **|**`ASTM C33 Size 57` **],** and if needed for stability, a fine aggregate consisting of natural sand or manufactured sand that meets the requirements of ASTM C33. The aggregate must meet the material requirements Table 307-2.1.

Table 307-2.1: Aggregate Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate		
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate [1]	Loss after five cycles: 12% maximum using Sodium Sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Fractured Faces	90% by weight of particles with at least two fractured faces	ASTM D5821
Flat Particles, Elongated Particles, or Flat and Elongated Particles[2]	10% maximum, by weight, for fraction retained on the ⅜-inch (9.5mm) sieve and 10% maximum, by weight, for the fraction passing the ⅜-inch (9.5 mm) sieve	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3%	ASTM C142
Fine Aggregate		
Clay lumps and friable particles	Less than or equal to 3%	ASTM C142
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

[1] Soundness test not required when aggregate is recycled concrete.

[2] A flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

307-2.2 Sampling and Testing.

307-2.2.1 Aggregate Base Materials.

The Contractor samples the aggregate base stockpile according to ASTM D75 to verify aggregate requirements gradation. Material must meet the requirements in paragraph 307-2.1. This sampling and testing is the basis for approval of the aggregate base quality requirements. **[__]**

****

The Engineer defines when additional sampling points are needed in the above paragraph. Generally testing from supplier and at least one test as delivered to job to ensure no material breakdown in transport.

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307-2.3 Stabilizing Material

307-2.3.1 Asphalt Binder.

[Use asphalt binder conforming to ASTM D6373 Performance Grade (PG) [asphalt | cement | not used].]

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Use the base binder grade for the project location.

****

307-2.3.2 Cement.

[Cement must conform to the requirements of ASTM C150, Type I, II or V; ASTM C595, Type IP, IL, IS, IT, or ASTM C989.]

307-2.4 Anti-stripping Agent.

[Not used.] [Any anti-stripping agent or additive (anti-strip) must be heat stable and not change the asphalt binder grade beyond specifications. The Department of Transportation (DOT) of the State in which the project is located must approve the antistrip material.]

307-2.5 Separation Geotextile.

[Not used.] [Use [[Class 2], [0.05 sec^{-1}] separation geotextile with a permittivity per ASTM D4491, apparent opening size per ASTM D4751 with [0.60 mm] maximum average roll value.]

****

If the drainage layer is constructed on a dense graded aggregate layer, e.g., P-209, a separation fabric is not needed. Use of a separation geotextile is recommended to maintain the integrity of the drainage layer when drainage layer is the first layer above subgrade.

See AASHTO M288 for additional notes regarding separation geotextiles.

****

307-3 MIXTURE COMPOSITION

307-3.1 Mix Design.

The job mix formula (JMF) must have a permeability of not less than 500 ft/day (150 m/day) or more than 1,500 ft/day (455 m/day) when tested with constant head permeability test ASTM D2434/AASHTO T215. Note, the mix used for production is the mix as adjusted to construct an acceptable control strip.

307-3.1.1 Asphalt Stabilized. [Not used.]

[The JMF is composed of a mixture of open graded aggregate, a minimum of 0.5% antistrip agent, and a minimum of 2% asphalt binder. An acceptable asphalt stabilized mix has sufficient asphalt binder to cover 95% of mixture with a shiny black appearance with minimal drain down at 200°F and binds the compacted mix when the aggregates are blended and mixed with the asphalt cement at [250°F (121°C)] and compacted at [150°F (65°C)].]

307-3.1.2 Cement Stabilized. [Not used.]

[The JMF is composed of a mixture of open graded aggregate 200 lbs of cement per cubic yard with a water cement ratio of 0.37, and additives as needed for workability.]

307-3.2 Submittals.

At least [30 days] prior to the placement of the drainage layer the Contractor must submit certified test reports to the RPR for the materials for the stabilized drainable base, as well as the JMF design information. The submittal package must include the following:

1. Sources of materials, including aggregate, [asphalt binder], [cement], additives, and bond-breaking materials (if used).
2. Physical properties of the aggregates, combined gradation of the aggregate, amount of coarse aggregate, amount of fine aggregate, [asphalt binder, antistrip agent], [cement] and bond-breaking materials.
3. [Percent of asphalt and amount of antistrip agent. | Amount of cement.]
4. Amount and type of additives.
5. Permeability of JMF.

Do not place drainage layer material until the RPR accepts the submittal in writing. During production, the Contractor must submit batch tickets for each load delivered that indicate amount of aggregate, amount of asphalt or amount of cement and water, amount of any additives.

307-4 CONSTRUCTION METHODS

307-4.1 Preparation of the Underlying Course.

The RPR must check and accept the underlying course before placing operations begin. Prior to placing the material, the final grade should be firm, moist, and free of frost. Use of chemicals to eliminate frost is not permitted.

307-4.2 Control Strip.

307-4.2.1 Consider the first **[** `half-day` **]** of construction the control strip. The Contractor must demonstrate, in the RPR's presence, that the materials, equipment, and construction processes meet the requirements of this specification for thickness, grade, and smoothness.

307-4.2.2 Batch, mix, transport, place, compact, and finish the material using the equipment proposed for production.

307-4.2.3 Compaction is required to seat the aggregate without crushing and creating a layer that is stable under construction traffic. Rollers must be in good condition and capable of reversing without backlash and compacting the stabilized drainage layer without undue displacement or excessive crushing of the aggregate.

1. **[** `For cement stabilized drainage layers, begin initial compaction within 30 minutes of placement.` **|** `For asphalt stabilized drainage layers, do not initiate additional compaction until the mixture cools to below 175°F (or lower as determined during construction of the test strip).` **]**
2. Three to four passes of a self-propelled, steel-wheel roller with weight between 5 and 12 tons (4.5 to 10.9 metric tons) is usually sufficient. Start with two to three passes in vibratory mode and a final pass in static mode of a steel wheel roller with a weight between 5 and 12 tons (4.5 to 10.9 metric tons).
3. If material is displacing or breaking down, perform all compaction in static mode. Use the minimum number of passes necessary to seat the aggregate and create a layer stable under construction traffic.

4. The RPR approves the actual rolling pattern and sequence established during placement of the control strip. In areas inaccessible to the paver and roller, hand operated vibrator-plate compactors may be used to seat the aggregate.

[307-4.2.4 `The asphalt stabilized drainage layer control strip is considered acceptable when aggregate is completely coated with asphalt cement with minimal evidence of crushing; the surface is firm, unyielding and stable under construction traffic.` | `The cement stabilized drainage layer control strip is considered acceptable when the surface is firm and unyielding and is stable under construction traffic.`]

307-4.2.5 Test the control strip for stability under construction traffic with ten passes of the construction vehicle with the highest ground pressure. The drainage layer is acceptable if there is no rutting or shoving greater than ½ inch. [`Test asphalt stabilized layers after the mat cools to ambient temperature.`][`Test cement stabilized layers after minimum of` [`48`] `hours.`]

307-4.2.6 The Contractor must remove and replace, at their expense, control strips not meeting the specification requirements. Do not begin full operations until the RPR accepts the control strip. Upon the RPR's acceptance of the control strip, the Contractor must use the same equipment, materials, and construction methods for the remainder of construction. The RPR must approve any adjustments to equipment, materials, and construction methods in advance. Minor adjustments to mix design due to site conditions are acceptable.

307-4.3 Weather Limitations.

Do not mix or place the drainage layer material while the air temperature is below 40°F (4°C). Do not place on frozen underlying courses or when aggregate is frozen. Do not place when rainfall is occurring or where rain is imminent.

307-4.4 Equipment.

The Contractor furnishes, and the RPR approves, all equipment necessary to mix, transport, place, compact, and finish the drainage layer.

307-4.5 Mixing.

The batch plant site, layout, equipment, and provisions for transporting material must ensure a continuous supply of material to the work. Construct stockpiles in a manner that prevents segregation and intermixing of deleterious materials. The RPR must have free access to the plant at all times for inspection of the plant's equipment and operation and sampling the drainage layer mixture and its components. Provide mixing plants which are automatic or semiautomatic, commercially manufactured units designed and operated to consistently produce the JMF.

307-4.6 Hauling.

Transport the mixture from the plant to the job site in trucks or other hauling equipment having beds that are smooth and clean. [Apply a release agent to prevent adhesion of the material to the beds. Drain excessive release agent prior to loading.] Provide truck bed covers to protect the material during transport from rain. Reject loads having crusts of unworkable material or have become wet. Do not haul over freshly placed material.

307-4.7 Placing.

Place the drainage layer material using a mechanical spreader, asphalt paver or concrete paver. Install the drainage layer in a single [6 inch (150 mm)] lift. The spreader or paver must be able to place a uniform, full-depth layer of material across the full width of the base in one pass. When two or more spreaders or pavers are required, operate the equipment so that work progresses along the full width of the base in a uniform manner, and the placement is no more than one hour apart. Alternate placement methods may be acceptable, if the Contractor can demonstrate with the construction of the control strip, that specified acceptance results can be achieved.

307-4.8 Compaction.

Compact the drainage layer using the approved compaction equipment and roller pattern/sequence, as established during construction of the approved control strip. Furnish sufficient rollers to handle the output of the plant. If the rolling pattern/sequence results in undue displacement of the surface, or causes crushing of the aggregate, stop work until the cause(s) are determined and corrections made. Do not pass the roller over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint.

307-4.9 Curing Cement Stabilized Drainage Layer.

[Not used.][The completed drainage layer must be kept moist until application of an impervious membrane or other curing methods as defined below.

307-4.9.1 Liquid Membrane.

Curing materials must be a liquid membrane-forming compounds for curing concrete conforming to the requirements of ASTM C309, Type 2, Class B.

307-4.9.2 Water Method.

Keep the surface of the cement stabilized drainage layer wet for at least 12 hours. Keep the surface of the cement stabilized drainage layer wet for at least 12 hours. This can be accomplished with sprinklers or by covering the surface with burlap or other water absorbing material and keeping that material wet for the entire cure period.]

307-4.10 Construction Joints.

Make the formation of all joints to ensure a continuous bond between old and new sections of the course. All joints must have the same texture and smoothness as other sections of the course. Form transverse joints by placement of a bulkhead or by tapering the mixture. Cut tapered joints back full depth and width creating a vertical joint before placing additional mixture against the joint. Cut back irregular or damaged joints to expose a clean, sound surface for full depth of course.

307-4.11 Quality Control (QC).

The Contractor performs tests for grade, gradation, and [asphalt content | cement content and water/cement ratio] daily. Asphalt content and gradation must be within job tolerances or appropriate steps taken to maintain production control within tolerances. The Contractor must correct at the Contractor's expense any area not meeting grade. The Contractor provides gradation, [asphalt content | cement content | batch tickets], and grade data to the RPR daily.

307-4.11.1 Grade.

The Contractor is responsible for measuring the grade and crown on a [50 | 25 | 12.5] foot grid, but must include grades at pavement centerline, crown (if different than centerline), edge of proposed full strength pavement and edge of proposed paved shoulder (if applicable). Grade must be within +0.0 to -0.05 feet (15 mm) of the specified grade in areas that will be paved, and within ±0.10 feet in all other areas. The Contractor is responsible for correcting any deviation in surface tolerances, at their expense, by removal and replacing SDBC. The Contractor must perform final grade checks in RPR's the presence.

307-4.11.2 Gradation.

Determine aggregate gradation a minimum of twice daily from mechanical analysis of extracted aggregate according to ASTM D5444, ASTM C136 and ASTM C117.

[307-4.11.3 Asphalt Content. | Cement Content.]

[Determine asphalt content a minimum of twice daily according to ASTM D6307 or ASTM D2172. Batch tickets must indicate amount of aggregate, asphalt binder, antistrip agent for each batch.]

[Batch tickets must indicate amount of aggregate, cement, water and additives for each batch. Batch ticket must indicate water/cement ratio.]

307-4.13 Maintenance.

Until placing the pavement, the Contractor must maintain the completed drainable base in a condition to meet all specification requirements. Make placement of the next higher pavement layer as soon as practicable, but no more than thirty calendar days after placement of the drainage layer. Do not open the asphalt stabilized drainable base course to traffic until the mixture has cooled to ambient temperature. Keep traffic to a minimum to avoid rutting, contamination, or displacement of SDBC. Limit traffic on ATPB to equipment needed to construct next higher pavement layer.

307-5 MATERIAL ACCEPTANCE

307-5.1 Sampling and Testing.

The RPR performs all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section. The RPR determines sampling locations on a random basis per ASTM D3665. The Contractor bears the cost of providing curing facilities for the strength specimens.

307-5.1.1 Thickness.

[The Contractor drills cores for thickness determination for each [1200 square yards (1000 square meters).] Determine thickness by measuring the depth of core hole.]

A survey determines if the thickness of the stabilized drainage layer is within +0 and -½ inch (12 mm) of the specified thickness. Prior to placement of the stabilized drainage layer, the [Contractor | RPR] surveys the [subgrade | subbase | base] on a [50 | 37.5 | 17.5 | 12.5] foot grid relative to centerline of base. After placement of the stabilized drainage layer, survey the surface on the same grid and the thickness of the stabilized drainage layer is determined.

****

The Engineer may change sampling frequency to compensate for project size and anticipated production.

The Engineer must select the method to determine the thickness and delete the other option. When the survey method is selected, the Engineer specifies the minimum survey grid.

****

307-6 METHOD OF MEASUREMENT

307-6.1 Measurement.

The quantity of SDBC is measured by the number of square yards (square meters) of material placed and accepted in the completed base course.

307-7 BASIS OF PAYMENT

307-7.1 Payment.s

Payment is made at the contract unit price per square yard (square meters) for SDBC as measured by RPR. This price is full compensation for furnishing all materials, for all preparation, mixing, placing, compacting curing and placement of overlaying bond breaker; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item P-307	SDBC - per square yard (square meters).

307-8 REFERENCES

307-8.1 This list of publications forms 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 C33	*Standard Specification for Concrete Aggregates*
ASTM D75	*Standard Practice for Sampling Aggregates*
ASTM C88	*Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate*
ASTM C131	*Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine*
ASTM C142	*Standard Test Method for Clay Lumps and Friable Particles in Aggregates*
ASTM D448	*Standard Classification for Sizes of Aggregate for Road and Bridge Construction*
ASTM D2434	*Standard Test Method for Permeability of Granular Soils (Constant Head)*
ASTM D3665	*Standard Practice for Random Sampling of Construction Materials*

ASTM C1701	*Standard Test Method for Infiltration Rate of In Place Pervious Concrete*

American Association of State Highway and Transportation Officials (AASHTO)

M288	*Standard Specification for Geosynthetic Specification for Highway Applications*
T215	*Standard Method of Test for Permeability of Granular Soils (Constant Head)*

END OF ITEM P-307

Part 6 – Flexible Pavements

Item P-401 Asphalt Mix Pavement

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- **State highway department specifications may be used in lieu of this specification for access roads, perimeter roads, stabilized base courses under Item P-501, and other pavements not subject to aircraft loading, or for pavements designed for aircraft gross weights of 30,000 pounds (13,600 kg) or less. When state highway department material specification are used:**
    - **The state specification must have a demonstrated satisfactory performance record under equivalent loadings and exposure.**
    - **When a density requirement is not specified by a state specification, modify it to include testing mat density to be at least 94% of TMD, and joint density to be at least 92% of TMD.**
    - **When state highway specifications are approved, include all applicable/approved state specifications in the contract documents.**
    - **Update any references to State Department of Transportation (DOT), State Materials Laboratory, etc., to “Owner,” “Engineer,” etc. as appropriate for project.**
- **The use of state highway department specifications for airfield pavements subject to aircraft loading by aircraft greater than 30,000 pounds and less than 60,000 pounds requires a modification to standards in accordance with FAA Order 5300.1, *Modifications to Agency Airport Design, Construction, and Equipment Standards.***
- **This item should be used for flexible pavements subject to aircraft loadings of gross weights greater than 30,000 lbs (13,600 kg) or tire pressures greater than 175 psi.**
- **The surface course is considered to be the top four inches. Any additional asphalt is considered base.**
- **Airfield pavement projects at nonprimary airports, serving aircraft less than 60,000 lbs (27,216 kg) and tire pressure less than 175 psi (1.2 mPa), may use state highway specifications in states where the state requested and received Federal Aviation Administration (FAA) approval to use state highway specifications.**
- **Leveling courses cannot exceed 1½ inches and only used when needed to correct surface irregularities in underlying layers.**

- **This specification contains job mix formula (JMF) options using Gyratory Mix Design Methods.**
- **Grade bumps apply to the entire thickness of asphalt. Use the same binder grade for all bituminous material used on the project surface and base. When recycled asphalt pavement (RAP) is used, see paragraph 401-3.4 for adjustments to the binder grade.**
- **When a fuel resistant surface is required, use either a fuel resistant asphalt binder or a fuel resistant surface treatment (Item P-629, P-630 or P-635). The Engineer must indicate the limits of fuel resistant surface on the plans.**
- **This specification contains warm mix asphalt provisions. Warm mix asphalt is when mix and placement temperatures are reduced approximately 50°F-100°F (10°C-38°C), using warm mix additives and or technology.**
- **Asphalt mix using WMA technology has shown a higher susceptibility to moisture damage and stripping due to the presence of water from lower production temperatures. Engineer must make sure that mixes incorporate better quality aggregates when determining the job mix formula. Aggregate sources that have a history of asphalt stripping will compound the probability. Aggregate sources that have either higher percentage of flat and elongated particles or higher percentage of fines or high absorption content may fall into this category.**

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401-1 DESCRIPTION

401-1.1 This item consists of pavement courses composed of mineral aggregate and asphalt binder, mixed in a central mixing plant and placed on a prepared base course, according to these specifications and conforming to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Construct each course to the depth, typical section, and elevation required by the plans.

401-2 MATERIALS

401-2.1 Aggregate.

Aggregates consist of crushed stone, crushed gravel, screenings, natural sand, and mineral filler, as required. The aggregates must not have any 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. Mineral filler is the fine-grained material with at least 70% passing the No. 200. Mineral filler is either naturally present or added to the aggregate mix. Submit aggregate test results required in Tables 401-2.1a and 401-2.1b with the mix design and prior to the start of a new construction season on projects spanning multiple construction seasons.

****

Some aggregates may contain ferrous sulfides and iron oxides which can cause stains on exposed surfaces. In areas where staining has been a problem or is suspected, the Engineer should verify that producers and aggregate suppliers take steps to minimize the inclusion of any ferrous sulfides or iron oxides in aggregate used in the project.

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401-2.1.1 Coarse Aggregate.

Coarse aggregate consists of sound, tough, durable particles, free from films of matter that prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Table 401-2.1a lists coarse aggregate material requirements.

401-2.1.2 Fine Aggregate.

Fine aggregate consists of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel, and is 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 subject to the limitations in Table 401-2.1b. Natural sand is not permitted in Warm Mixed Asphalt (WMA). Table 401-2.1b. lists the fine aggregate materials.

401-2.1.3 Sampling.

Follow ASTM D75 in sampling coarse and fine aggregate.

Table 401-2.1a: Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to degradation	Loss: 40% maximum	ASTM C131
Soundness of aggregates by using sodium sulfate or magnesium sulfate	Loss after five cycles: 12% maximum using sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum [0.3% maximum when FRA]	ASTM C142
Coarse aggregate angularity[1]	For pavements designed for aircraft gross weights of ≥ 60,000 lbs (27,200 kg): Uncompacted Voids > 45%	American Association of State Highway and Transportation (AASHTO) T 326 Method A
	For pavements designed for aircraft gross weights ≤ 60,000 lbs (27,200 kg): Uncompacted Voids > 40%	
Fractured particles	For pavements designed for aircraft gross weights of 60,000 lbs (27,200 kg) or more 100% with at least two fractured faces	ASTM D5821
	For pavements designed for aircraft gross weights of less than 60,000 lbs (27,200 kg) 75% two fractured faces/85% with at least one fractured face	
Flat, Elongated, or Flat and Elongated particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1	ASTM D4791

Table 401-2.1b: Fine Aggregate Material Requirements

Material Test	Requirement	Standard
Liquid limit	25 maximum	ASTM D4318
Plasticity Index	4 maximum	ASTM D4318
Soundness of aggregates by using sodium sulfate **or** magnesium sulfate	Loss after five cycles: 10% maximum using Sodium sulfate - or - [15%][1] maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	1.0% maximum	ASTM C142
Sand equivalent	[45 minimum]	ASTM D2419
[Sand equivalent, Fuel Resistant Asphalt (FRA)]	[35 minimum]	[ASTM D2419]

Material Test	Requirement	Standard
Uncompacted Voids	For pavements designed for aircraft gross weights ≥ 60,000 lbs (27,200 kg) Uncompacted voids > 45% For pavements design for aircraft gross weights < 60,000 Uncompacted voids not required	ASTM C1252, Method A
Natural Sand [2]	For pavements designed for aircraft ≥60,000 ((27,200 kg) lbs [0% to 10%] maximum by weight of total aggregate For pavements designed for aircraft < 60,000 lbs (27,200 kg) [0% - 15%] maximum by weight of total aggregate For WMA 0% For Fuel Resistant Asphalt (FRA) 0%	ASTM D1073

[1] With FRA maximum 13%.

[2] The addition of natural sand to a mix containing all crushed coarse and fine aggregates normally increases its workability and compactability. The addition of natural sand tends to decrease the stability of the mixture. It is recommended to limit natural sand to the minimum amount necessary to achieve a workable mixture.

401-2.2 Mineral Filler.

Mineral filler (baghouse fines) may be added in addition to material naturally present in the aggregate. Mineral filler must meet the requirements of ASTM D242 and the requirements in Table 401-2.2.

Table 401-2.2: Mineral Filler Requirements [1]

Material Test	Requirement	Standard
Plasticity Index	4 maximum	ASTM D4318

401-2.3 Asphalt Binder.

Use Asphalt Binder conforming with ASTM D6373 Performance Grade (PG) **[__]**. Use the same asphalt binder grade for all asphalt layers for surface and base, unless the job mix formula (JMF) includes RAP then follow guidance in paragraph 401-3.4. When P-401 is used as a stabilized base beneath a rigid pavement, use the base binder grade for that location. **[** For fuel resistant asphalt (FRA), use asphalt binder conforming with ASTM D6373 Performance Grade (PG) **[** 82-28 | 88-22 **]**. Test the original FRA asphalt binder following ASTM D7173. The FRA asphalt binder must meet the maximum binder temperature difference of 4°C when using the ASTM D36 Ring-and-Ball apparatus.

The asphalt specimens prepared with the FRA asphalt binder must meet the fuel resistance requirements specified in Table 401-2.3 when tested according to paragraph 401-3.5. After passing the requirements of Table 401-3.3a, identify the grade of the asphalt binder as PG 82-28FR or 88-22FR.]

Table 401-2.3: Asphalt Binder PG Plus Test Requirements [1]

Material Test	Requirement	Standard
Elastic Recovery	75% minimum	ASTM D6084
[Elastic Recovery Fuel Resistant Asphalt]	[85% minimum]	[ASTM D6084]

[1] If Asphalt Binder is not modified, as reported by asphalt supplier, a PG Plus test is not required.

****

The Engineer must use the following guidance in selecting the asphalt binder grade to include in the above paragraph.

The Airfield Asphalt Pavement Technology Program (AAPTP) Binder Tool provides guidance to assist in the selection of the Asphalt Binder. The Engineer must validate, and may need to, adjust the asphalt binder the tool recommended. Note the binder tool adjusts the grade based upon aircraft gross weight and aircraft speed.

The AAPTP binder tool is available at https://www.airfieldasphaltbinder.org.

Some states follow ASTM D6373, while others follow AASHTO M332. Ensure that the binder supplied meets the minimum requirements of ASTM D6373.

****

401-2.3.1 Warm Mix Additive.

The proposed warm mix additive must be on the local state Department of Transportation (DOT) qualified product list, if the state maintains one. If the local state does not have a qualified products list use the WMA products from Florida, Texas, or Virginia. All WMA additives must be used according to the manufacturer’s recommendations.

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The FAA does not have performance data on WMA produced using foaming additives with respect to ability to perform under aircraft loading. Accelerated pavement studies as well as literature indicates inferior rutting performance when WMA include manufactures syntehetic xeolite-based hybrid warm mix additives. It is not recommended to use foaming or hybrid

warm mix additives for airfield pavements designed for aircraft with gross weights exceeding 60,000 pounds (27,200 kg)

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401-2.4 Anti-strip Agent.

Anti-strip must be approved for use by the local State DOT where the project is located.

401-3 COMPOSITION

401-3.1 Mixture(s) Composition.

The asphalt mix is composed of a mixture of aggregates, filler, and anti-strip agent, if required, and asphalt binder. Size and handle the aggregate fractions in separate size groups and combine in proportions such that the resulting mixture meets the grading requirements of the JMF.

401-3.2 Job Mix Formula (JMF) Laboratory.

The laboratory used to develop the JMF must possess a current certificate of accreditation according to ASTM D3666 or from a national accrediting authority, or a current State DOT accreditation. Submit a copy of the laboratory's current accreditation and accredited test methods to the Resident Project Representative (RPR) with the JMF submittal.

401-3.3 JMF.

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The design criteria in Table 401-3.3a are target values necessary to meet the acceptance requirements contained in paragraph 401-6.2. The criteria's basis is a production process which has a material variability with the following standard deviations: Air Voids = 0.65%.

****

Design the asphalt mixture using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Prepare and compact samples using a gyratory compactor according to ASTM D6925. The Contractor must submit the JMF in writing at least [30] days prior to the start of paving operations. The Contractor must develop the project JMF using aggregates proposed for use on project. A separate JMF is required for surface and base courses when they utilize different aggregate gradations. The responsible Professional Engineer (PE) of the laboratory that developed the JMF must date, and stamp or seal, the JMF, and includes the following items.

- Manufacturer's Certificate of Analysis (COA) for the asphalt binder used in the JMF according to paragraph 401-2.3. The certificate of asphalt performance grade is with modifier already added, if used, and must indicate compliance with ASTM D6373. For plant modified asphalt binder, provide a certified test report indicating grade certification of the modified asphalt binder.

- Manufacturer's COA for the anti-strip material if used in the JMF according to paragraph 401-2.4. Type and amount of anti-strip agent, if used.
- Certified material test reports for the coarse and fine aggregate and mineral filler according to paragraph 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 and fine aggregate percentage of uncompacted voids.
- Percent fractured faces for coarse aggregate.
- Percent by weight of flat particles, elongated particles, flat and elongated particles (and criteria), and coarse aggregate angularity.
- Percent of asphalt.
- Number of 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. Note, to achieve minimum VMA during production, the mix design must account for material breakdown during production.
- [`Test results for asphalt resistance to fuel when tested according to paragraph 401-3.5.`]
- Tensile Strength Ratio (TSR).
- Asphalt Pavement Analyzer (APA) or Hamburg Wheel Tracking results.
- Date JMF was developed. Mix designs without a date are not acceptable.
- Name of WMA additive and target dosage rate, when used. For additives not pre-blended into the asphalt binder, provide procedure for proper incorporation of additive into laboratory and job mixture.
- [`Percentage and properties (asphalt content, asphalt binder properties, and aggregate properties) of reclaimed asphalt mix pavement (RAP) according to paragraph 401-3.4.`]
- [`Source of RAP`]

- **[__]**

****

Delete if RAP is not permitted per paragraph 401-3.4.

The Owner may add additional testing to meet local conditions under a MOS.

****

401-3.3.1 A request to use a previously approved JMF may be considered provided the following verification is completed:

- It was developed and approved for use on a federally funded FAA grant project within the previous 24 months.
- The aggregate source(s) and sizes must be the same as used in the previous JMF. The contractor must provide current aggregate field gradations for review.
- Binder grade and design compaction level on current project are the same as used in previous JMF.
- If applicable, change in binder supplier must be noted. Additional testing may be required if binder supplier differs from previous JMF.
- All documentation from the previous JMF will be provided to the RPR for review and approval. The required documentation is outlined above in paragraph 401-3.3. Failure to provide the mandatory documentation will invalidate the request to use a previous JMF.

401-3.3.2 The RPR will review and determine if the previous JMF complies with the requirements of the specification. Once a determination is made, the RPR will notify the contractor if the previous JMF will be accepted or if a new JMF is required.

401-3.3.3 If the previous JMF is accepted, the contractor will proceed with trial batch verification and material quality testing demonstrating the mix can be produced within the specified tolerances as follows:

- Contractor must complete all material quality testing as required in Tables 401-2.1a, 401-2.1b and 401-2.2a. Submit data to RPR for review and approval.
- Contractor must verify asphalt design criteria using trial batching at the optimum design asphalt binder content at design gyrations for the following: air voids, VMA and TSR. Contractor must use testing methods as defined in paragraph 401-3.3.1 for each criteria. If JMF included fuel-resistant asphalt, contractor must verify maximum weight loss by immersion in fuel.

- Upon completing required field production tests, the RPR will notify the contractor in writing if the JMF verification is acceptable to proceed to production or corrections are required.
- The JMF after any adjustments from trial batching will be the JMF used for production.

401-3.3.4 For projects spanning multiple construction seasons, the approved JMF may be used during each season provided the following:

- Prior to the start of production each season, validate with new testing that materials meet the aggregate quality requirements in Tables 401-2.1a, 401-2.1b and 401-2.2.

401-3.3.5 During production, the Contractor may adjust proportions of aggregate and binder within the quality control (QC) suspension limits, any adjustments beyond these limits requires a new JMF. The RPR must accept the new JMF in writing before using the new material. During production, if the source of aggregate materials changes, submit a new JMF to the RPR for review. A new control strip is required for all new or modified JMFs.

401-3.3.6 During production, if the source of binder changes verify design criteria using specimens prepared according to test requirements in Table 401-3.3a for air voids, VMA, TSR and APA or Hamburg Wheel Tracking.

Table 401-3.3a: Asphalt Design Criteria [4]

Test Property	Value	Test Method
Number of Gyrations	[75]	
[Number of Gyrations FRA]	[50]	
Air voids (%)	3.5	ASTM D3203
[Air voids FRA (%)]	[2.5]	[ASTM D3203]
[Maximum weight loss by immersion in fuel FRA]	[1.5%]	[When tested per paragraph 401-3.5]
Percent voids in mineral aggregate (VMA), Minimum	See Table 401-3.3b	ASTM D6995
Tensile Strength Ratio (TSR)[1]	Not less than [80] at a saturation of 70-80%	ASTM D4867
Asphalt Pavement Analyzer (APA) [2, 3]	For pavements designed for aircraft gross weights of	AASHTO T340 250-pound wheel load at 250 psi hose pressure at high temperature for location

Test Property	Value	Test Method
	100,000 lbs (45,360 kg) or more [Less than 8.0 mm @ 4000 passes] For pavements designed for aircraft gross weights of less than 100,000 lbs (45,360 kg) [Less than 10 mm @ 4000 passes]	
APA [2, 3, 4]	For pavements designed for aircraft gross weights of 100,000 lbs (45,360 kg) or more [Less than 4.0 mm @ 8000 passes] For pavements designed for aircraft gross weights of less than 100,000 lbs (45,360 kg) [Less than 5.0 mm @ 8000 passes]	AASHTO T340 100-pound wheel load at 100 psi hose pressure at high temperature for location
Hamburg Wheel Tracking Test [3, 4]	8 mm @ 20,000 passes	AASHTO T324 at high temperature for location

[1] Compact test specimens for TSR 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] APA test specimens prepared at design air voids ±0.5%.

[3] APA is the preferred test; however, APA is not available in all parts of USA. Use APA with 250-pound wheel load and 250 psi when available. Acceptable to use Hamburg Wheel Test.

[4] Temperature to condition WMA samples for Hamburg Wheel Tracking: For PG 58-XX (or lower) 45°C, PG 64-XX 50°C, PG 70-XX or higher 55°C. Hamburg value for WMA 6mm @ 20,000.

****

Specify 75 gyrations for airports serving aircraft greater than 60,000 lbs (27,216 kg)or when aircraft tire pressures are greater than 175 psi.

Specify 50 gyrations for airports serving aircraft 60,000 lbs (27,216) or less and when aircraft tire pressures is less than 175 psi.

Specify 50 gyrations for FRA.

FAA research shows that mixes meeting or exceeding the APA requirements in Table 401-3.3a perform well under aircraft loading.

Specify a TSR of not less than 85 in areas with aggregate with a history of stripping.

****

The gradations in Table 401-3.3b represent the limits that determine the suitability of aggregate for use. Aggregate must be well graded from coarse to fine and not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

Table 401-3.3b: Aggregate Gradation - Asphalt Pavements

Sieve Size	Job Gradation Percentage by Weight Passing Sieve[2]	Production Tolerances (Suspension Limit)
1 inch (25.0 mm)	*	±9%
¾ inch (19.0 mm)	*	±9%
½ inch (12.5 mm)	*	±9%
⅜ inch (9.5 mm)	*	±9%
No. 4 (4.75 mm)	*	±7.5%
No. 8 (2.36 mm)	*	±7.5%
No. 16 (1.18 mm)	*	±7.5%
No. 30 (600 µm)	*	±4.5%
No. 50 (300 µm)	*	±4.5%
No. 100 (150 µm)	*	±3%
No. 200 (75 µm)	*	±2%
Minimum VMA[1]	*	
	*	
	*	
Recommended Minimum Construction Lift Thickness	*	

[1] To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.

[2] Tested according to ASTM C136 and ASTM C117.

The aggregate gradations shown are based on aggregates of uniform specific gravity. Correct the percentages passing the various sieves when aggregates of varying specific gravities are used, as indicated in the *Asphalt Institute MS-2 Mix Design Manual, 7th Edition*.

****

The Engineer specifies the aggregate gradation from the gradations shown in this note. Insert the gradation into Table 401-3.3b. Asterisks denote insert points.

Where locally available aggregates cannot be economically blended to meet the grading requirements of the gradations shown, gradations may be

modified to fit the characteristics of such local aggregates. The modified gradation must meet all other mix design requirements.

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Table 401-3.3b: Aggregate – Asphalt Pavement

Sieve Size	Percentage by Weight Passing Sieves		
	Gradation 1 [1]	Gradation 2	Gradation 3 [2]
1 inch (25.0 mm)	100	--	--
¾ inch (19.0 mm)	90-100	100	--
½ inch (12.5 mm)	68-88	90-100	100
⅜ inch (9.5 mm)	60-82	69-89	90-100
No. 4 (4.75 mm)	45-67	53-73	58-78
No. 8 (2.36 mm)	32-54	38-60	40-60
No. 16 (1.18 mm)	22-44	26-48	28-48
No. 30 (600 µm)	15-35	18-38	18-38
No. 50 (300 µm)	9-25	11-27	11-27
No. 100 (150 µm)	6-18	6-18	6-18
No. 200 (75 µm)	3-6	3-6	3-6
VMA	14.0	15.0	16.0
Recommended Minimum Construction Lift Thickness[2]	3-inch	2-inch	⅜-inch

[1] Gradation 1 recommended for base course. Gradation 2 is recommended for surface course.

[2] Gradation 3 is intended for leveling courses or for use with FRA. Limit leveling courses to no more than 1½ inches. When used with FRA recommended minimum construction lift thickness is 1½ inch.

401-3.4 Reclaimed Asphalt Pavement (RAP).

[Do not use RAP. |RAP may be used in any layer except the top [4 inches (100 mm)] of load bearing pavements. RAP may be used on shoulders, blast pads, and pavements not used by aircraft. Reclaimed asphalt consisting of RAP, coarse aggregate, fine aggregate, mineral filler, and asphalt [sourced from airport pavement]. The RAP must be of a consistent gradation, asphalt content, and properties. When RAP is fed into the plant, the maximum RAP size is one inch (25 mm). Design the reclaimed asphalt pavement mix using procedures contained in the *Asphalt Institute MS-2 Mix Design Manual*, 7th Edition. Establish the percentage of asphalt in the RAP for the mixture design according to ASTM D2172 using the appropriate dust correction procedure. The JMF must meet the requirements of paragraph 401-3.3. The amount of RAP is limited to **[__]** percent. In addition to the requirements of paragraph 401-3.3, the JMF indicates the percent of reclaimed asphalt pavement and percent and grade of new asphalt binder. For the PG graded asphalt binder selected in paragraph 401-2.3, adjust as follows:

- For 0-20% RAP, there is no change in virgin asphalt binder content.
- For > 20 to 30% RAP, select asphalt binder one grade softer, e.g., PG 64-22 would soften to PG 58-28.

RAP Containing Coal Do not use tar. Remove coal tar surface treatments prior to recycling underlying asphalt material. Do not use recycled asphalt shingles (RAS). **]**

****

The Engineer determines whether RAP is/is not permitted and makes the appropriate selection. Limit RAP to RAP produced from airport pavements.

Do not use RAP for surface mixes, except on shoulders. However, it can be used very effectively in lower layers or for shoulders. The Engineer specifies the maximum percentage of reclaimed asphalt allowed in the mix. Limit the amount of RAP to 30%, as long as the resulting recycled mix meets all specified requirements for virgin mixtures. As a minimum, the top 4 inches (100 mm) is considered the surface layer. The Contractor may obtain the RAP from the job site or an existing source.

The job mix formula (JMF) must include the RAP source.

****

401-3.5 Fuel Resistance.

[Not used. **] [** Fuel Resistant asphalt must have less than +1.5% weight loss when tested with the following procedure:

1. Prepare three test specimens according to the Mix Design requirements at optimum FRA asphalt binder content and 2.5 ±0.7% air voids.
2. Determine the percent air voids in each specimen, replace specimens that do not meet air void

requirements. Dry the specimens under a fan at room temperature, 68℉ -80℉ (20℃-27℃), for a minimum of 24 hours.

3. Totally immerse sample in kerosene meeting ASTM D3699 at room temperature for 2.0 minutes.
4. After submersing in kerosene for 2.0 minutes ±30 seconds, remove the sample and immediately surface dry it with a clean paper towel. Immediately determine the weight of the sample in air to the nearest 0.1 grams. Report this as weight "A", weight before.
5. Resubmerge the sample in kerosene for 24 hours.
6. After 24 hours ±10 minutes carefully remove the sample from the kerosene and suspension container and place on an absorptive cloth or paper towel. Dry the specimen under a fan at room temperature for 24 hours.
7. After drying for 24 hours ±10 minutes weight the sample in air to the nearest 0.1 gram. Report this as weight "B", weight after.
8. Percent weight loss by fuel immersion = (A-B)/A ×100]

401-3.6 Pre-paving Meeting and Control Strip.

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For large complex paving projects the Owner may choose to have the prepaving meeting run by an independent moderator, instead of the RPR or Contractor.

****

401-3.6.1 Pre-paving Meeting.

Prior to construction of the control strip, a pre-paving meeting is required. The Contractor must submit the Contractor's Quality Control Plan (CQCP) and JMF and receive approval prior to the pre-paving meeting. The [RPR | Contractor | Independent Moderator] facilitates the meeting. At a minimum, the meeting includes:

☐ Owner's representative, Superintendent, Contractor Paving Superintendent, Asphalt Plant Manager, Contractor material and testing technicians, Owner material and testing technicians, Contractor QC Manager, Owner's QA manager, QC, and QA inspectors [and additional required attendees].

☐ Agenda for meeting will include:

- ○ Submittal review
- ○ JMF Review/discussion
- ○ Work hours
- ○ Production Plan (Location of stockpiles, location of plant, rate of production, and hours of production)
- ○ Paving Laydown Plan includes (as a minimum):
    1. Sequence of paving lanes minimizing number of cold joints
    2. Width and location of lanes
    3. Location of temporary ramps
    4. Transport paths
    5. Laydown temperature
    6. Estimated time of completion of work including time for all paving activities (e.g., milling, application of tack coat, transport, placement, compaction and cooling).

    (What will the paving sequence be, what are the hours of paving?)
- ○ Delivery and Placement (Equipment, number of trucks, type of material transfer vehicle (MTV), type and number of pavers)
- ○ Compaction Plan (Equipment and procedures, type, number, and size)
- ○ QC Testing Plan (Who obtains QC test samples. How will QC test samples be handled? Who performs QC testing? How and when are results reported, how will results be used, and who has the authority to stop work?)
- ○ QA Testing Plan (Who obtains QA samples? How will they be transported to the testing location? Where will they be tested, how will results be reported, and what constitutes acceptable work?)
- ○ How, when, and to whom will QC and QA test results be reported?
- ○ What constitutes acceptable work, and what is the response to failed tests?
- ○ When will stop work orders be issued, and who can issue stop work orders?
- ○ How will traffic control be handled?
- ○ How will coordination with airport operations be handled?

  - Coordination of emergency response.
  - Lighting plan for night-time work.
  - Traffic Control Plan (Marking, signage, are escort vehicles required, how will coordination with airport operations be handled, coordination of emergency response, l and lighting for nighttime work).
  - **[** Add additional items as necessary **]**

401-3.6.2 Control Strip.

401-3.6.2.1 **[** A control strip is not required. **]** Do not begin full production until an acceptable control strip is constructed and the RPR accepts in writing for each JMF proposed for use on the project. The Contractor prepares and places asphalt mix according to the JMF. Construct the control strip using the same pavement structure, i.e., subgrade, subbase, base, etc., as the project. A new control strip is required for new JMF and at the re-start of construction on projects that span multiple construction seasons.

401-3.6.2.2 The Contractor is not permitted to place the control strip until the RPR accepts the CQCP and JMF in writing, and the pre-paving meeting is complete. The control strip must consist of at least 250 tons (227 metric tons) or ½ sublot, whichever is greater.

401-3.6.2.3 Place the control strip following the approved paving plan as discussed at the prepaving meeting. The control strip must include all the longitudinal joint types (cold, hot) and construction techniques (e.g., echelon, wedge, or joint heaters) included in the Paving Plan. When the Paving Plan includes cold joints, cut cold joints back according to paragraph 401-4.14 using the same procedure used during production. The equipment used in construction of the control strip must be the same type, configuration, and weight used on the project.

401-3.6.2.4 The control strip will be considered one lot for payment based upon the average of a minimum of 3 samples (no sublots required for the control strip. The RPR considers the control strip acceptable if the gradation, asphalt content, tests of performance grade of binder meet or exceed project specifications, and VMA are within the action limits specified in paragraph 401-5.5.1; has a mat density greater than or equal to 94.0% [standard mix], [96% FRA], laboratory air voids > 2% and < 5% [FRA > 1.5% and < 3.5% FRA], and a joint density within -2% of the mat density. Minor adjustments to the JMF may be required to place an acceptable control strip. The production mix is the adjusted JMF used to place the acceptable control strip.

401-3.6.2.5 The Contractor must remove unacceptable control strips at the Contractor's expense. Do not start full production until the Contractor places an acceptable control strip.

401-3.6.2.6 Payment is only made for an acceptable control strip according to paragraph 401-8.1.]

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For small projects, less than 3,000 tons (2722 metric tons), a prepaving meeting and control strip are not required. However, prepaving meeting and control strips are recommended for all paving projects regardless of size.

****

401-4 CONSTRUCTION METHODS

401-4.1 Weather Limitations.

Do not place asphalt upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 401-4.1. The RPR may waive the temperature requirements, if requested; however, all other requirements including compaction must be met.

Table 401-4.1: Surface Temperature Limitations of Underlying Course

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 inches (7.5 cm) or greater	40	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 must conform to the requirements of AASHTO M156 including the following items.

401-4.2.1 Plant Inspection.

The RPR, or authorized representative, must 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.

401-4.2.2 Storage and Surge Bins.

The asphalt mixture stored in storage and/or surge bins must meet the same requirements as asphalt mixture loaded directly into trucks. Do not store asphalt mixture in storage and/or surge bins for a period greater than twelve hours.

401-4.3 Aggregate Stockpile Management.

Construct aggregate stockpiles in a manner that prevents segregation and intermixing of deleterious materials. Weigh, batch, and stockpile aggregates from different sources separately. Do not use aggregates that become segregated or mixed with earth or foreign material.

401-4.4 Hauling Equipment.

Trucks used for hauling asphalt must have tight, clean, and smooth metal beds. To prevent the asphalt from sticking to the truck beds, lightly coat the truck beds with a minimum amount of paraffin oil, lime solution, or other material the RPR approves. Do not use petroleum products for coating truck beds. Each truck must have a suitable cover to protect the mixture from adverse weather.

401-4.5 MTV.

[Use of an MTV with remixing, heating, and storage capability is required. |Material transfer vehicles are not required.]

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The MTV is recommended for all pavements where the weight of the MTV will not damage the pavement structure.

The use of an MTV is optional for shoulder construction.

An MTV is required for runway and taxiway construction on pavements designed for aircraft weighing 100,000 lbs (45,360 kg) or more.

****

401-4.6 Asphalt Pavers.

Asphalt pavers must be self-propelled with an activated heated screed, capable of spreading and finishing courses of asphalt that meet the specified thickness, smoothness, and grade. The asphalt paver must be equipped with a control system capable of automatically maintaining the specified screed grade and elevation. When paving wider than the basic screed, use auger and tunnel that extend to within 12-18 inches from the end plated of the screed. The paver must able to pave to the minimum width specified in paragraph 401.4.12.

401-4.7 Rollers.

The number, type, and weight of rollers must be sufficient to compact the asphalt to the required density while it is still in a workable condition without crushing the aggregate, creating depressions, or causing any other damage to the pavement surface.

401-4.8 Asphalt Binder Preparation.

Heat the asphalt binder in a manner that avoids local overheating and provides a continuous supply of the asphalt binder to the mixer at a uniform temperature. The temperature of asphalt binder delivered to the mixer must be as recommended by the supplier.

401-4.9 Mineral Aggregate Preparation.

Heat and dry the aggregate for the asphalt such that the maximum temperature and rate of heating does not damage the aggregate. The temperature of the aggregate and mineral filler must not exceed **[** `350°F (175°C)` **]** when the asphalt binder is added. The temperature must be sufficient to obtain complete uniform coating on the aggregate particles.

****

Temperatures may be reduced when using WMA technologies. Amount of reduction based upon WMA additive manufacturer or technology.

****

401-4.10 Asphalt Mixture Preparation.

Prepare the asphalt mixture according to the JMF. Mix the aggregate and binder until the aggregate has a uniform coating of asphalt binder. The wet mixing time is the time required to achieve 95% of coated particles, as described in ASTM D2489. For continuous mix plants, the minimum mixing time is 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 mixture upon discharge must not exceed 0.5%.

****

For batch plants, wet mixing time begins with the introduction of asphalt binder into the mixer and ends with the opening of the mixer discharge gate. Mixing time should be the shortest time required to obtain uniform

distribution of aggregate sizes and thorough coating of aggregate particles with asphalt binder.

****

401-4.11 Tack Coat Application.

Immediately before placing the asphalt mixture, clean the underlying course of all dust and debris. Apply a tack coat according to Item P-603 to all horizontal and vertical surfaces prior to placement of the first and each subsequent lift of asphalt mixture.

401-4.12 Paving Laydown Plan, Preparation, Transporting, Placing, and Finishing.

401-4.12.1 Paving Laydown Plan.

Prior to the placement of the asphalt, the Contractor must prepare a Paving Plan that includes:

1. Sequence of the paving lanes minimizing the number of cold joints.
2. Width and location of lanes:
    a. Place the asphalt mix in consecutive adjacent lanes having a minimum width of [[__] feet ([__] m)] except where edge lanes require less width to complete the area.
    b. Offset the longitudinal joint in one course by at least one foot from the longitudinal joint in the course immediately below.
    c. The longitudinal joint in the surface top course must be at the centerline of crowned pavements.
    d. Offset transverse joints by at least 10 feet (3m) from transverse joints in previous course.
    e. 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.
3. Location of any temporary ramps.
4. Transport paths.
5. Laydown temperature.
6. Estimated time of completion of work including time for all paving activities (e.g., milling, application of tack coat, transport, placement, compaction and cooling).

The RPR must approve the Paving Plan and any modifications to it.

401-4.12.2 Preparation.

1. Saw cut edges of existing asphalt pavement abutting the new work.
2. Remove the cut off material and laitance.
3. Before new asphalt material is placed, apply a tack coat according to Item P-603.
4. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat.
5. Begin placement of the asphalt mix 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. Place the asphalt mix in consecutive adjacent lanes having a minimum width of **[[__]** `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. **[__]**

401-4.12.3 Transportation.

1. Schedule deliveries so that the placing and compacting of asphalt is uniform with minimum stopping and starting of the paver.
2. Hauling over freshly placed material is not permitted until the material is compacted, as specified, and allowed to cool to approximately ambient temperature.
3. The Contractor is responsible for repairing any damage to the pavement caused by hauling operations at their expense.
4. Spread and lute the asphalt with hand tools in irregular areas or that contain unavoidable obstacles where use of mechanical spreading and finishing equipment is impractical.

****

The Engineer specifies the widest paving lane practicable in an effort to hold the number of longitudinal joints to a minimum. Additional job-specific construction limitations may be added as necessary.

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401-4.12.4 Appearance.

RPR may reject any batch of asphalt on the truck or placed in the mat, rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or overheated asphalt mixture. The basis of such rejection may only be a visual inspection or temperature measurements.

In the event of such rejection, the Contractor may take a representative sample of the rejected material in the RPR's presence. If a laboratory can demonstrate, in the RPR's presence, that such material was erroneously rejected, the material will be paid for at the contract unit price. The Contractor must remove and replace areas of segregation, at their expense. Remove the area by saw cutting and milling a minimum of the construction lift thickness, as specified in paragraph 401-3.3.2, for the approved mix design. The area for removal and replacement, is at a minimum, the width of the paver and a minimum of 10 feet (3 m) long.

401-4.13 Compaction of Asphalt Mixture.

After placing, thoroughly and uniformly compact the asphalt mixture by self-propelled rollers. Compact the surface as soon as possible when the asphalt has attained sufficient stability so the rolling does not cause undue displacement, cracking, or shoving. The sequence of rolling operations and type of rollers used are at the Contractor's discretion. The speed of the roller must, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. The Contractor will, at their expense, correct any surface defects and/or displacement occurring because of the roller, or from any other cause.

Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. Equip the roller wheels with a scraper and keep moistened with water as necessary to prevent adhesion of the asphalt to the roller. In areas not accessible to the roller, compact the mixture with approved power tampers. Any asphalt that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way is defective must be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work is done at the Contractor's expense. Skin patching is not permitted.

401-4.14 Joints.

Joints must have the same texture as other sections of the course and meet all requirements for smoothness and grade. Apply asphalt tack coat to all joints according to Item P-603 to the clean, dry joint prior to placing any additional fresh asphalt against the joint.

401-4.14.1 Transverse Joint.

Do not let the roller pass over the unprotected end of the freshly laid asphalt except when necessary to form a transverse joint. Create transverse joints either by placing a bulkhead or by tapering the course. Prior to placing the adjacent lane, cut back the tapered edge to its full depth and width on a straight line exposing a vertical face. Prior to placing fresh asphalt against the joint coat all contact surfaces with an asphalt tack coat.

401-4.14.2 Hot Joints.

Hot joints are longitudinal joints placed before the surface temperature of the adjacent asphalt has cooled to less than **[** `175°F (80°C)` **]**.

****

Temperatures may be reduced when using WMA technologies. Amount of reduction based upon WMA additive manufacturer or technology.

****

401-4.14.3 Longitudinal Cold Joints.

Longitudinal joints left exposed for more than four hours; or when the surface temperature has cooled to less than **[** `175°F (80°C)` **]**; or are irregular, damaged, uncompacted, or otherwise defective, must be cut back with a cutting wheel or pavement saw, removing the minimum amount necessary but not more than 4 inches (121 mm), to expose a clean, sound, uniform vertical surface for the full depth of the course. Remove all cutback material and any laitance produced from cutting joints.

401-4.14.4 Alternate Longitudinal Joint Techniques.

If demonstrated and approved with the control strip, the Contractor may use wedge joints, joint heaters, or other alternative joint construction provided that the control strip met all joint density requirements. The cost of this work is considered incidental to the cost of the asphalt. The Contractor must demonstrate that the alternative joint construction process meets or exceeds minimum joint density requirements or joints must be cut back.

****

The Contractor may provide additional joint density QC by use of joint heaters at the Contractor’s expense. Electrically powered infrared heating equipment should consist of one or more low-level radiant energy heaters to uniformly heat and soften the pavement joints. Configure the heaters to uniformly heat an area up to 18 inches (0.5 m) in width and three inches (75 mm) in depth. Infrared equipment must be thermostatically controlled to provide a uniform, consistent temperature increase throughout the layer being heated up to a maximum temperature range of 200°F to 300°F (93°C to 150°C).

Propane powered infrared heating equipment must be attached to the paving machine and the output of infrared energy set in the one to six-micron range. Arrange heat equipment end-to-end directly over the joint to be heated in sufficient numbers to produce a minimum of 240,000 British Thermal Units (BTU) per hour. Position the joint heater no more than one inch (25 mm)

above the pavement to be heated and in front of the paver screen. Heaters must be fully adjustable. Heaters must be operational at all times.

Operate the heaters so excessive heat is not produced when the units pass over new or previously paved material.

****

401-4.15 Diamond Grinding.

Complete any diamond grinding prior to pavement grooving. Accomplish diamond grinding by sawing with saw blades impregnated with industrial diamond abrasive. Perform diamond grinding with a machine designed specifically for diamond grinding capable of cutting a path at least three feet (0.9 m) wide. Use enough 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 Contractor determines the actual number of blades and type of blades based upon the hardness of the aggregate. Equipment or grinding procedures that causes ravels, aggregate fractures, spalls, or disturbance to the pavement is not permitted.

The Contractor must demonstrate to the RPR the grinding equipment will produce satisfactory results prior to making corrections to surfaces. Taper grinding in all directions to provide smooth transitions to areas not requiring grinding. Continuously remove the slurry resulting from the grinding operation and leave the pavement in a clean condition. Apply an asphalt spray seal with aggregate surface treatment to all areas that have been subject to grinding as the RPR approved. Note, that a larger area may need to be sealed to ensure that seal coat does not appear to be a pavement marking. Perform friction tests according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, on all runway and rapid exit taxiways that have received a seal coat. The Contractor must coordinate testing with the RPR and provide the RPR the opportunity to be present during testing. Each test includes performing friction tests at 40 mph and 60 mph, (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline.

Do not permit aircraft on the runway or rapid exit taxiway until the testing validates that surface friction is above the minimum action levels for maintenance planning friction levels in AC 150/5320-12, when tested at speeds of 40 and 60 mph (65 and 95 km/h), wet, with approved CFME. Areas are not acceptable for payment until they meet the maintenance planning friction levels. The Contractor must provide the RPR a written report of friction test results. There will be no additional payment for any diamond grinding and associated sealing and friction testing.

[401-4.16 Leveling Course.

`The leveling course is the first variable thickness lift placed to correct surface irregularities prior to placement of subsequent courses. The leveling course must meet the aggregate gradation in Table 401-2.1b, paragraph 401-3.3. The leveling course must meet the requirements of paragraph 401-3.3, 401-6.2b for air voids, but not be` subject to the density requirements of paragraph 401-6.2.2 for mat density and 401-6.2c for joint density. The leveling course must be compacted with the same effort used to achieve density of the control strip. The leveling course must not exceed 1½ inches, see Table 401-2.1b, paragraph 401-3.3.]

401-4.17 Nighttime Paving Requirements.

The Contractor must provide adequate lighting during any nighttime construction. Prior to the start of any nighttime work, the RPR must approve a Lighting Plan.

401-5 CONTRACTOR QUALITY CONTROL (CQC)

401-5.1 Contractor Quality Control (CQC) Program.

[The Contractor must develop a Contractor Quality Control Program (CQCP) according to Item C-100.] The Contractor will use the CQCP to control the production and construction process applicable to these specifications. The Contractor will use the testing and monitoring described in this section to adjust their processes when necessary. If a Contractor fails to properly control their processes, the RPR will halt production of material until satisfactory corrective actions have been taken by the Contractor. Final acceptance and payment for work is made based on the acceptance procedures in the section Material Acceptance.

401-5.2 Contractor QC Facilities.

[The Contractor must provide or contract for testing facilities according to Item C-100. The RPR is 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.]

401-5.3 Contractor QC Testing.

The Contractor will 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 must include, but not necessarily be limited to, tests for the control of aggregate gradation, volumetrics, temperatures, aggregate moisture, field compaction, and surface smoothness. Develop the QC Testing Plan as part of the CQCP. Note, final acceptance and payment is based upon QA testing performed by the RPR.

401-5.3.1 Asphalt Binder.

The plant QC technician must sample the asphalt binder from the in-line sampling valve, prior to the start of construction of the control strip and every 8,000 tons during production, when the high grade of the asphalt binder is 76 and above. Prior to sampling, flush at least one gallon of asphalt binder from the in-line valve. Take one-quart samples of unmodified binders and two one-quart samples of modified binders. Label samples with the sampling date and time, project, asphalt mixture type being produced, and specified asphalt binder grade RPR must be present for samples used for testing and for testing of binder. For modified binders, also test for elastic recovery according to ASTM D6084, procedure B. The Contractor must provide the RPR the test results. Suspend paving when PG grade is one step low until the correct binder is delivered for use to the project. When high temperature performance grade is two grades lower than specified, remove and replace the lot.

401-5.3.2 Air Content and Voids in Mineral Aggregate.

Determine the air content and VMA daily once per lot based upon ASTM D3203 and ASTM D6995.

401-5.3.3 Gradation.

Determine aggregate gradations a minimum of twice per day from mechanical analysis of extracted aggregate according to ASTM D5444, ASTM C136, and ASTM C117.

401-5.3.4 Moisture Content of Aggregate.

Determine the moisture content of aggregate used for production a minimum of once per day according to ASTM C566.

401-5.3.5 Moisture Content of Asphalt.

Determine the moisture content of the asphalt once per day according to AASHTO T329 or ASTM D1461.

401-5.3.6 Temperatures.

Check temperatures at least four times per day, to determine the temperatures of the dryer, the asphalt binder in the storage tank, the asphalt mix at the plant, and the asphalt mix at the job site.

401-5.3.7 In-place Density Monitoring.

The Contractor must conduct any necessary testing to ensure that the specified density for both mat and joint is within acceptance limits in paragraph 401-6.2.

401-5.3.8 Smoothness for Contractor QC.

The Contractor must 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 must be made by the Contractor before construction continues. The goal is to meet smoothness criteria without grinding.

The Contractor may use either a 12-foot (3.7 m) straightedge or a rolling inclinometer meeting the requirements of ASTM E2133. Straight-edge testing starts with half the length of the straightedge at the edge of pavement section being tested and then moved ahead half the length of the straightedge for each successive measurement. Testing must be continuous across all joints. The surface irregularity is 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 (3.7 m) straightedge simulation function.

Do not take smoothness readings across grade changes or cross slope transitions. The transition between new and existing pavement is evaluated separately for conformance with the plans. Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than ¼ inch (6 mm) must be corrected with diamond grinding per paragraph 401-4.15 or by removing and replacing the full depth of the surface course.

Keep control charts showing area of each day’s placement and the percentage of corrective grinding required. When corrective grinding is required make corrections to production and placement as necessary to eliminate need for grinding on subsequent placement. Any time that over 10% of a day’s production requires corrective action stop production until corrective measures are implemented.

401-5.3.8.1 Transverse Measurements.

Take transverse measurements for each day’s production placed. Take transverse measurements perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the RPR. The joint between lanes is tested separately to check smoothness between lanes.

401-5.3.8.2 Longitudinal Measurements.

Take longitudinal measurements for each day’s production placed. Perform longitudinal tests parallel to the centerline of paving within 6-12 inches of the edges and at the center of paving lanes ≤20 feet (6 m) wide and at the third points when paving lanes are > 20 feet (6 m) wide.

401-5.3.9 Grade.

Evaluate grade daily, making adjustments to paving operations as necessary to meet specifications As a minimum, grade must be evaluated prior to and after the placement of the first lift and after placement of the surface lift.

Take measurements 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 must not vary from the gradeline elevations and cross-sections shown on the plans by more than ½ inch (12 mm) vertically **[** `and 0.1 feet (30 mm) laterally` **]**. The documentation is provided by the Contractor to the RPR **[** `within 24 hours` | `by the end of the following working day` **]**.

Correct deviations due to smoothness or grade on the final surface course, in either the transverse or longitudinal direction, that will trap water greater than ¼ inch (6 mm) with diamond grinding per paragraph 401-4.15 or by removing and replacing the surface course to full depth. Taper grinding in all directions to provide smooth transitions to areas not requiring grinding All diamond grinding areas are subject to the final pavement thickness tolerances specified in paragraph 401-6.1.

Keep control charts to show location and area of each day’s placement and the percentage of corrective grinding required. Corrections to production and placement must be initiated when corrective grinding is required. If the Contractor’s machines and/or methods produce areas that need corrective actions for more than 10% of a day’s production, stop production until the Contractor implements corrective measures.

401-5.4 Control Charts.

The Contractor must maintain linear control charts for both individual measurements and range (e.g., difference between highest and lowest measurements) based upon the approved JMF: for aggregate gradation, asphalt content, and VMA. The VMA for each day is calculated and monitored by the QC laboratory.

Post control charts in a location satisfactory to the RPR and kept current. At a minimum, the control charts must 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 will use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. The Contractor must adjust processes or materials as soon as a process reaches the action limit and must suspend production anytime the process reaches the suspension limit.

401-5.4.1 Individual Measurements.

Control charts for individual measurements must be established to maintain process control within tolerance for aggregate gradation, asphalt content, and VMA. The control charts must use the JMF target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits.

Table 401-5.4a: Control Chart Limits for Individual Measurements [1]

Sieve	Action Limit	Suspension Limit
¾ inch (19.0 mm)	±6%	±9%
½ inch (12.5 mm)	±6%	±9%
⅜ 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%
Minimum VMA	-0.5%	-1.0%

401-5.4.2 Range.

Establish control charts to control gradation process variability. Plot the range 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. If the Contractor elects to perform more than two tests per lot, adjust the Suspension Limits by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.

Table 401-5.4b: Control Chart Limits Based on Range

Sieve	Suspension Limit
½ inch (12.5 mm)	±11%
⅜ 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%
VMA	-0.8%

401-5.4.3 Corrective Action.

`[ The CQCP indicates that appropriate action is taken when the process is believed to be out of tolerance. The Plan will contain rules to gauge` when a process is out of control and detail what action is taken to bring the process into control. As a minimum, a process is 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.]

401-5.5 QC Reports.

The Contractor must maintain records and submit reports of QC activities daily [, according to Item C-100].

401-5.6 Final Profilograph.

[Not used.][Contractor, in the presence of the RPR, performs a final profilograph for runway meeting the requirements of ASTM E1274 or an inertial profiler meeting ASTM E950. Note: follow manufacturer’s recommendations for inertial profilers. Do not attempt to profile a RW by accelerating while turning onto RW from a connecting TW. Use equipment that utilizes electronic recording and automatic computerized reduction of data to indicate the Profile Index for the pavement using a 0.2-inch (5 mm) blanking band. The profilograph must be calibrated prior to use and operate by a factory or State DOT approved, trained operator. Profilograph is performed one foot, [15 feet (4.5 m)] right and left of project centerline. Electronic data and results are provided within [48 hrs] of profilograph roughness tests to the owner.]

[Perform a final profilograph the full length of the project to document the pavement roughness].

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Edit as required for the project.

Profilograph roughness and acceptance paragraphs only apply when the overall project is a new and/or reconstructed runway(s) and/or taxiway(s) greater than 500 feet (152 m) in length. When using lightweight inertial profiler, they need approximately 100 feet for acceleration and deceleration. Only collect data in straight line segments, do not attempt to profile a RW by accelerating while turning onto RW from a connecting TW.

Profilograph roughness is not applicable to aprons and should be used with caution on projects to rehabilitate runways and/or taxiways unless the project includes provisions to correct existing deficiencies.

Any changes to the profilograph roughness acceptance limits requires a modification to standards according to FAA Order 5300.1, *Modifications to Agency Airport Design, Construction, and Equipment Standards*.

The Engineer must select who provides the specified equipment and the timeframe for receiving the test data. The Airport should retain a copy of the profilograph roughness test and reports for inclusion in the Airport's Pavement Maintenance Management Program (PMP).

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401-6 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 is performed by the RPR at no cost to the Contractor except that coring as required in this section is completed and paid for by the Contractor.

401-6.1.1 QA Testing Laboratory.

The QA testing laboratory performing these acceptance tests must be accredited according to ASTM D3666. The QA laboratory accreditation must be current, and include all test methods required for acceptance sampling and testing.

401-6.1.2 Lot Size.

A standard lot is equal to one day's production divided into approximately equal sublots between 400 to 600 tons. Combine the sublots when only one or two sublots are produced in a day's production, 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 apply separately for each plant.

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For large projects with high production rates, the Engineer may adjust the lot size to be half day's production.

For small projects, with multiple small placements or if the total project size is less than 3,000 tons (2,270 metric tons), acceptable material is paid for by the ton (metric ton) placed per day.

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401-6.1.3 Asphalt Air Voids.

Plant-produced asphalt is tested for air voids on a sublot basis.

401-6.1.3.1 Sampling.

Sample material from each sublot according to ASTM D3665. Take samples from material deposited into trucks at the plant or at the job site according to 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 or more than 60 minutes` **]** to maintain the material at or above the compaction temperature as specified in the JMF.

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The Engineer should increase hold times to not less than 60 minutes and not more than 90 minutes when absorptive aggregates are used.

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401-6.1.3.2 Testing.

Determine air voids for each sublot according to ASTM D3203 for a set of compacted specimens prepared according to ASTM D6925.

401-6.1.4 In-place Asphalt Mat and Joint Density.

Each sublot is tested for in-place mat and joint density as a percentage of the theoretical maximum density (TMD).

401-6.1.4.1 Bond.

Each lift of asphalt must be bonded to the underlying layer. If cores reveal that the surface is not bonded, take additional cores as the RPR directed, to determine the extent of unbonded areas. Unbonded areas must be removed by milling and replaced at no additional cost as the RPR directed.

401-6.1.4.2 Thickness.

Thickness of each lift of asphalt is evaluated by the RPR for compliance to the requirements shown on the plans after any necessary corrections for grade. Make measurements of thickness using the cores extracted for each sublot for density measurement. The maximum allowable deficiency at any point will not be more than ½ inch (12 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 sublot must be corrected by the Contractor at their expense by removing the deficient area and replacing with new pavement. The Contractor, at their expense, may take additional cores as the RPR approved to circumscribe the deficient area.

401-6.1.4.3 Mat Density.

Take one core from each sublot. The RPR determines core locations according to ASTM D3665. Do not take cores for mat density closer than one foot (30 cm) from a transverse or longitudinal joint. The bulk specific gravity of each cored sample is determined according to ASTM D2726. The percent compaction (density) of each sample is determined by dividing the bulk specific gravity of each sublot sample by the TMD for that sublot.

401-6.1.4.4 Joint Density.

Take one core centered over the longitudinal joint for each sublot that has a longitudinal joint. If the longitudinal joint is formed with a wedge, take the core in the middle of the wedge. The RPR determines core locations according to ASTM D3665. The bulk specific gravity of each core sample is determined according to ASTM D2726. The percent compaction (density) of each sample is determined by dividing the bulk specific gravity of each joint density sample by the average TMD for the sublot. The TMD used to determine the joint density at joints formed between lots is the lower of the average TMD values from the adjacent lots.

401-6.2 Acceptance Criteria.

401-6.2.1 General.

Acceptance is based on the implementation of the CQCP and the following characteristics of the asphalt and completed pavements: air voids, mat density, joint density, and grade**.**

****

Only include profilograph roughness for runway and/or taxiway pavement projects greater than 500 feet (150 m) in length.

Engineer needs to tailor specification for PWL or pass/fail acceptance for air voids, mat and joint density. PWL is the preferred acceptance method. However, for projects with less than 3000 tons, of asphalt pass/fail criteria is acceptable.

****

401-6.2.2 Air Voids and Mat density.

[Acceptance of each lot of plant produced material for mat density and air voids is based on the percentage of material within specification limits (PWL). If the PWL of the lot equals or exceeds 90%, the lot is acceptable. **|**Acceptance of each lot of plant produced material for air voids is based upon the average air void from the sublots. For standard asphalt mix, the average air voids of the lot are equal to or greater than 2% and equal to or less than 5%, then the lot is acceptable. If the average is below 2% or greater than 5%, the lot must be removed and replaced at the Contractor's expense.] [For FRA, if the average air voids of the lot are equal to or greater than 1.5% and equal to or less than 3.5%, then the lot is acceptable. If the average is below 1.5% or greater than 3.5%, the lot must be removed and replaced at the Contractor's expense.]

[Acceptance of each lot of plant produced material for mat density is based on the average of all the densities taken from the sublots. If the average mat density of the lot so established equals or exceeds 94%, the lot is acceptable. If the average mat density of the lot is below 94%, remove and replace the lot at the Contractor's expense.] Acceptance and payment are determined according to paragraph 401-8.1.

401-6.2.3 Joint Density.

[Acceptance of each lot of plant produced asphalt for joint density is based on the PWL. If the PWL is less than 90%, the Contractor must evaluate the reason and adjust materials, equipment, and processes accordingly. If the PWL is less than 80%, the Contractor ceases operations until the reason for poor compaction has been determined. If applicable, a lot pay factor reduction is evaluated and incorporated according to paragraph 401-8.1.]

[Acceptance of each lot of plant produced asphalt for joint density is based on the average of all the joint densities taken from the sublots. If the average joint density of the lot is less than 92%, the Contractor stops production and evaluates the method of compacting joints. Production may resume once the reason for poor compaction has been determined and appropriate measures have been taken to ensure proper compaction.]

401-6.2.4 Grade.

Survey the final finished surface of the pavement to verify that the grade elevations and cross-sections shown on the plans do not deviate more than ½ inch (12 mm) vertically [or 0.1 feet (30 mm) laterally]. Take cross-sections of the pavement at a minimum [50-foot (15-m)] longitudinal spacing and at all longitudinal grade breaks. Minimum cross-section grade points include grade at centerline, [±10 feet of centerline], and edge of [runway | taxiway] pavement. The survey and documentation must be stamped and signed by a licensed surveyor.

****

For new RW or RW rehabilitation of entire length of RW include the following requirement to run a profilograph on the completed project. Make sufficient runs to cover at least the keel section of the runway. This is just for the Owner's records and will not be used for acceptance or payment.

****

401-6.3 Percentage of Material Within Specification Limits (PWL).

[Not Used.] [The PWL is determined according to procedures specified in Item C-110. The specification tolerance limits (L) for lower and (U) for upper are contained in Table 401-6.3.

Table 401-6.3: Acceptance Limits for Air Voids and Density

Test Property	**Pavements Specification Tolerance Limits**	
	L	U
Air voids total mix (%)	2.0	5.0
FRA air voids total mix (%)	1.5	3.5
Surface course mat density (%)	92.8	-
FRA mat density (%)	96	-
Base course mat density (%)	91.8	-
Joint density (%)	90.5	--
FRA joint density (%)	90.5	--

401-6.3.1 Outliers.

Check all individual tests for mat density and air voids for outliers (test criterion) according to ASTM E178, at a significance level of 5%. Discard outliers and determine the PWL using the remaining test values. The criteria in Table 401-6.3 are 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 Acceptance.

401-6.4.1 General.

Resampling of a lot of pavement for mat density, air voids, or joint density, is only allowed if the Contractor requests in writing, within 48 hours after receiving the written test results from the RPR. A retest can consist of all the sampling and testing procedures contained in paragraphs 401-6.1 and 401-6.2. Only one resampling of a lot is permitted.

1. Calculate a redefined **[** PWL **|**average density **]** for the resampled lot. The number of tests used to calculate the redefined **[** PWL **|**average tests **]** will include the initial tests made for that lot plus the retests.
2. The Contractor bears the cost for resampling and retesting.

401-6.4.2 Payment for Resampled Lots.

Use the redefined **[** PWL for a resampled lot - calculate the payment for that lot according to Table 401-8.1. **|**Average density is used to determine if resampled lot is acceptable. **]**

401-6.4.3 Outliers.

Check for outliers according to ASTM E178, at a significance level of 5%.

****

Use this paragraph only when there is a need to restore proper cross-section prior to overlaying. Show areas of the pavement requiring a leveling course on the plans. Use gradation three for leveling courses.

****

401-7 METHOD OF MEASUREMENT

401-7.1 Measurement.

[Measure asphalt by the number of tons **[kg]** used in the accepted work. Use batch weights or truck scale weights to determine the basis for the tonnage. **]**

401-8 BASIS OF PAYMENT

401-8.1 Payment.

Payment for a lot of asphalt meeting all acceptance criteria as specified in paragraph 401-6.2 is made based on the results for joint density, grade, diamond grinding, and binder testing when applicable. Payment for acceptable lots is adjusted according to paragraph 401-8.1.3.

1. The total project payment for plant mix asphalt pavement will not exceed **[__]** percent of the product of the contract unit price and the total number of tons (kg) of asphalt used in the accepted work.
2. The price is compensation for furnishing, preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

****

The Engineer specifies a value ranging from 100% to the maximum lot pay factor amount of 106%. For mixtures that contain RAP, do not include separate payment for asphalt binder.

When the total project payment for Item P-401 exceeds the contract unit price, any federally funded grant or Passenger Facility Charge (PFC) funds used to pay the excess may require amending the project's grant or PFC

application. When the total project payment is less than 106% the RPR must monitor total project payment to ensure not exceeding the limitation. Individual lots can exceed 100% if PWL is greater than 96 and no adjustments for repairs, grinding or repairs.

****

401-8.1.1 Basis of Adjusted Payment for Mat Density, Air Voids, and Joint Density.

[The pay factor for each individual lot is calculated according to Table 401-8.1. A pay factor is calculated for mat density, air voids, and joint density. For each lot accepted, the adjusted contract unit price is the product of the lot pay factor including any adjustments for joint density and grade for the lot and the contract unit price. Payment is subject to the total project payment limitation specified in paragraph 401-8.1.1. Payment more than 100% for accepted lots of asphalt are used to offset payment for accepted lots of asphalt pavement that achieve a lot pay factor less than 100%, except as noted below.

1. The lot pay factor is the higher of the two values when calculations for both mat density and air voids are 100% or higher. The lot pay factor is the product of the two values when one of the calculations for either mat density or air voids is 100% or higher. The lot pay factor is the lower of the two values when calculations for both mat density and air voids are less than 100%.
2. If PWL for joint density is less than 90% then the lot pay factor is reduced by 5%. If the PWL for joint density is less than 80% then the lot pay factor is reduced by 10%.]

Table 401-8.1: Price Adjustment Schedule [1]

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% is subject to the total project payment limitation specified in paragraph 401-8.1.1.

[2] The lot must 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 will not be removed, it is paid for at 50% of the contract unit price and the total project payment is reduced by the amount withheld for the rejected lot.

401-8.1.2 Adjusted Payment for Grinding.

The lot pay factor is reduced by 5% for lots with grinding over 10% of lot.

401-8.1.3 Adjusted Payment from Grade.

The lot pay factor is reduced by 5% for lots not meeting grade over 10% of the lot.

[______ | Payment is made at the contract unit price for Item P-401 Asphalt [Surface | Base | Leveling] course per ton for all material that meets acceptance criteria in paragraph 401-6.2.]

401-8.2 Payment.

Payment is made under:

Item P-401-8.1 Asphalt [Surface | Base | Leveling] Course – [per ton (kg)]

401-9 REFERENCES

401-9.1 This list of publications forms 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 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 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 D3699	*Standard Specification for Kerosene*
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 Ductilometer*
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 Gyratory Compactor.*
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 Inclinometer 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 T340	*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	*FAA Rigid and Flexible Iterative Elastic Layered Design*

END OF ITEM P-401

Part 7 – Rigid Pavement

Item P-501 Cement Concrete Pavement

****

This specification is for the surface course for airfield rigid pavements subject to aircraft loadings greater than 30,000 lbs (13,600 kg).

For airfield pavement projects at non-primary airports, serving aircraft less than 60,000 lbs (27,215 kg), state highway specifications may be used in states where the state requested and received Federal Aviation Administration (FAA) approval to use state highway specifications. The use of State Highway specifications at other locations requires a Modification of Standards (MOS) according to FAA Order 5300.1.

State highway department material specifications may be used for access roads, perimeter roads, and other pavements subject to aircraft loading less than or equal to 30,000 lbs (13,600 kg).

When using state highway material specifications, include all applicable/approved state specifications in the contract documents.

- **State specifications must include the material requirements of paragraph 501-2.1 for reactivity.**
- **The state specification must have a demonstrated satisfactory performance record under equivalent loadings and exposure.**
- **When state highway specifications are approved, include all applicable/approved state specifications in the contract documents.**
- **Update any references to State Department of Transportation (DOT), State Materials Laboratory, etc., to “Owner,” “RPR,” etc. as appropriate for project.**

****

501-1 DESCRIPTION

501-1.1 This work consists of pavement composed of cement concrete constructed on a prepared underlying surface according to these specifications. The work must conform to the lines, grades, thickness, and typical cross-sections shown on the plans. The terms cement concrete, hydraulic cement concrete, and concrete are interchangeable in this specification.

501-2 MATERIALS

501-2.1 Aggregates.

Aggregate test results required in Tables 501-2.1a and 501-2.1b must be submitted with the concrete mix design and prior to the start of a new construction season on projects that span multiple construction seasons.

501-2.1.1 Reactivity.

Fine and coarse aggregates used on a project must be tested and evaluated according to ASTM C1567. Tests must be representative of aggregate sources providing material for production.

1. Test the aggregates, cementitious material, and any reactivity reducing chemicals according to ASTM C1567. Use the cement proposed for use with the project concrete mix. If the expansion does not exceed 0.08% at 28 days, the proposed materials are acceptable. If the expansion is greater than 0.08% at 28 days, the aggregates are not acceptable unless adjustments to the mixture reduce the expansion to less than 0.08% at 28 days. Otherwise evaluate and test new aggregates, cementitious material, and any reactivity reducing materials.
2. If lithium nitrate is proposed for use with or without supplementary cementitious materials, test the aggregates according to Corps of Engineers (COE) Concrete Research Division (CRD) C662 in lieu of ASTM C1567. Lithium nitrate admixture, nominal 30% ±0.5% weight lithium nitrate in water, if used. If the expansion does not exceed 0.08% at 28 days, the proposed combined materials are acceptable. If the expansion is greater than 0.08% at 28 days, the aggregates are not acceptable unless adjustments to the combined materials mixture reduces the expansion to less than 0.08% at 28 days. Otherwise, evaluate and test new aggregates.

501-2.1.2 Fine Aggregate.

Grading of the fine aggregate, as delivered to the mixer, will conform to the requirements of ASTM C33 and the parameters identified in Table 501-2.1a listing fine aggregate material requirements and deleterious limits.

Table 501-2.1a: Fine Aggregate Material Requirements

Fine Aggregate Material Requirements		
Sand Equivalent	**[** 45 **]** minimum	ASTM D2419
Fineness Modulus (FM)[1]	2.50 ≤ FM ≤ 3.40	ASTM C136
Limits for Deleterious Substances in Fine Aggregate for Concrete		
Clay lumps and friable particles	1.0% maximum	ASTM C142
Coal and lignite	0.5% using a medium with a density of Sp. Gr. of 2.0	ASTM C123
Total Deleterious Material	1.0% maximum	

[1] If FM < 2.5 but greater than 2.3, evaluate fineness modulus of combined gradation. If fineness modulus for combined gradation 2.50 ≤ FM ≤ 3.40 the fine aggregate is acceptable.

501-2.1.3 Coarse Aggregate.

The maximum size coarse aggregate is **[__]**.

Aggregates delivered to the mixer must be clean, hard, uncoated aggregates consisting of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, or a combination. Aggregates must not have any known history of detrimental pavement staining. Steel blast furnace slag is not permitted. Table 501-2.1b lists the coarse aggregate material requirements and deleterious limits.

****

Select maximum aggregate size (typically 1-1/2-inch, 1-inch, or 3/4-inch) based on what is locally available and considering freeze-thaw vulnerability.

Some aggregates may contain ferrous sulfides and iron oxides which can cause stains on exposed concrete surfaces. In areas where staining has been a problem or is suspected, the Engineer should verify that producers and aggregate suppliers took steps to minimize the inclusion of any ferrous sulfides or iron oxides in aggregate to be used in the project.

If there is a concern that these may exist, a known indicator to identify staining particles is to immerse the aggregate in a lime slurry. If staining particles are present, a blue-green gelatinous precipitate will form within five to ten minutes, rapidly changing to a brown color on exposure to air and light. The reaction should be complete in 30 minutes. If brown gelatinous precipitate does not form, there is little chance of reaction in concrete. (Portland Concrete Association, Design and Control of Concrete Mixtures).

Freeze-Thaw testing is generally not required in International Energy Conservation Code (IECC) Climate Zones 1-2 and the Engineer must check in Zones 3 and 4. Most areas in Zone 3 don’t need freeze-thaw testing and

most areas in Zone 4 do need testing. However, there are areas in Zone 3 that do need testing and areas in Zone 4 that do not need testing. The Engineer must evaluate local freeze-thaw records in these areas to determine whether or not freeze-thaw testing is required. When freeze-thaw testing is required, the Engineer must review entire specification to ensure consistency of requirements for freeze-thaw.

****

Table 501-2.1b: Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 for any size group coarser than ⅜ (9.5 mm) sieve [1]	ASTM D4791
Bulk density of slag [2]	Weigh not less than 70 lbs per cubic foot (1.12 Mg/cubic meter)	ASTM C29
[D-cracking (Freeze-Thaw) [3]	Method A Durability factor ≥ 90 Method B Durability Factor ≥ 95	ASTM C666 **]**

[1] A flat particle is one having a ratio of width to thickness greater than five; an elongated particle is one having a ratio of length to width greater than five.

[2] Only required if slag is specified.

[501-2.1.4 The Contractor must 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 not dated, are over one year old, or are for different gradations are not acceptable. Crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite, or trap rock are considered resistant to Freeze-Thaw. C666 testing is not required. However, these aggregates must meet all other quality tests specified in Item P-501. **]**

The amount of deleterious material in the coarse aggregate will not exceed the following limits.

Table 501-2.1c: Limits for Deleterious Substances in Coarse Aggregate

Deleterious Material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (75 µm)	ASTM C117	1.0[1]
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert[2] (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	**[** `1.0` **]**[3] **[** `0.1` **]**[3]
Total of all deleterious material		3.0[1]

[1] The limit for material finer than 75-µm is permitted to be increased to 1.5% for crushed aggregates consisting of dust of fracture that is essentially free from clay or shale. Test results supporting acceptance of increasing limit to 1.5% with statement indicating material is dust of fracture must be submitted with Concrete mix. Acceptable techniques to characterizing these fines include methylene blue adsorption or X-ray diffraction analysis. The total of all deleterious materials increases up to 3.5%.

[2] Chert and aggregates with less than 2.4 specific gravity.

[3] Limit chert to 0.1% in areas subject to freeze and thaw.

501-2.1.5 Combined Aggregate Gradation.

This specification is targeted for a combined aggregate gradation developed following the guidance presented in Tri-Service Pavements Working Group (TSPWG) Manual UFC TSPWG M 3-250-04.97-05, except materials must be in conformance with paragraphs 501-2.1, 501-2.2 and 501-2.8.

501-2.1.6 Contractors Combined Aggregate Gradation.

The Contractor submits their combined aggregate gradation using the following format.

Table 501-2.1d: Contractor's Combined Aggregate Gradation

Sieve Size	Contractor's Concrete mix Gradation (Percent passing by weight)	Production Tolerances
2 inch (50 mm)	*	±2%
1½ inch (37.5 mm)	*	±2%
1 inch (25.0 mm)	*	±4%
¾ inch (19.0 mm)	*	±4%
½ inch (12.5 mm)	*	±4%
⅜ inch (9.5 mm)	*	±4%
No. 4 (4.75 mm)	*	±4%
No. 8 (2.36 mm)	*	±2%
No. 16 (1.18 mm)	*	±2%
No. 30 (600 µm)	*	±2%
No. 50 (300 µm)	*	±2%
No. 100 (150 µm)	*	±2%

****

The table remains blank until the Contractor submits the concrete mix.

Reference Tri-Service Pavements Working Group (TSPWG) Manual UFC TSPWG M 3-250-04.97-05, Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements.

https://www.wbdg.org/FFC/DOD/STC/tspwg_m_3-250-04.97-05.pdf.

****

501-2.2 Cementitious Materials.

Cement must conform to the requirements of **[** `ASTM C150, Types I, II or V; ASTM C595 Types IS, IP, IL, or IT; ASTM C1157 Types GU, HS, MS, MH or LH` **]**. **[** `ASTM C150 Type III, ASTM C1157 Type HE, ASTM C1600 Type` **[** `URH` **|**`VRH` **|**`MRH` **|**`GRH` **|**`RH-CAC` **]]**.

****

Retain all cements appropriate for the project's use.

For repair projects or projects that require high early strength for early opening to aircraft traffic ASTM C1157 HE, ASTM C150 Type III or ASTM C1600 cements may be required. These projects may require multiple mix designs, some with high early strength and some with standard cements. Do not include high early strength cements unless project includes need for

rapid repairs or early strengths due to operational needs. Since other construction items generally control the critical path on repair projects, such as marking or lighting when specifying cements for these projects consider time from mixing to load application.

When both standard cement and high early strength cement are used on the project, the Engineer must indicate on the plans where high early strength is required.

****

501-2.2.1 Coal Ash.

Coal ash must meet the requirements of ASTM C618. The Contractor must furnish the previous three most recent, consecutive ASTM C618 reports for each source of coal ash proposed in the concrete mix and furnish additional reports as they become available during the project.

501-2.2.2 Slag Cement (Ground Granulated Blast Furnace (GGBF)).

Slag cement will conform to ASTM C989, Grade 100 or Grade 120.

501-2.2.3 Raw or Calcined Natural Pozzolan.

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N. This includes the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and having a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a total available alkali content less than 3%.

501-2.24 Ultrafine Fly Ash (UFFA) and Ultrafine Pozzolan (UFP).

UFFA and UFP must conform to ASTM C618, Class F or N, and the following additional requirements:

1. The strength activity index at 28 days of age must be at least 95% of the control specimens.
2. The average particle size will not exceed 6 microns.

501-2.3 Isolation Joint Filler.

Premolded joint filler for isolation joints must conform to the requirements of ASTM D8139 or ASTM D1751 or ASTM D1752. Furnish the filler for each joint in a single piece for the full depth and width required for the joint. If more than one piece is required for a joint, the abutting ends must be fastened securely and held accurately to shape by stapling or other positive fastening means.

501-2.4 Reinforcement.

Reinforcing will consist of **[__]** conforming to the requirements of ASTM **[__]**.

****

The Engineer designates one of the following:

ASTM A615	**Standard Specification for Deformed and Plain Carbon-Steel Bars 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 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 A184 or A704 Bar mats	
ASTM A1035	**Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement**
ASTM A884	**Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement**
ASTM D7957	**Standard Specification for Solid Round Glass Fiber Reinforced Polymer Bars for Concrete Reinforcement.**

Note: addition of fibers to PCC will increase its toughness but will not increase its strength. Fibers help keep cracks small but do not stop cracking.

Furnish welded wire fabric in flat sheets only.

Delete the paragraph on reinforcement when not applicable to the project.

****

501-2.5 Dowel and Tie Bars.

****

When fiber bars are used, epoxy coating is not required.

****

Use **[** plain steel dowel bars conforming to ASTM A615 **|** solid round fiber reinforced polymer bars ASTM D7957 **]**. Dowels will be free from burring or other deformation restricting slippage in the concrete.

501-2.5.1 Dowel Bars.

[Before delivery to the construction site, epoxy coat each dowel bar per ASTM A1078.

`Patched ends are not required for Type 1 coated dowels. Coat the dowels with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings will be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens. [___]`

501-2.5.2 Tie Bars.

Use deformed steel tie bars conforming to the requirements of ASTM A615. Use tie bars designated as Grade 60 in ASTM A615 or ASTM A706 for construction requiring bent bars.

501-2.6 Water.

Water from a drinking water source is suitable for mixing and curing. Water from other sources must meet the requirements of ASTM C1602.

501-2.7 Material for Curing Concrete.

Curing materials must meet the requirements of one of the following specifications:

1. Liquid membrane-forming compounds for curing concrete must meet the requirements of ASTM C309, Type 2, Class A, or Class B.
2. White polyethylene film for curing concrete must meet the requirements of ASTM C171.
3. White burlap-polyethylene sheeting for curing concrete must meet the requirements of ASTM C171.
4. Waterproof paper for curing concrete must meet the requirements of ASTM C171.

501-2.8 Admixtures.

Admixtures must meet the requirements of the following specifications:

501-2.8.1 Air-Entraining Admixtures.

Air-entraining admixtures must meet the requirements of ASTM C260 and consistently entrain the air content in the specified ranges under field conditions. The air-entraining agent and any water reducer admixture must be compatible.

501-2.8.2 Chemical Admixtures.

Chemical admixtures must meet the requirements of ASTM C494. Do not use calcium chloride or admixtures containing calcium chloride. Do not use ASTM C494 Type S admixtures.

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Type S admixtures may be used under a MOS.

****

501-2.8.3 Lithium Nitrate.

The lithium admixture must be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 lbs/gallon (1.2 kg/L), and have the approximate chemical form shown in Table 501-2.8.

Table 501-2.8: Lithium Admixture

Constituent	Limit (Percent by Mass)
LiNO3 (Lithium Nitrate)	30 ±0.5
SO4 (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

The lithium nitrate admixture dispensing and mixing operations must be verified and certified by the lithium manufacturer's representative.

501-2.9 Epoxy-resin.

When used, epoxy-resin materials must conform to the requirements of ASTM C881, type as appropriate for application and class as appropriate for application temperature.

501-2.10 Bond Breaker.

[Use ½" layer of ASTM C33 Number 89 choke stone |Use a fabric bond breaker that meets the requirements of AASHTO M 288 Class I woven fabric with elongation less than 50% at the specified strengths. Provide a Certificate of Compliance (COC)from the fabric manufacturer that the material may be used as a bond breaker. |Liquid membrane forming compound will meet the requirements of paragraph 501-2.7.][Not required.]

****

The Engineer must include a bond breaker when concrete pavement is placed directly above the P-306 Lean Concrete Base Course and is recommended with any stabilized base.

****

501-3 CONCRETE MIX

501-3.1 General.

Do not place concrete until an acceptable concrete mix has been submitted to the RPR and approved.

501-3.2 Concrete Mix Laboratory.

A laboratory used to develop the concrete mix must possess a current certificate of accreditation according to ASTM C1077, or from a national accrediting authority, or from a current State DOT accreditation. A copy of the laboratory's current accreditation and accredited test methods must be submitted to the RPR prior to start of construction.

501-3.3 Concrete Mix Proportions.

Develop the concrete mix using materials that meet requirements of this specification. Proportion the concrete to achieve a 90-day flexural strength of 650 psi, per ASTM C78. The percentage of air in the mix must be 7% in areas subject to freeze/thaw and 4% in areas not subject to freeze-thaw. Determine air content by testing according to ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate, air content **[** ___ **]**.

501-3.3.1 Use the minimum amount of cementitious material, as defined in paragraph 501-2.2, required to ensure a workable, durable mix. Use a ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates between 0.38 – 0.45 by weight. The water cement ratio used in the laboratory trial mix is the maximum water cement ratio to be used during production. Prepare flexural strength test specimens according to ASTM C192 and test according to ASTM C78. Once the concrete mix is finalized, develop a time vs flexural **[** `and a flexural vs compressive` **]** strength gain correlation(s) for the concrete mix. The correlation(s), as a minimum, must include tests at 3, 7, 14, 28 and 90 days. This correlation for strength at 14 days will be utilized for acceptance under paragraph 501-6.5. If maturity meters are to be used to estimate strength for construction loading or placement of concrete in cold weather, develop time/temperature/flexural strength correlations according to ASTM C1074.

****

The following procedure establishes a correlation between compressive and flexural strength for the concrete mix. Each concrete mix requires a separate correlation. For projects which include acceptances based upon compressive strength must include the requirement to develop this correlation.

Cylinders/Beams

a. Fabricate all beams and cylinders for each mixture from the same batch or blend of batches. Fabricate and cure all beams and cylinders according to ASTM C192, using 6-inch × 6-inch (150 × 150 mm) steel beam forms and 6-inch × 12-inch (150 × 300 mm) single-use cylinder forms.

b. Cure test beams from each mixture for 3, 7, 14, [`28` **] and [** `90` **]-day flexural tests; three beams to be tested per age.**

c. Cure test cylinders from each mixture for 3, 7, 14, [`28` **] and [** `90` **]-day compressive strength tests; three cylinders to be tested per age.**

d. Test beams according to ASTM C78, and test cylinders according to ASTM C39.

e. Using the average strength for each age, plot all results on separate graphs for each w/c versus:

- **3-day flexural strength**
- **7-day flexural strength**
- **14-day flexural strength**
- **[** `28-day flexural strength` **]**
- **[** `90-day flexural strength` **]**
- **3-day compressive strength**
- **7-day compressive strength**
- **14-day compressive strength**
- **[** `28-day compressive strength` **]**
- **[** `90-day compressive strength` **]**

f. From the above expected strengths for the selected mixture determine the following Correlation Ratios:

(1) Ratio of the 14-day compressive strength of the selected mixture to the [`90` **]-day flexural strength of the mixture (for acceptance).**

(2) Ratio of the 7-day compressive strength of the selected mixture to the [`90` **]-day flexural strength of the mixture (for Contractor QC control).**

g. If there is a change in materials, make additional mixture design studies using the new materials and determine new Correlation Ratios.

h. Do not place any concrete pavement until the Engineer approves the Contractor's mixture proportions.

****

501-3.3.3 Changes in the source of aggregate require a new mix design. Changes in supplier of cementitious material require a new trial batch, if trial batch is not acceptable, a new mix design is required. Minor changes in dosage of admixtures are acceptable. Changes in supplier of admixtures or addition or deletion of an admixture requires a trial batch. If the trial batch is not acceptable, a new mix design is required. 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 Engineer must specify the appropriate air content for the exposure level for the project location at the maximum aggregate size specified in paragraph 501-2.1.3.

Table 501-3.5 Recommended Air Content (Percent)

Exposure Level	Maximum Size Aggregate inch (mm)				
	2 inch (50 mm)	1-1/2 inch (37.5 mm)	1 inch (25.0 mm)	3/4 inch (19.0 mm)	1/2 inch (12.5 mm)
Mild	2.0%	2.5%	3.0%	3.5%	4.0%
Moderate	4.0%	4.5%	4.5%	5.0%	5.5%
Severe	5.0%	5.5%	6.0%	6.0%	7.0%

1. Mild exposure – When desired for other than durability, such as to improve workability. Used where pavement will not be exposed to freezing or to deicing agents.
2. Moderate exposure – Service in a climate where freezing is expected but where the concrete will not be continually exposed to moisture or free water for long periods prior to freezing and will not be exposed to deicing agents or other aggressive chemicals.
3. Severe exposure – Concrete which is exposed to deicing chemicals or other aggressive agents or where the concrete may become highly saturated by continual contact with moisture or free water prior to freezing.

****

501-3.4 Concrete Mix Submittal.

Submit the concrete mix to the RPR at least **[** 30 **]** days prior to the pre paving workshop. The submitted concrete mix must not be more than one year old and must use the materials designated for production for the project. Production must not begin until the RPR approves the concrete mix in writing. Each of the submitted concrete mixes (e.g., slip form, side form machine finish, side form hand finish, hot and cold weather) must be stamped or sealed by the responsible professional Engineer who developed the mix design and include the following items and quantities as a minimum:

- Certified material test reports for aggregate according to paragraph 501-2.1. Certified reports must include reporting each test, test method, test result, and requirement specified (criteria).
- Combined aggregate gradations and analysis; and including plots of the fine aggregate fineness modulus.
- Reactivity Test Results.
- Coarse aggregate quality test results, including deleterious materials.
- Fine aggregate quality test results, including deleterious materials.
- Mill certificates for cement and supplemental cementitious materials.
- Product data sheets for all admixtures, including lithium nitrate if applicable.
- Specified flexural strength and air content.
- Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio and air content and amount and type of any admixtures for concrete mixes that include allowance for use of admixtures to accommodate hot or cold weather, verify concrete mix with admixtures with trial batches.
- When admixtures used check that all admixtures are compatible, with checks for slump loss, set time, air entrainment.
- Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
- Correlation ratios for acceptance testing and Contractor QC testing.
- Time-temperature-flexural strength relationship (when maturity method to be used for cold weather or opening of pavement for construction loads).

501-3.4.1 The results of the concrete mix must include a statement giving the maximum nominal coarse aggregate size, weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Base aggregate quantities on saturated surface dry condition.

501-3.4.2 A request to use a previously approved concrete mix will be considered provided the following verification is completed:

- It was developed and approved for use on an federally funded airport grant project within the previous 24 months.

- The aggregate source(s) and sizes must be the same as used in the previous concrete mix. The contractor must provide current aggregate field gradations for review. The aggregates must meet the requirements of Table 501-2.1a, Table 501-2.1b, Table 501-2.1c and Table 501-2.1d. Cementitious material must meet the requirements of paragraph 501-2.2.

- All documentation from the previous concrete mix will be provided to the RPR for review and approval. The required documentation is outlined above in paragraph 501-3.4.

501-3.4.3 For projects that span multiple construction seasons prior to the restart of production verify with testing that aggregates meet requirements of Table 501-2.1a, Table 501-2.1b, Table 501-2.1c and Table 501-2.1d. In addition, a trial batch is required, if the trial batch is not acceptable a new mix design is required.

501-3.4.5 Changes in the supplier of cementitious material requires a new trial batch, if the trial batch is not acceptable a new mix design is required.

501-3.4.6 Minor changes in dosage of admixtures is acceptable.

501-3.4.7 Changes in supplier of admixture or addition or deletion of an admixture requires a trial batch, if the trial batch is not acceptable a new mix design is required.

501-3.4.8 Prior to and during production, the RPR may request samples for testing to verify the quality of materials and to ensure conformance with the applicable specifications.

501-3.5 Addition of Admixtures.

501-3.5.1 Air-entraining Admixtures.

Add air-entraining admixture in a way that ensures uniform distribution of the agent throughout the batch. Determine air content by testing according to ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

501-3.5.2 Water-reducing Admixtures.

Add water-reducing admixtures to the mix as recommended by the manufacturer.

501-3.5.3 Other Admixtures.

Add set controlling, and other RPR-approved admixtures to the mix as recommended by the manufacturer.

501-3.5.4 Lithium Nitrate.

Add lithium nitrate to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements according to paragraph 501-2.8.3.

501-4 CONSTRUCTION METHODS

501-4.1 Pre-Paving Meeting and Control Strip.

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For large complex paving projects the Owner may choose to have the prepaving meeting run by an independent moderator, instead of the RPR or Contractor.

****

501-4.1.1 Pre-paving Meeting.

Prior to construction of the control strip, a pre-paving meeting is required. The contractors CQCP and concrete mix must be submitted and approved prior to the pre-paving meeting. The **[** `RPR` **|** `Contractor` **|** `Independent Moderator` **]** facilitates this meeting. At a minimum, this meeting will include:

☐ Owner representative, superintendent, **[** `Contractor` **]** paving superintendent, concrete plant manager, Contractor material and testing technicians, Owner material and testing technicians, Contractor QC manager, Owner QA manager, QC and QA inspectors **[** `and additional required attendees` **]**.

☐ Agenda for meeting will include:

- Submittal review
- Review/discussion of concrete mix
- Location of concrete mix plant, location of stockpiles, delivery of materials to the plant, rate of production of concrete mix, delivery, and placement
- Work hours
- Production Plan (location of stockpiles, location of plant, rate of production, hours of production)
- Paving Plan (What will the paving sequence be, hours of paving?)
- Hot and Cold weather paving plans. (Adjustments to concrete mixture, adjustments to delivery, adjustments to placement and finishing, additional materials needed (evaporative membrane, blankets, etc.))
- Delivery and Placement (Equipment, number of trucks, concrete placer)
- QC Testing Plan (Who will obtain QC test samples? How will QC test samples be handled? Who will perform QC testing, how and

when will results be reported, how will results be used, and who has authority to stop work?)

- QA Testing Plan (Who will obtain QA samples. How will they be transported to testing location, where will they be tested, how will results be reported, and what constitutes acceptable work?)
- How will QC and QA test results be reported?
- What constitutes acceptable work, what is the response to failed tests?
- When will stop work orders be issued, who can issue stop work orders?
- How will traffic control be handled?
- How will coordination with airport operations be handled?
- Coordination of emergency response
- Lighting plan for nighttime work
- Traffic Control Plan (marking, signage, are escort vehicles required, how will coordination with airport operations be handled, coordination of emergency response, lighting for nighttime work)
- **[** `Additional items as necessary` **]**

501-4.1.2 Control Strip**.**

The purpose of the control strip is to allow for adjustments to the concrete mix and to demonstrate that the materials, concrete mix, equipment (mixing, transport, placement, finishing), construction processes, personnel, and QC processes can produce and place the concrete mix in conformance with the specifications. An acceptable control strip is within quality control limits for air, edge slump, mix proportions, thickness, smoothness, and strength. As a minimum, take samples for strength testing at three, seven, and 14 days. Production paving can begin if control strip strength at 14 days meets or exceeds strength of the concrete mix design at 14 days. The control strip(s) may be the first days planned production and must be at least to the next planned joint after the initial 250 feet (75 m) of each type of pavement construction (slip-form pilot lane, slip-form fill-in lane, or fixed form).

The Contractor must have control strips for all methods to be used on the project, pilot, fill-in, and fixed-form. The control strip must include all proposed methods of finishing. Each control strip is accepted separately. Minor adjustments to the concrete mix design (aggregate proportions, cementitious material, admixtures, and water) may be required to place an acceptable control strip. The production mix is the adjusted concrete mix used to place the acceptable control strip. Once the RPR accepts the control strip, the Contractor must use the same equipment, materials, and construction methods, and personnel for the remainder of concrete paving. The coarseness factor (CF) and WF from the production mix is the QC point for monitoring aggregates. The Contractor may make minor adjustments as required to stay within QC limits. Adjustments to processes or materials beyond the QC limits must be approved in advance. The acceptable control strip is paid for according to paragraph 501-8.2. A new control strip is required for new JMF and at the restart of construction on projects that span multiple construction seasons.

501-4.2 Equipment.

The Contractor is responsible for the proper operation and maintenance of all equipment necessary for handling materials and performing all parts of the work to meet this specification.

501-4.2.1 Plant and Mixing Equipment.

The plant and mixing equipment must conform to the requirements of ASTM C94 and/or ASTM C685.

501-4.2.2 Equipment for Transfer and Spreading.

Equipment for transferring and spreading concrete from the transporting equipment to the paving lane in front of the finishing equipment is provided. The equipment will be specially manufactured, self-propelled, transfer equipment which accepts the concrete outside the paving lane and spreads it evenly across the paving lane in front of the paver and strikes off the surface evenly to a depth which permits the paver to operate efficiently.

501-4.2.3 Finishing Equipment.

501-4.2.3.1 Slip-form.

The standard method of constructing concrete pavements is with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement. The paver-finisher must be a heavy duty, self-propelled, machine designed specifically for paving and finishing high quality concrete pavements. **[** `The paver-finisher must have a minimum weight of 2,200 lbs per foot of lane width with sufficient horsepower to strike off the concrete mix and maintain required grade.` **]**

****

It is necessary to have a paver with enough power and weight to strike off the concrete. If the paver is too light, and does not have sufficient power, the

paver will ride up on the PCC, or the paver will not be able to strike off the pavement on grade.

****

501-4.2.3.2 Fixed-form.

On projects requiring less than **[** `10,000 cubic yards (7650 cubic meters)` **]** of concrete pavement or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with equipment specifically designed for placement and finishing using stationary side forms. The RPR must review and accept the methods and equipment. Only use hand screeding and float finishing on small irregular areas as the RPR allows.

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When allowing fixed forms, the Engineer may reduce the quantity of concrete.

****

501-4.2.4 Vibrators.

The vibrator will be the internal type. The number of vibrators, spacing and rate of vibration of each vibrating unit must be sufficient to consolidate the pavement without segregation or voids. The vibrators must stop automatically when forward motion ceases. The Contractor provides an electronic or mechanical means to monitor vibrator status. Only use handheld vibrators in irregular areas or small fixed form placements using screeds.

501-4.2.5 Concrete Saws.

The Contractor must provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor provides at least one standby saw in good working order and a supply of saw blades, at the worksite, at all times, during sawing operations.

501-4.2.6 Fixed Forms.

Use fixed forms made of steel and furnished in sections not less than 10 feet (3 m) in length. Provide forms with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. The top face of the form must not vary from a true plane more than ⅛ inch (3 mm) in 10 feet (3 m), and the upstanding leg must not vary more than ¼ inch (6 mm). The forms must contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, and as the base form to adjust for variations in grade. Forms must extend the full depth of the pavement section, except shims less than one-inch are permitted to correct for variations in grade.

501-4.3 Form Setting.

Set forms to line and grade as shown on the plans, sufficiently in advance of the concrete placement, to ensure continuous paving operation. Set forms to withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Clean and oil forms prior to the concrete placement.

501-4.4 Base Surface Preparation Prior to Placement.

The Contractor must correct any damage to the prepared base, subbase, and subgrade prior to concrete placement. The underlying surface must be entirely free of frost when concrete is placed. Moisten the prepared grade with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. [Apply bond breaker.] [Seat choke stone bond breaker with two coverages of a [pneumatic | steel roller]] [The RPR must approve the installation of the bond breaker prior to placement of concrete.]

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The Engineer ensures the plans show the appropriate prepared base, subbase, and subgrade extend a width sufficient to support the paving machine track without any noticeable displacement of the paver. Typical widths up to three feet (1 m) are required to support the paver track.

The Engineer determines type of bond breaker including application rate.

****

501-4.5 Handling, Measuring, and Batching Material.

Construct and manage aggregate stockpiles in a manner that prevents segregation, intermixing and introduction of deleterious materials. Stockpile, weigh, and batch aggregates from different sources separately at the concrete batch plant. Do not use aggregates that have become segregated or intermixed with earth or foreign material. Stockpile or bin for at least 12 hours prior to batching, washed aggregates, or aggregates produced or handled with hydraulic methods. Store and maintain all aggregates at a uniform moisture content prior to use. Provide a continuous supply of materials to the work to ensure continuous placement.

501-4.6 Mixing Concrete.

The concrete may be mixed at the worksite, in a central mix plant or in truck mixers. All concrete will be mixed and delivered to the site according to the requirements of ASTM C94 or ASTM C685. Mixed concrete from the central mixing plant can be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is discharged from the truck should not exceed **[** 60 **]** minutes when the concrete is hauled in non-agitating trucks, or **[** 90 **]** minutes when the concrete is hauled in truck mixers or truck agitators. The temperature of the concrete when placed, must not ever exceed **[** 90°F (32°C) **]**. Retempering concrete by adding water or by other means is not permitted. With transit mixers, additional water may be added to the batch materials and additional mixing performed, provided the addition of water is performed within **[** 45 **]** minutes after the initial mixing operations and provided the water/cementitious ratio specified is not exceeded.

****

Depending on the location of the batch plant, this time can be adjusted. Provide the batch plant location to ensure that the time limit is reasonable to allow for delivery and placement of concrete within the allotted time. Time limit must consider the time from batching to placement including: transit time, time to enter security check points, time to cross active taxiways or runways, ambient weather conditions, types of cementitious materials, admixtures as well as placement methods. In addition to location of batch plant and delivery time ambient conditions, types of cementitious materials and admixtures as well as placement procedures all time between mixing and placement.

****

501-4.7 Weather Limitations on Mixing and Placing.

Do not mix, place, or finish concrete when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated. The Contractor must have materials available for the protection of the concrete during cold, hot and/or inclement weather.

501-4.7.1 Cold Weather.

The Contractor is responsible for the strength and quality of the concrete placed during cold weather. Before starting paving operations, the Contractor must be prepared to protect the concrete from freezing. **[** Maturity meters, to monitor and record time and pavement temperature, must be installed at the time of placement when the air temperature in the shade and away from artificial heat is expected to fall below 40˚F during the next three days. **]** The Contractor must maintain the temperature of the pavement at or above 40˚F until the pavement has attained a flexural strength of at least 450 psi. The flexural strength of the concrete is determined using maturity relationship according to ASTM C1074. Place maturity meters in three locations for each day’s concrete paving operations. Place `one maturity meter in the final 15 feet of paving and place the other two maturity meters at locations the RPR designates. Locate the maturity meter probes on the outside edge of the slab, at least 1 foot (0.3 m) and not more than 2 feet from the edge and at mid depth of the slab. Each maturity meter must be able to record the time and temperature. The maturity meters will remain in place until the concrete has attained a flexural strength of 450 psi. Logs from the maturity meters must be submitted to the Engineer daily.` **]** Curing during cold weather is according to paragraph 501-4.13.4.

501-4.7.2 Hot Weather.

During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the Contractor must implement their approved hot weather paving plan**.** Place the concrete at the coolest temperature practicable. In no case, can the temperature of the concrete exceed 90°F (32°C) when placed. Protect the concrete placement from exceeding an evaporation rate of 0.2 psf (0.98 kg/square meters per hour) per hour. When conditions are such that problems with plastic cracking can be expected, (low humidity, high wind combined with high temperatures) and particularly if any plastic cracking begins to occur, the Contractor must immediately take such measures to protect the concrete surface, minimize time from mixing to placement. If the Contractor's measures are not effective in preventing plastic cracking, immediately stop paving operations. Cure concrete during hot weather according to paragraph 501-4.13.5.

501-4.7.3 Temperature Management Program.

Prior to the start of paving operation for each day of paving, the Contractor must provide the RPR with a Temperature Management Program that minimizes the chances for uncontrolled cracking for the concrete to be placed. (Federal Highway Administration HIPERPAV 3 is one example of a Temperature Management Program.) As a minimum, the program will address the following items**:**

1. Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.
2. Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 19-9, PCA, Design and Control of Concrete Mixtures.
3. Anticipated timing of initial sawing of joint.
4. Anticipated number and type of saws to be used.

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Federal Highway Administration HIPERPAV III is one example of a Temperature Management Program. See ACI 305 Guide to Hot Weather Concreting and ACI 306 Guide to Cold Weather Concreting. It will provide an analysis of strength vs stress.

****

501-4.7.4 Rain.

The Contractor must have materials available for the protection of the concrete during inclement weather. Such protective materials consists of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations must stop and all available personnel must begin covering the surface of the unhardened concrete with the protective covering. If pavement gets rained on prior to placement of protection, any excess water must be removed with dry burlap or similar material. If initial set has not occurred, the surface may be finished after excess water has been removed. If removing more than ¼ inches of paste exposes aggregate, the Contractor must remove and replace pavement at the Contractor's expense. In order not to remove pavement damage by rain, the Contractor must hire a petrographer to perform an analysis to document the depth and extent of damage. Pavement must meet all acceptance criteria for smoothness, thickness, grade, air, and strength.

501-4.8 Concrete Placement.

At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface must not exceed three feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes, front end loaders and grading equipment must not be used to distribute the concrete in front of the paver, unless approved by the RPR. All concrete must be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement.

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The Engineer selects flexural or compressive strength based on the concrete mix requirement. Also recommend giving Contractor option of using field specimens or maturity meters for opening pavement.

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501-4.8.1 Slip-form Construction.

The concrete must be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver must be regulated from outside reference lines. The paver must vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration must be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms must be rigidly held together laterally to prevent spreading of the forms. Consolidate the full depth of plastic concrete by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit must not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes. The spacing of internal units must be uniform and not exceed 18 inches (0.5 m).

The term internal vibration means vibrating units located within the specified thickness of pavement section. The rate of vibration of each vibrating unit must be sufficient to consolidate the pavement without, segregation, voids, or vibrator trails and the amplitude of vibration must be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or amplitude should be adjusted proportionately with the rate of travel to result in a uniform density and air content. The paving machine must be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete must be held at a uniform consistency. Operate the slip-form paver with as nearly a continuous forward movement as possible. Coordinate all operations of mixing, delivering, and spreading concrete to provide for uniform progress with minimal stopping and starting of the paver. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements must also be stopped immediately. Do not apply additional tractive force to the paver. When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement must be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid damage to the edge of the pavement.

Not more than 15% of the total free edge of each 500-foot (150 m) segment of pavement, or fraction of, will have an edge slump exceeding ¼ inch (6 mm), and none of the free edge of the pavement will have an edge slump exceeding ⅜ inch (9 mm). The total free edge of 500 feet (150 m) of pavement is considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane must not have any free edge, etc. The area affected by the downward movement of the concrete along the pavement edge must be limited to not more than 18 inches (0.5 m) from the edge. When excessive edge slump cannot be corrected before the concrete has hardened, remove the area with excessive edge slump the full width of the slip form lane and replace at the Contractor's expense, as the RPR directed.

501-4.8.2 Fixed-form Construction.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms will be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing. Side forms will remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound will be applied to the concrete immediately after the forms have been removed. Side forms must be thoroughly cleaned and coated with a release agent each time they are used and before concrete is placed against them.

Spread, screed, shape and consolidate concrete by one or more self-propelled machines. These machines must uniformly distribute and consolidate concrete without segregation so that the completed pavement conforms to the required cross-section with a minimum of handwork. The number and capacity of machines furnished must be adequate to perform the work required at a rate equal to that of concrete delivery. The equipment must be specifically designed for placement and finishing using stationary side forms. The RPR reviews and accepts methods and equipment. Concrete for the full paving width must be effectively consolidated by internal vibrators. The rate of vibration of each vibrating unit must be sufficient to consolidate the pavement without segregation, voids, or leaving vibrator trails. Power to vibrators must be connected so that vibration ceases when forward or backward motion of the machine is stopped.

501-4.8.3 Consolidation.

Concrete must be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators must be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than 2 inches (50 mm). Vibrators must not be used to transport or spread the concrete. For each paving train, sufficient parts for rapid replacement and repair of vibrators or additional vibrator spuds will be available at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) or over-consolidation (vibrator trails, segregation, or any other evidence) will require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the RPR.

501-4.9 Strike-off of Concrete and Placement of Reinforcement.

Following the placing of the concrete, strike it off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement will be at the elevation shown on the plans. Reinforced concrete may be placed in either one or two layers. When reinforced concrete pavement is placed in two layers, strike off the bottom layer to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. Place the reinforcement directly upon the concrete, after which the top layer of the concrete is placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than thirty minutes without being covered with the top layer or if initial set has taken place, remove and replace with freshly mixed concrete at the Contractor’s expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement, or it may be placed in plastic concrete by mechanical or vibratory means after spreading. Reinforcing steel, at the time concrete is placed, must be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale, or a combination of both, considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

501-4.10 Joints.

Construct joints as shown on the plans and according to these requirements. Construct all joints with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints will not vary more than ½-inch (12 mm) from their designated position and must be true to line with not more than ¼-inch (6 mm) variation in 10 feet (3 m). Test the surface across the joints with a 12-foot (3 m) straightedge as the joints are finished and any irregularities more than ¼ inch (6 mm) must be corrected before the concrete has hardened. Prepare, finish, or cut all joints to provide a groove of uniform width and depth as shown on the plans.

501-4.10.1 Construction.

Longitudinal construction joints must be slip-formed or formed against side forms as shown in the plans. Install transverse construction joints at the end of each day’s placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes, or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint must be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor will remove the excess concrete back to the previous planned joint.

501-4.10.2 Contraction.

Install contraction joints at the locations and spacing as shown on the plans. Install contraction joints to the dimensions required by sawing a kerf into the concrete surface after the concrete has hardened or by forming a groove or cleft in the top of the slab while the concrete is still plastic. When the groove is formed in plastic concrete, smooth the sides of the grooves, finished even and smooth, with an edging tool. If an insert material is used, the installation and edge finish is according to the manufacturer's instructions. Finish the joint or cut clean so that spalling is avoided at intersections with other joints. Grooving or sawing must produce a slot at least ⅛ inch (3 mm) wide and to the depth shown on the plans.

501-4.10.3 Isolation (Expansion).

Install isolation joints as shown on the plans. The premolded filler of the thickness as shown on the plans, must extend from the bottom of the joint sealant reservoir to the bottom of the slab and the width of the slab at the joint. The filler must be fastened uniformly along the hardened joint face with no buckling or debris between the filler and the concrete interface, including a temporary filler for the sealant reservoir at the top of the slab. Finish and tool the edges of the while the concrete is still plastic.

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An isolation joint is primarily used to separate structures with different foundations and pavements with different joint patterns. It does not provide for expansion by the material compressing, but rather allowing the joint to slip. There should rarely be an occasion to dowel an isolation joint since it defeats the purpose of the joint and does not permit isolation and slippage. A thickened-edge is the preferred load transfer method for isolation joints.

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501-4.10.4 Dowels and Tie Bars for Joints.

501-4.10.4.1 Tie bars.

Tie bars will consist of deformed bars installed in joints as shown on the plans. Place tie bars at right angles to the centerline of the concrete slab and space at intervals shown on the plans. Hold tie bars in position parallel to the pavement surface and in the middle of the slab depth and within the tolerances in paragraph 501-4.10.5. When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars must not be painted, greased, or enclosed in sleeves. Install two-piece hook bolts when slip-form operations call for tie bars.

501-4.10.4.2 Dowel bars.

Place dowel bars across joints in the proper horizontal and vertical alignment as shown on the plans. Coat the dowels with a bond-breaker or other lubricant recommended by the manufacturer and the RPR approved. Bond dowels bars at longitudinal construction joints in drilled holes.

501-4.10.4.3 Placing Dowels and Tie Bars.

Horizontal spacing of dowels must be within a tolerance of ±¾ inch (19 mm). The vertical location on the face of the slab must be within a tolerance of ±½ inch (12 mm). The method used to install dowels must ensure that the horizontal and vertical alignment will not be greater than ¼ inch per feet (6 mm per 0.3 m), except for those across the crown or other grade change joints. Measure dowels across crowns and other joints at grade changes to a level surface. Check horizontal alignment perpendicular to the joint edge. To maintain alignment, shim basket assemblies adjacent to thickened edges. Wipe clean the portion of each dowel intended to move within the concrete or expansion cap and coat with a thin, even film of lubricating oil or light grease before the concrete is placed. Install dowels as specified in the following subparagraphs.

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Do not place dowels and tie bars closer than 0.6 times the dowel bar or tie bar length to the planned joint line. If the last regularly spaced longitudinal dowel and/or tie bar is closer than that dimension, it must be moved away from the joint to a location 0.6 times the dowel bar and/or tie bar length, but not closer than 6 inches (150 mm) to its nearest neighbor.

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501-4.10.4.4 Contraction Joints.

Hold dowels and tie bars in longitudinal and transverse contraction joints within the paving lane securely in place by means of rigid metal frames or basket assemblies of an approved type. Hold the basket assemblies securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires. At the Contractor’s option, dowels and tie bars in contraction joints may be installed by insertion into the plastic concrete using approved equipment and procedures per the paver manufacturer’s design. Base approval of installation methods on the results of the control strip showing that the dowels and tie bars are installed within specified tolerances as verified by cores or non-destructive rebar location devices the RPR approved.

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Non-destructive rebar location devices include the MIT scanner, Pachometer, R-Meter, etc.

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501-4.10.4.5 Construction Joints.

Install dowels and tie bars by the cast-in- place or the drill-and-dowel method. Installation by removing and replacing in preformed holes is not permitted. Prepare and place dowels and tie bars across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. Construction joints may be constructed with a split form and dowel basket.

501-4.10.4.6 Joints in Hardened Concrete.

Install dowels in hardened concrete by bonding the dowels into holes drilled into the concrete. The concrete must have reached a minimum **[** `compressive strength of 3100 psi ((21.4 MPa))` **|** `flexural strength of 450 psi (3.1 MPa)` **]** before drilling begins. Determine strength with time, temperature strength relationship with maturity meters according to ASTM C1074. Drill holes sooner with demonstration that drills do not cause spalling beyond the limits of the grout retention ring. Drill holes ⅛ inch (3 mm) greater in diameter than the dowels into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur. Spalling greater than two times the drill diameter requires modification of the equipment and operation. Depth of dowel hole will be within a tolerance of ±½ inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole will be blown out with oil-free, compressed air. Bond dowels in the drilled holes using epoxy resin. Inject epoxy resin in the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel to completely fill the void around the dowel. Application by buttering the dowel is not permitted. Hold the dowels in alignment at the collar of the hole by means of a suitable metal or plastic grout retention ring fitted around the dowel. Ensure the epoxy is fully cured before placement of adjacent lanes.

501-4.10.5 Sawing of Joints.

Sawing commences, without regard to time of day, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and must continue without interruption until all joints have been sawn. Remove all slurry and debris produced in the sawing of joints by vacuuming and washing. Re-apply curing compound or system in the initial saw-cut and maintained for the remaining cure period.

Joints must be cut in locations as shown on the plans. The initial joint cut must be a minimum ⅛ inch (3 mm) wide and to the depth shown on the plans. Prior to placement of joint sealant or seals, widen the top of the joint by sawing as shown on the plans.

501-4.11 Finishing.

Finishing operations must be a continuing part of placing operations starting immediately behind the strike-off of the paver. Provide initial finishing by the transverse screed or extrusion plate. The sequence of operations is transverse finishing, longitudinal machine floating if used, straightedge finishing, edging of joints, and then texturing. Use the machine method for finishing. Use the hand method only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Immediately modify as necessary, equipment, mixture, and/or procedures producing more than ¼ inch (6 mm) of mortar-rich surface, determined by using a metal plate or spatula, to eliminate this condition, or operations must cease. Finishing equipment and tools will be maintained clean and in an approved condition. At no time is water added to the surface of the slab with the finishing equipment or tools, or in any other way. Fog (mist) sprays or other surface applied finishing aids specified to prevent plastic shrinkage cracking, the RPR approved, may be used according to the manufacturer's requirements.

501-4.11.1 Machine Finishing with Slipform Pavers.

The slipform paver must be operated to produce pavement surfaces and edges meeting the specified tolerances. Immediately replace or modify as necessary, any equipment or procedure that fails to meet these specified requirements. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float is permitted. Immediately modify as necessary, equipment, mixture, and/or procedures producing more than ¼ inch (6 mm) of mortar-rich surface necessary to eliminate this condition, or operations must cease. Remove excessive slurry from the surface with a cutting straightedge and wipe off the edge. Immediately remove any slurry which runs down the vertical edges by hand, using stiff brushes or scrapers. Do not use slurry, concrete or concrete mortar to build up the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

501-4.11.2 Machine Finishing with Fixed Forms.

Design the machine to straddle the forms and operate to screed and consolidate the concrete. Do not use machines that cause displacement of the forms. The machine must make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, stop the operation immediately and adjust the equipment, mixture, and procedures, as necessary.

501-4.11.3 Other Types of Finishing Equipment.

Clary screeds, other rotating tube floats, or bridge deck finishers are not permitted, except when placing and finishing irregular or odd-shaped slabs, near buildings or trench drains, or on projects so small it is not practical to pave with a slip form paver. Rotating tube floats are not permitted at any time. The RPR must discuss and approve the equipment to be used for finishing at the pre-paving workshop. When allowed, bridge deck finishers must have a minimum operating weight of 7500 lbs (3400 kg) and a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Only use vibrating screeds or pans for isolated slabs where hand finishing is permitted as specified, and only where the RPR specifically approved. All proposed finishing methods must be demonstrated in the approved control strip.

501-4.11.4 Hand Finishing.

Hand finishing methods are not permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade, and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. The use of a cutting straightedge is not considered hand finishing.

501-4.11.5 Straightedge Testing and Surface Correction.

After striking off the pavement and while the concrete is still plastic, test it for trueness with a 12-foot (3.7-m) finishing straightedge swung from handles capable of spanning at least half the width of the slab. Hold the straightedge in contact with the surface in successive positions parallel to the centerline and go over the whole area from one side of the slab to the other, as necessary. Advancing is in successive stages of not more than half the length of the straightedge. Remove any excess water and laitance more than ⅛ inch (3 mm) thick from the surface of the pavement and wasted. Immediately fill any depressions with freshly mixed concrete, strike off, consolidate, and refinish. Cut down high areas and refinished. Give special attention to ensure that the surface across joints meets the smoothness requirements. Continue straightedge testing and surface corrections until the entire surface is free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats must be confined to a minimum; only use in emergencies and in areas not accessible to finishing equipment.

501-4.12 Surface Texture.

Finish the surface of the pavement as designated below for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. The texture must be uniform in appearance and approximately $^{1}/_{16}$ inch (2 mm) in depth. Any imperfections resulting from the texturing operation must be corrected to the RPR's satisfaction.

501-4.12.1 Brush or Broom Finish.

`[ Apply when the water sheen has practically disappeared. The equipment must operate transversely across the pavement surface. | Not used. ]`

501-4.12.2 Burlap Drag Finish.

`[Burlap, at least 15 ounces per square yard (555 grams per square meter), typically produces acceptable texture. To obtain a textured surface, remove the transverse threads of the burlap approximately one foot (30 cm) from the trailing edge. A heavy buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the pavement surface. | Not used.]`

501-4.12.3 Artificial Turf Finish.

`[Apply by dragging the surface of the pavement in the direction of concrete placement with an approved full width drag made with artificial turf. The leading transverse edge of the artificial turf drag will be securely fastened to a lightweight pole on a traveling bridge. At least 2 feet (60 cm) of the artificial turf must be in contact with the concrete surface during dragging operations. Approval of the artificial turf is done only after the Contractor demonstrates providing a satisfactory texture. One type providing satisfactory texture consists of 7,200 approximately 0.85-inch-long polyethylene turf blades per square foot. |Not used.]`

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The Engineer specifies the type(s) of finishes to be used on project.

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501-4.13 Curing.

Immediately after finishing operations are completed and bleed water is gone from the surface, cure all exposed surfaces of the newly placed concrete for a seven-day cure period according to one of the methods below. Not all mixes have bleed water, and in areas of low humidity there may not be any bleed water. Do not leave the concrete exposed for more than ½ hour during the curing period. When a two-saw-cut method is used to construct the contraction joints, reapply the curing compound to the saw-cut immediately after the initial cut has been made if the initial curing has already been applied. Do not saw the sealant reservoir until after the curing period has been completed. When the one cut method is used to construct the contraction joint, cure the joint with wet rope, wet rags, or wet blankets. Keep the rags, ropes, or blankets moist for the duration of the curing period.

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The Engineer deletes cure types that may not be feasible in operating areas subject to aircraft jet blast.

The use of supplementary cementitious materials (for example, coal ash, slag cement) or set-retarding admixtures may delay the occurrence of bleed water.

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501-4.13.1 Impervious Membrane Method.

After bleed and surface moisture has evaporated curing with liquid membrane compounds. Spray all exposed surfaces of the pavement with white pigmented curing compound immediately after surface finishing and before setting concrete. Do not apply curng compound during rainfall. Apply curing compound with mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 square feet (14 square meters). Use fully atomizing type spraying equipment equipped with a tank agitator. At the time of use, the compound must be in a thoroughly mixed condition with the pigment dispersed throughout the vehicle. During application, stir the compound continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms is permitted. When hand spraying is RPR-approved, a double application rate must be used to ensure coverage. If the film becomes damaged from any cause, including sawing operations, within the required curing period, the damaged portions must be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs must be protected immediately to provide a curing treatment equal to that provided for the surface.

501-4.13.2 White Burlap-polyethylene Sheets.

The surface of the pavement must be entirely covered with the sheeting. Use the sheeting's length (or width) so it extends at least twice the thickness of the pavement beyond the edges of the slab. Place the sheeting so that the entire surface and both edges of the slab are completely covered. Place and weight the sheeting to remain in contact with the surface covered. The covering must be fully saturated and in position for seven days after the placing the concrete.

501-4.13.3 Alternate Moist Curing Methods.

Cover the entire area with burlap or other water absorbing material. The material must be of sufficient thickness to retain water for adequate curing without excessive runoff. Keep the material wet and maintained for seven days. When stripping the forms, the vertical walls must be kept moist. It is the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

501-4.13.4 Concrete Protection for Cold Weather.

Maintain the concrete at a temperature of at least 50°F (10°C) for a period of 72 hours after placing, and at a temperature above freezing for the remainder of the seven-day curing period. The Contractor is responsible for the quality and strength of the concrete placed during cold weather. The Contractor removes and replaces any damaged concrete at the Contractor's expense.

501-4.13.5 Concrete Protection for Hot Weather.

Concrete should be continuously moisture cured for the entire curing period and commence as soon as the surfaces are finished and must continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, protect the concrete surface from drying with an application of a liquid membrane-forming curing compound while surfaces are still damp. Apply a second application 24 hours after the first. The RPR may approve other curing methods.

501-4.14 Removing Forms.

Do not remove forms from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After removing the forms, cure the sides of the slab in accordance with paragraph 501-4.13. If honeycombed areas are evident when the forms are removed, materials, placement, and consolidation methods, review and make appropriate adjustments to ensure adequate consolidation at the edges of future concrete placements. Repair honeycombed areas that extend into the slab less than approximately 1 inch (25 mm) with a grout as approved by the RPR. Consider honeycombed areas that extend into the slab greater than a depth of 1 inch (25 mm) defective work. Remove and replace according to paragraph 501-4.19.

501-4.15 Protection of Pavement.

The Contractor must protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents until the RPR accepts. This includes watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. The Contractor must repair or replace any pavement damage prior to final acceptance. Do not place aggregates, rubble, or other similar construction materials on airfield pavements. Damaged pavements will be removed and replaced at the Contractor's expense. Remove slabs to the full depth, width, and length of the slab.

501-4.16 Opening to Traffic.

501-4.16.1 Construction Traffic.

Hauling equipment or other mechanical equipment may permitted on adjoining previously constructed pavement when the concrete strength reaches 2.0 × edge stress of equipment. [`a flexural strength of 450 psi (3.1 MPa)` | `a compressive strength of 3,100 psi (21.4 MPa)`], [`based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed` | `based upon maturity meter time, temperature, strength correlations per ASTM C1074`].

Prior to opening the pavement to construction traffic, all joints must either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion If such tests are not conducted, the pavement must not be opened to traffic until seven days after the concrete was placed. When supported by detailed calculations of strength required to support actual construction loads lower opening strengths may be used to open pavement to construction traffic. Prior to opening, in place strength must be at least 50% greater than strength needed to support construction loads.

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Engineer needs to evaluate if any limitations on construction equipment especially on slabs eight inches or less in thickness. It may be necessary to limit size and amount of material in delivery trucks.

To evaluate edge stress using FAARFIELD:

1. Model the pavement section.

2. Add the construction traffic, note that you may want to consider each load individually, e.g. single axle, dual tandem axle. Adjust the weight as necessary.

3. Under design options select 'show design stress'.

4. Run a life analysis.

5. Divide the FAARFIELD edge stress by 0.75 to determine free edge stress.

6. Minimum flexural strength prior to loading is 2 times the free edge stress.

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501-4.16.2 Aircraft Traffic.

Limited operations of aircraft traffic can begin as soon as concrete pavement has a flexural strength of [`550 psi`]. [`When opening pavement prior to reaching design strength aircraft operations are limited to` [`indicate what aircraft may use pavement early, such as "aircraft less than 100,000 lbs."`]]

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Before opening pavement to aircraft traffic before pavement has reached its design strength, consider weight of aircraft that will use the pavement prior to it reaching design strength. Both size of aircraft and number of operations need to be considered when evaluating operations on concrete before it has reached design strength. Run a FAARFIELD analysis of the aircraft that need to operate on the pavement when it first opens to ensure that the pavement has sufficient strength.

To evaluate edge stress using FAARFIELD:

1. Model the pavement section.

2. Add the aircraft traffic, adjust the weight as necessary.

3. Under design options select 'show design stress'.

4. Run a life analysis.

5. Divide the FAARFIELD edge stress by 0.75 to determine free edge stress and divide the center stress by 0.95 to determine center slab stress.

6. Minimum flexural strength prior to loading is 2 times the maximum edge or center stress.

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501-4.17 Repair, Removal, or Replacement of Slabs.

Repair, remove, and replace new pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable, as defined by acceptance criteria in paragraph 501-6.6, as directed by the RPR at the Contractor's expense. Repair spalls along joints specified. Removing partial slabs is not permitted. Remove and replace the slab's full depth and full width. The limit of removals must be normal to the paving lane and to each original transverse joint. The RPR determines whether cracks extend full depth of the pavement. This may require drilling cores on the crack to determine depth of cracking. Cores will have a diameter of 2 inches (50 mm) to 4 inches (100 mm), be drilled and filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with a bonding agent, using approved procedures. Drilling of cores and refilling holes is at no expense to the Owner.

501-4.17.1 Shrinkage Cracks.

Shrinkage cracks not exceeding one-third of the pavement depth must be cleaned and either high molecular weight methacrylate (HMWM) applied; or epoxy resin (Type IV, Grade 1) pressure injected using procedures recommended by the manufacturer and the RPR approved. Following the application of HMWM, the surface may require sandblasting to restore skid resistance. All epoxy resin injection must take place in the RPR's presence. Treat shrinkage cracks exceeding one-third the pavement as full depth cracks according to paragraphs 501-4.19.2 and 501-4.19.3.

501-4.17.2 Slabs with Cracks Through Interior Areas.

Interior area is defined as the area more than 6 inches (150 mm) from either adjacent original transverse joint. At no cost to the Owner, remove and replace the full slab when there are any full depth cracks, or cracks greater than one-third the pavement depth, that extend into the interior area.

501-4.17.3 Cracks Close to and Parallel to Joints.

Treat all full-depth cracks within 6 inches (150 mm) either side of the joint and essentially parallel to the original joints, as follows.

1. Full depth Cracks and Original Joint Not Cracked. Treat the full-depth crack as the new joint and fill the original joint with an epoxy resin.
    a. Full-depth Crack. Form the joint sealant reservoir for the crack by sawing to a depth of ¾ inches (19 mm), ±$^1/_{16}$ inch (2 mm), and to a width of ⅝ inch (16 mm), ±⅛ inch (3 mm). Saw the crack with equipment specially designed to follow random cracks. Modify or replace any equipment or procedure that causes raveling or spalling. Seal the joint accordance with P-605, or as the RPR directed.
    b. Original Joint. Fill the reservoir and as much of the lower saw cut as possible, with epoxy resin Type IV, Grade 2, thoroughly tooled into the void using approved procedures, if the original joint sealant reservoir is sawn out. If only the original narrow saw cut has been made, clean and inject with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel

crack goes part way across paving lane and then intersects and follows the original joint, which is cracked only for the remained of the width, treat it as specified above for a parallel crack, and prepare and seal the cracked original joint as originally designed.

2. Full Depth Cracks and Original Joint Cracked. Remove and replace the entire slab containing the crack if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap.

501-4.17.4 Removal and Replacement of Full Slabs.

Make a full depth cut perpendicular to the slab surface along all edges of the slab with a concrete saw cutting any dowels or tie-bars. Remove damaged slab protecting adjacent pavement from damage. Damage to adjacent slabs may result in removal of additional slabs as the RPR directed at the Contractor’s expense. The underlying material must be repaired, re-compacted and shaped to grade. Dowels of the size and spacing specified for other joints in similar pavement on the project must be installed along all four edges of the new slab according to paragraph 501-4.10.4. Placement of concrete is as specified for original construction. Prepare and seal the joints around the new slab as specified for original construction.

501-4.17.5 Spalls Along Joints.

1. Fill spalls less than 1 inch (25 mm) wide and less than the depth of the joint sealant reservoir with joint sealant material.
2. Repair spalls larger than 1 inch (25 mm) and/or deeper than the joint reservoir, but less than ½ the slab depth, and less than 25% of the length of the adjacent joint as follows:
    a. Make a vertical saw cut at least 1 inch (25 mm) outside the spalled area and to a depth of at least 2 inches (50 mm). Saw cuts will be straight lines forming rectangular areas surrounding the spalled area.
    b. Remove unsound concrete and at least ½ inch (12 mm) of visually sound concrete between the saw cut and the joint or crack with a light chipping hammer.
    c. Clean cavity with high-pressure water jets supplemented with compressed air as needed to remove all loose material.
    d. Apply a prime coat of epoxy resin, Type III, Grade I, to the dry, cleaned surface of all sides and bottom of the cavity, except any joint face.

e. Fill the cavity with low slump concrete or mortar or with epoxy resin concrete or mortar.

f. Use an insert or other bond-breaking medium to prevent bond at all joint faces.

g. Saw a reservoir for the joint sealant to the dimensions required for other joints, or as required to be routed for cracks. Thoroughly clean and seal the reservoir with the sealer specified for the joints.

3. Spalls deeper than ½ of the slab depth or spalls longer than 25% of the adjacent joint require replacement of the entire slab.

501-4.17.6 Diamond Grinding of Concrete Surfaces.

Complete diamond grinding prior to pavement grooving. Do not perform diamond grinding of the hardened concrete until the concrete achieves a minimum strength of **[** `450 psi` **|** `550 psi` **]**. Equipment that causes ravels, aggregate fractures, spalls, or disturbance to the joints is not permitted. The depth of diamond grinding must not exceed ½ inch (13 mm). All areas performed with diamond grinding are subject to the final pavement thickness tolerances specified.

Perform diamond grinding with a machine specifically designed for diamond grinding capable of cutting a path at least three feet (0.9 m) wide. The saw blades must be ⅛ inch (3-mm) wide with enough flush cut blades that 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 Contractor must determine the number and type of blades based on the hardness of the aggregate. The Contractor demonstrates to the RPR that the grinding equipment produces satisfactory results prior to making corrections to surfaces. Taper grinding in all directions to provide smooth transitions to areas not requiring grinding. Continuously remove the slurry resulting from the grinding operation and leave the pavement in a clean condition. All grinding is at the Contractor's expense.

501-5 CONTRACTOR QUALITY CONTROL (CQC)

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All federally funded projects over $500K dollars where paving is the major work item, must have a CQCP. It is strongly encouraged that a CQCP be developed for all projects

For projects that do not include a formal CQCP, can edit this section to remove reference to a CQCP. However, QC testing is still required regardless of project size.

****

501-5.1 QC Program.

[The Contractor develops a Quality Control Program according to Item C-100. No partial payment is made for materials subject to specific quality control requirements without an approved QC Program.] The Contractor uses the CQCP to control the production and construction process applicable to these specifications. The Contractor uses the testing and monitoring described in this section to adjust their processes when necessary. Unless otherwise specified in this section, quality control test results will not be used to reject work. If a Contractor fails to properly control their processes, the RPR halts production of material, until the Contractor takes satisfactory corrective actions. Final acceptance and payment for work is made based on the acceptance procedures in the section Material Acceptance.

501-5.2 CQC.

[The Contractor provides or contracts for testing facilities according to Item C-100. The RPR is permitted unrestricted access to inspect the Contractor’s QC facilities and witness QC activities. The RPR advises 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 must be suspended immediately and not permitted to resume until the deficiencies are satisfactorily corrected.]

501-5.3 Contractor QC Testing.

The Contractor performs all QC tests necessary to control the production and construction processes applicable to this specification [and as set forth in the CQCP. The testing program includes, but is not necessarily limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content. A QC Testing Plan is developed, with RPR approval, as part of the CQCP.

The RPR may, at any time, despite previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture rendered unfit for use due to contamination, segregation, or improper slump. A visual inspection may be the only basis for rejection. In the event of such rejection, the Contractor may take a `representative sample of the rejected material in the RPR's presence. If it can be demonstrated in the laboratory, in the RPR's presence, that such material was erroneously rejected, payment is made for the material at the contract unit price` **].**

501-5.3.1 Fine Aggregate.

501-5.3.1.1 Gradation.

At least twice daily, perform a sieve analysis according to ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

501-5.3.1.2 Moisture Content.

Perform at least two direct measurements of moisture content according to ASTM C70 or ASTM C566 per week to check the calibration of electric moisture meters. Make at least two tests per day according to ASTM C70 or ASTM C566 when moisture checked by direct measurements

501-5.3.1.3 Deleterious Substances.

Prior to production of control strip, and a minimum of every 30 days during production, test fine aggregate as delivered to the mixer for deleterious substances as specified in paragraph 501-2.1.2.

501-5.3.2 Coarse Aggregate.

501-5.3.2.1 Gradation.

At least twice daily, perform a sieve analysis according to ASTM C136 from randomly sampled material from discharge gate of storage bins or from conveyor belt for each size of aggregate.

501-5.3.2.2 Moisture Content.

Perform at least two direct measurements of moisture content according to ASTM C566 per week to check the calibration of electric moisture meters. Make at least two tests per day according to ASTM C566 when moisture checked by direct measurements.

501-5.3.2.3 Deleterious Substances.

Prior to production of the control strip, and a minimum of every 30-days during production, test coarse aggregate as delivered to the mixer for deleterious substances as specified in paragraph 501-2.1.3.

501-5.3.3 Batch Weights.

List batch weights of all cementitious material, coarse aggregate, fine aggregate, dosage rate, and type of additives and weight water added.

501-5.3.4 Air Content.

Test air content of each sublot from material randomly sampled from trucks at the paving site, according to ASTM C231, for gravel and stone coarse aggregate, and ASTM C173 for slag or other porous coarse aggregate. Take material samples according to ASTM C172.

501-5.3.5 Unit Weight and Yield.

Determine unit weight and yield at the same time as air content tests for each sublot according to ASTM C138 with samples taken, according to ASTM C172.

501-5.3.6 Temperatures.

Check temperatures at least four times per lot at the job site according to ASTM C1064.

501-5.3.7 Flexural Strength.

Cast sufficient beams per lot for strength testing at 14 days, if beams are to be used for opening pavement to construction traffic additional beams for tests at 3 and 7 days will be required. It is recommended that Contractor have at least one extra beam in each set for additional testing when required.

****

Note: change in deviations on final surface course that require grinding, limited to deviations > ¼ inch that trap water, intent here is to focus on areas that may cause issues with the safe operation of aircraft and to minimize grinding if it will not improve safety.

****

501-5.3.8 Smoothness for Contractor Quality Control.

The Contractor must perform smoothness testing in transverse and longitudinal directions, daily, to verify 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 aircraft hydroplaning. If smoothness criteria is not met, the Contractor makes the appropriate changes and corrections to the construction process 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 starts with half the length of the straightedge at the edge of pavement section being tested and then moved ahead half the length of the straightedge for each successive measurement. Testing must be continuous across all joints. The surface irregularity will 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, evaluate the data using the FAA profile program, ProFAA, using the 12-foot straightedge simulation function.

Do not make smoothness readings across grade changes or cross slope transitions. The transition between new and existing pavement must be evaluated separately for conformance with the plans.

****

Include detail for transition between new and existing pavement including smoothness and grade limitations.

****

501-5.3.8.1 Transverse Measurements.

Take transverse measurements for each day's production placed. Take transverse measurements perpendicular to the pavement centerline each 50 feet (15 m) or more often as the RPR determined. Test the joint between lanes separately to facilitate smoothness between lanes.

501-5.3.8.2 Longitudinal Measurements.

Take longitudinal measurement for each day's production placed. Perform longitudinal tests parallel to the centerline of paving within 6-12 inches of the edges and at the center of paving lanes ≤ 20 feet (6 m) and at the third points when paving lanes are > 20 feet (6 m).

Correct deviations on the final surface course, in either the transverse or longitudinal direction, that will trap water greater than ¼ inch (6 mm) with diamond grinding per paragraph 501-4.17.6 or by removing and replacing to full depth. Taper grinding in all directions to provide smooth transitions to areas not requiring grinding All diamond grinding areas are subject to the final pavement thickness tolerances specified in paragraph 501-6.6.

Keep control charts to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement must be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce areas that need corrective actions more than 10% of a day's production, stop production until the Contractor implements corrective measures.

501-5.3.9 Grade.

Evaluate grade prior to, and after placement of, the concrete surface.

Take measurements 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 ½ inch (12 mm) vertically [and 0.1 feet (30 mm) laterally]. The Contractor provides the documentation to the RPR [within 48 hours | by the end of the following working day].

Ground off areas with humps or depression exceeding grade or smoothness and retain water on the surface provided the course thickness after grinding is not more than ½ inch (12 mm) less than the thickness specified on the plans. If these areas cannot be corrected with grinding, then remove and replace slabs retaining water according to paragraph 501-4.19.4. Grinding will be according to paragraph 501-4.19.6. All corrections will be at the Contractors expense.

501-5.4 Control Charts.

The Contractor must maintain linear control charts for fine and coarse aggregate gradation, slump, air content and strength. The Contractor must also maintain a control chart plotting the coarseness factor/workability factor from the combined gradations according to paragraph 501-2.1.4. Post control charts in a location to the RPR’s satisfaction. Keep charts current. As a minimum, the control charts will identify the project number, the contract item number, the test number, each test parameter, the action and suspension limits, or specification limits, applicable to each test parameter, and the Contractor’s test results. The Contractor uses 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 potential problem, and the Contractor is not taking satisfactory corrective action, the RPR may halt production or acceptance of the material.

501-5.4.1 Fine and Coarse Aggregate Gradation.

The Contractor records the running average of the last five gradation tests for each control sieve on linear control charts. Superimposed on the control charts is the action and suspension limits. The Contractor takes gradation tests per ASTM C136. The Contractor takes at least [two] samples per lot from the flowing aggregate stream or conveyor belt per ASTM D75 to check the final gradation.

501-5.4.2 Air Content.

The Contractor will maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for air content according to the following Action and Suspension Limits.

501-5.4.3 Combined Gradation.

The Contractor will maintain a control chart plotting the coarseness factor and workability factor on a chart according to paragraph 501-2.1.4. Anytime the CF/WF drifts from the CF/WF established with the acceptable control strip, adjustments will be made to CA/FA in production mix to return the CF/WF to the target point. Production will be suspended any time the CF or WF exceed the suspension limits in Table 501-5.4.

Table 501-5.4: Control Chart Limits [1]

Control Parameter	Individual Measurements	
	Action Limit	Suspension Limit
Gradation [2]	* [3]	* [3]
Coarseness Factor (CF) [4]	±3.5	±5
Workability Factor (WF) [4]	±2	±3
Air Content	±1.5%	±2.0%

[1] Develop and maintain control charts for each control parameter indicated.
[2] Develop and maintain control charts for each sieve size.
[3] The Contractor determines action and suspension limits for individual sieves based upon production tolerances in Table 501-2.1d.
[4] Starting point of CF and WF, for production, is CF and WF used to place acceptable control strip.

501-5.5 Corrective Action at Suspension Limit.

The CQCP must indicate that appropriate action is taken when the process is believed to be out of control. The CQCP must detail what action are taken to bring the process into control and contains sets of rules to gauge when a process is out of control. As a minimum, a process is deemed out of control and corrective action taken, if any one of the following conditions exists.

501-5.5.1 Fine and coarse aggregate gradation. When two consecutive averages of five tests are outside of the suspension limits, immediate steps, including a halt to production, must be taken to correct the grading.

501-5.5.2 Coarseness and Workability factor. When the CF or WF reaches the applicable suspension limits, the Contractor must take immediate steps, including halting production, to correct the CF and WF.

501-5.5.3 Fine and coarse aggregate moisture content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher must be adjusted.

501-6 MATERIAL ACCEPTANCE

501-6.1 QA Program.

All acceptance sampling and testing necessary to determine conformance with this section will be performed by the RPR.

501-6.2 QA Testing Laboratory.

QA testing organizations performing these acceptance tests will be accredited according to ASTM C1077. The QA laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be included on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods will be submitted to the RPR prior to start of construction.

501-6.3 Lot Size.

Concrete is accepted for strength and thickness on a lot basis. Lots are established for each separate concrete pay item, for each day's production. A lot consists of a day's production not to exceed **[** `2,000 cubic yards (1530 cubic meters)` **|** **[__]** `square yards (`**[__]**`square meters)` **]** for each separate pavement item. Divide each lot into approximately equal sublots with individual sublots between 400 to 600 cubic yards. Three produced sublots constitute a lot. Where one or two sublots are produced, they are incorporated into the previous or next lot. Where more than one plant is simultaneously producing concrete for the job, the lot sizes apply separately for each plant.

501-6.4 Partial Lots.

When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot or for overages or minor placements to be considered as partial lots, use the following procedure to adjust the lot size and the number of tests for the lot. Three produced sublots constitute a lot. Where one or two sublots have been produced, they are incorporated into the next lot or the previous lot and the total number of sublots will be used in the acceptance criteria calculation, that is, n=5 or n=6.

****

The Engineer specifies the lot size for a project based on the total quantity and the expected production rate. The lot size should not exceed 2,000 cubic yards (1,530 cubic meters).

For projects where basis of payment is square yards (square meters), the Engineer converts the lot size to an equivalent area that contains 2,000 cubic yards (1,530 cubic meters) or less.

****

501-6.5 Acceptance Sampling and Testing.

The RPR performs all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, except for coring for thickness determination. The Contractor must provide adequate facilities for the initial curing of beams. The Contractor bears the cost of providing initial curing facilities and coring and filling operations.

501-6.5.1 Strength.

501-6.5.1.1 Sampling.

Take one sample for each sublot from the concrete delivered to the job site. The RPR determines sampling locations according to random sampling procedures contained in ASTM D3665. Sample the concrete according to ASTM C172.

501-6.5.1.2 Test Specimens.

The RPR is responsible for the casting, initial curing, transportation, and curing of specimens according to ASTM C31. Test each sample and slump, air content, temperature, and unit weight. Make two specimens from each sample for strength testing. Within 24 to 48 hours, transport the samples from the field to the laboratory while in the molds. Cure the samples in saturated lime water.

Determine the strength of each specimen according to[`ASTM C39` | `ASTM C78`]. Compute the strength for each sublot by averaging the results of the two test specimens representing that sublot.

501-6.5.1.3 Acceptance.

The RPR determines acceptance of pavement for strength according to paragraph 501-6.6.2.1. All individual strength tests within a lot are checked for outliers according to ASTM E178, at a significance level of 5%. Outliers are discarded and the remaining test values used to determine acceptance according to paragraph 501-6.5.2.

When acceptance test results indicate a need to reject the lot. Compare the QA and QC test results. When the QA/QC tests are within 10%, use the results of the QA tests. When the OC test results are 10% greater than the QA tests but less than 20%, use the QC test. If the difference between the QA and QC tests are greater than 20% follow Engineering Brief (EB) 34 procedures.

****

The Engineer must make the appropriate selections in paragraph 501-3.3 depending on whether the strength is specified based upon flexural or compressive strength.

****

501-6.5.2 Pavement Thickness by Cores.

[`Not used.`]

[`501-6.5.2.1 Sampling.`

`The Contractor takes one core for each sublot in the RPR’s presence. The RPR determines` sampling locations according to random sampling procedures contained in ASTM D3665. Exclude areas such as thickened edges, with planned variable thickness, from sample locations.

Follow ASTM C42, Obtaining and Testing of Drilled Cores. Cores will be a minimum 6 inch (150 mm) in diameter, neatly cut with a core drill. The Contractor furnishes all tools, labor, and materials for cutting samples and filling the cored hole. The Contractor fills core holes with a non-shrink grout the RPR approved within one day after sampling.

501-6.5.2.2 Testing.

The RPR determines the thickness of the cores by the average caliper measurement according to ASTM C174. Photograph each core and include the photograph with the test report.

501-6.5.2.3 Acceptance.

The RPR determines acceptance of pavement for thickness according to paragraph 501-6.6.

501-6.5.2.4 Storage of Cores.

[Not used.][Store and condition cores according to ASTM C42 paragraph 7. Note, if cores obtained and stored according to ASTM C42 they may be used for later testing if there are disputes between QC and QA strength tests.]]

501-6.5.3 Pavement Thickness by Survey.

[Not used.][Survey is required before and after placement of the pavement. Survey the underlying base course and the finished pavement on using the same locations matching the locations of joints and center of panels by a State Certified Land Surveyor. Areas such as thickened edges and planned variable thickness will not be considered. Select a random location within each sublot and calculate the difference between underlying base and pavement surface. Should calculations determine that the pavement thickness is out of tolerance a core can be taken at the random location in question. When survey is used for thickness determination the number of cores taken can be reduced to one core per lot in lieu of one core per sublot.]

****

For new RW or RW rehabilitation of entire length of RW include the following requirement to run a profilograph on the completed project. Make sufficient runs to cover at least the keel section of the runway. This is just for the Owner's records and will not be used for acceptance or payment.

****

501-6.5.4 Profilograph.

[Not used.][Contractor, in the presence of the RPR, performs a final profilograph for runway using a profilograph meeting the requirements of ASTM E1274 or an inertial profiler meeting ASTM E950. Note: follow manufacturer's recommendations for operation of profilers. Do not attempt to profile a RW by accelerating while turning onto RW from a connecting TW. Use equipment that utilizes electronic recording and automatic computerized reduction of data to indicate the Profile Index for the pavement using a 0.2-inch (5 mm) blanking band. The profilograph must be calibrated prior to use and operate by a factory or State Department of Transportation (DOT) approved, trained operator. Profilograph is performed 1 foot, [15 feet (4.5 m)] [25 feet (7.5 m)] [50 feet (15 m)] right and left of project centerline. Electronic data and results are provided within [48 hrs] of profilograph roughness tests to the owner.

[Reduce bumps exceeding ½ inch with diamond grinding until they do not exceed ¼ inch when retested. Taper diamond grinding in all directions providing smooth transitions to areas not ground.]. [Runways and taxiways must have a profile index not greater than 7 inches per mile. All other pavements have a profile index not greater than 9 inches per mile. Reduce bumps exceeding ½ inch with diamond grinding until they do not exceed ¼ inch when retested. Taper diamond grinding in all directions providing smooth transitions to areas not ground.]Perform a final profilograph `the full length of the project to document the pavement roughness. ] ]`

501-6.6 Acceptance Criteria.

501-6.6.1 General.

Acceptance is based on the following characteristics of the completed pavement:

1. Strength
2. Thickness
3. Grade
4. Adjustments for repairs

Acceptance for strength, thickness, and grade, is based on the criteria contained according to paragraphs 501-6.6.2.1, 501-6.6.2.2, and 501-6.6.2.3, respectively.

****

When the design strength in paragraph 501-3.3 is based on compressive strength, substitute compressive strength for flexural strength.

****

`[ Strength and thickness are evaluated for acceptance on a lot basis using the method of estimating PWL. Production quality must achieve 90 PWL or higher to receive full pavement. The PWL is determined according to procedures specified in Item C-110.`

`The lower specification tolerance limit (L) for strength and thickness is:`

Table 501-6.6: Lower Specification Tolerance Limit (L)

	Lower Specification Tolerance Limit (L)
Strength	0.93 × 14-day strength [1] as determined in paragraph 501-3.3
Thickness	Lot Plan Thickness in inches, - 0.50 in

[1] The 14-day strength is the 14-day strength from the mix design correlation for the concrete mix with the water cementitious ratio selected for production.

****

The basis of the lower specification tolerance limits above are on applying statistical analysis to FAA design assumptions. There is not any need to compensate for the above factor in the design process.

****

501-6.6.2 Strength.

`[ If the PWL of the lot equals or exceeds 90%,the lot is acceptable. | Compute the strength for each sublot by averaging the results of that sublot. When sublot strength equals or exceeds the strength as specified in paragraph 501-3.3, the sublot is acceptable ].` Acceptance and payment for the lot is determined according to paragraph 501-8.1.

501-6.6.3 Thickness.

`[ If the PWL of the lot equals or exceeds 90%, the lot is acceptable. | If sublot thickness is less than ½ inch (12 mm) from plan thickness, the lot is acceptable. ] Acceptance and payment for the lot is determined according to paragraph 501-8.1. ]`

****

For small maintenance and repair projects.

Where the project has multiple small placements or the total project size is less than 2000 cubic yards (1530 cubic meters), the use of percent within limits (PWL) is not appropriate, and acceptable material is paid for by the cubic yard (square yard). The engineer must tailor the specification for acceptance by average strength and thickness not less than ½ inch less than plan thickness.

****

501-6.6.4 Grade.

The final finished surface of the pavement of the completed project will not vary from the gradeline elevations and cross-sections shown on the plans by more than ½ inch (12 mm) vertically `[ or 0.1 feet (30 mm) laterally ]`. Provide RPR with documentation of final grade survey according to paragraph 501-5.3.9, performed by a licensed surveyor.

501-7 METHOD OF MEASUREMENT

501-7.1 Concrete pavement is measured by the number of **[** cubic yards (cubic meters) **|** square yards (square meters) **]** of **[** plain **|** reinforced **]** pavement as specified in-place, completed and accepted.

501-8 BASIS OF PAYMENT

501-8.1 Total Project Payment.

****

The Engineer specifies a value ranging from 100% to 106%. When the total project payment for Item P-501 pavement exceeds the contract unit price, any federally funded grant or Passenger Facility Charge (PFC) funds used to pay the excess may require amending the project's grant or PFC application. When the total project payment is less than 106%, the RPR must monitor that payment does not exceed contract limit, since individual lots with a PWL greater than 96 with no adjustments for repairs, grinding, or grade can exceed 100%.

****

The total final project payment, after completion of all lots, for concrete pavement meeting acceptance criteria in paragraph 501-6.6, will not exceed **[__]** percent of the product of the contract unit price for each separate concrete pavement pay item and the total number of **[** cubic yards (cubic meters) **|** square yards (square meters) **]** of concrete pavement used in the accepted work. On projects using PWL, payment for individual lots may be as much as 106 percent. Payment is full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified and on the drawings.

Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 501-6.6. Acceptance Criteria is based on the results of strength, thickness, grade, and repairs. Adjust payment for acceptable lots of concrete pavement according to paragraph 501-8.2.1 for strength and thickness; paragraph 501-8.2.2 for repairs, paragraph 501-8.2.3 adjustment for grade, and paragraph 501-8.2.4 adjustment for grinding.

501-8.2 Lot Payment.

The payment basis for acceptable lots is upon **[** pay factor for **]** strength and thickness and adjustments for repairs, grinding, and grade.

501-8.2.1 Basis of Lot Pay Factor.

[Not used. **|** The pay factor for each individual lot is calculated according to the Price

`Adjustment Schedule Table. Calculate a pay factor for both strength and thickness.`

Table 501-8.2: Price Adjustment Schedule

Percentage of Materials Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 90	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject [1]

[1] Remove and replace the lot, unless, after receipt of FAA concurrence, the Owner and Contractor agree in writing that the lot remains; the lot paid at 50% of the contract unit price; and the total project payment limitation reduced by the amount withheld for that lot.

1. The lot pay factor is the higher of the two values when calculations for both strength and thickness are 100% or higher.
2. The lot pay factor is the product of the two values when only one of the calculations for either strength or thickness is 100% or higher.
3. The lot pay factor is the lower of the two values when calculations for both strength and thickness are less than 100%.]

501-8.2.2 Adjusted Payment for Repairs.

The lot pay factor is reduced by 5% for lots which contain repairs for shrinkage cracks and spalls, according to paragraphs 501-4.17.1 and 501-4.17.5, on more than 5% of the slabs within a lot. Minor spall repairs that can be filled with joint sealant are not considered repairs. The lot pay factor is reduced by 10% for lots which contain repairs for full depth cracks, according to paragraphs 501-4.17.2 and 501-4.17.3, on more than 5% of the panels within the lot. Note, adjustment for repairs is limited to 10%.

501-8.2.3 Adjusted Payment for Grinding.

The lot pay factor is reduced by 5% for lots with grinding over 10% of lot.

501-8.2.4 Adjusted Payment from Grade.

The lot pay factor is reduced by 5% for lots not meeting grade over 10% of the lot.

****

Edit payment as required for project. Separate pay items are needed for each different thickness of pavement for project. The maximum lot pay factor is 106% and the maximum adjustments for repairs is 10%, for grinding 5% and grade 5%. Up to 20% reduction in payment for repairs, grinding and grade.

****

501-8.2.5 Payment.

The Contractor may achieve a maximum pay factor of 106% for each lot and is paid for the lot at the calculated pay factor with adjustments. For each lot accepted, the adjusted contract unit price is the **[** `product of the lot pay factor for the lot and the contract unit price minus adjustments for repairs, grinding and grade` **|**`product of 100 minus adjustments for repairs, grinding and grade and the contract unit price` **]**. Payment is subject to the total project payment limitation specified in paragraph 501-8.1.

However, total payment for the line item will not exceed the total payment limitation as specified in paragraph 501-8.1.

Payment is made under:

501-8.3 Concrete Pavement.

[`per cubic yard (cubic meter)` **|**`per square yard (square meter)` **]**

501-9 REFERENCES

501-9.1 This list of publications forms 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 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 A996	*Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement*
ASTM A1035	*Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement*
ASTM A1064	*Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete*
ASTM A1078	*Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement*
ASTM C29	*Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate*
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 C70	*Standard Test Method for Surface Moisture in Fine Aggregate*
ASTM C78	*Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)*
ASTM C88	*Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate*
ASTM C94	*Standard Specification for Ready-Mixed Concrete*
ASTM C114	*Standard Test Methods for Chemical Analysis of Hydraulic Cement*
ASTM C117	*Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing*
ASTM C123	*Standard Test Method for Lightweight Particles in Aggregate*

ASTM C136	*Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*
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 C138	*Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete*
ASTM C142	*Standard Test Method for Clay Lumps and Friable Particles in 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 C173	*Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method*
ASTM C174	*Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores*
ASTM C227	*Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)*
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 C295	*Standard Guide for Petrographic Examination of Aggregates 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 C566	*Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying*
ASTM C595	*Standard Specification for Blended Hydraulic Cements*
ASTM C618	*Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*
ASTM C642	*Standard Test Method for Density, Absorption, and Voids in Hardened 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 C881	*Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete*
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 C1064	*Test Method for Temperature of Freshly Mixed Hydraulic-Cement 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)*
ASTM C1365	*Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis*
ASTM C1567	*Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D75	*Standard Practice for Sampling Aggregates*

ASTM D1751	*Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)*
ASTM D1752	*Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction*
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 D4791	*Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate*
ASTM E178	*Standard Practice for Dealing with Outlying Observations*
ASTM E1274	*Standard Test Method for Measuring Pavement Roughness Using a Profilograph*
ASTM E2133	*Standard Test Method for Using a Rolling Inclinometer to Measure Longitudinal and Transverse Profiles of a Traveled Surface*

American Concrete Institute (ACI)

ACI 305R	*Guide to Hot Weather Concreting*
ACI 306R	*Guide to Cold Weather Concreting*
ACI 309R	*Guide for Consolidation of Concrete*

Advisory Circulars (AC)

AC 150/5320-6	*Airport Pavement Design and Evaluation*

Federal Highway Administration (FHWA)

HIPERPAV 3, version 3.2

Portland Concrete Association (PCA)

PCA	*Design and Control of Concrete Mixtures, 16th Edition*

U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD)

CRD C662	*Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)*

United States Air Force Engineering Technical Letter (ETL)

ETL 97-5	*Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements*

END OF ITEM P-501

Part 8 – Miscellaneous

Item P-602 Prime Coat

****

Item P-602 can be used to provide a protective layer to prevent the surface of the aggregate base course from raveling under construction traffic and provides a waterproof layer, preventing it from absorbing or losing excess moisture before paving. Prime coats are recommended for aggregate bases unable to be covered with the next layer the same construction season, or when the completed aggregate base course carries light construction traffic. Item P-602 also helps bond the top layer of the granular base to the first layer of asphalt pavement.

Cutback asphalts penetrate the aggregate base material better than emulsified asphalts; however, many areas do not permit cutback asphalts. Check with state and local environmental regulations before specifying a cutback prime cost.

Review State Department of Transportation (DOT) specifications to determine what materials are commonly available in the project area. When using emulsified asphalt, it is recommended to use slow setting materials allowing more time for the material to penetrate the base material.

****

602-1 DESCRIPTION

602-1.1 This item consists of an application of prime coat material on the prepared base course according to these specifications and in reasonably close conformity to the lines shown on the plans.

602-2 MATERIALS

602-2.1 Prime Coat Material.

The **[** `emulsified` **|** `cutback` **]** asphalt material must be as specified in **[** `ASTM D3628` **|** `ASTM D2399` **]** for use as a prime coat appropriate to local conditions. The Contractor must provide a copy of the manufacturer’s Certificate of Analysis (COA) for the asphalt material. The Contractor must provide the COA to the Resident Project Representative (RPR) who must approve the COA before applying the prime coat. The manufacturer’s COA is subject to verification by testing the material delivered for the project’s use.

602-3 CONSTRUCTION METHODS

602-3.1 Weather Limitations.

Apply the prime coat only when the existing surface is dry; the atmospheric temperature is 40°F (4°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 RPR may give approval to waive the temperature requirements.

602-3.2 Equipment.

602-3.2.1 The equipment must include a self-powered pressure asphalt material distributor and equipment for heating asphalt material. Equipment must not cause rutting, shoving, or otherwise damage the base, surface, or other layers in the pavement structure.

602-3.2.2 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.

602-3.2.3 Include 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 with the distributor equipment.

602-3.2.4 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 must start and stop on building paper.

602-3.2.5 Provide a power broom and power blower suitable for cleaning the surfaces to which the asphalt coat is to be applied.

602-3.2.6 Calibrate asphalt distributors annually according to ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as the RPR approved.

602-3.3 Control Strips.

The Contractor must place a minimum of three test strips 100 ft long by the full width of the distributor to determine the application rate. The test strip application rates must be between 0.15 and 0.30 gallons per square yard and provide a residual rate between 0.05 and 0.12 gallons per square yard. The RPR must approve the application rate prior to be used for production.

602-3.4 Prime Coat Material Application.

Before applying the prime coat, immediately sweep the full width of the surface to be primed with a power broom to remove all loose dirt and other objectionable material. Uniformly apply the asphalt emulsion with an asphalt distributor at a shot rate approved by the RPR in the control strip.

Allow the prime coat to cure without being disturbed for a minimum of [`48 hours`], or as long as needed to attain penetration into the treated course. Furnish and spread sand as needed to blot and cure excess asphalt material. Remove blotting sand prior to asphalt concrete lay down operations. Keep traffic off surfaces freshly treated with asphalt material. Provide sufficient warning signs and barricades to prevent traffic from travelling over freshly treated surfaces. 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.

602-3.5 Freight and Waybills.

The Contractor must submit waybills and delivery tickets during the progress of the work. Before the final estimate is allowed, file certified waybills and certified delivery tickets with the RPR for all emulsified asphalt used in the pavement construction covered by the contract. Do not remove emulsified asphalt from storage until the RPR takes the initial outage and temperature measurements. The delivery or storage units are not released until the RPR takes the final outage.

602-4 METHOD OF MEASUREMENT

602-4.1 The material for prime coat is measured by the [`gallon (liter)` | `ton (kg)`]. Correct the volume to the volume at 60°F (16°C) according to ASTM D4311. The prime coat material paid for must be the measured quantities of residual prime coat material used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Deduct any amount of prime coat material more than 10% over the specified application rate for each application from the measured quantities, except for irregular areas where hand spraying of the prime coat material is necessary. Water added to prime coat is not measured for payment.

602-5 BASIS OF PAYMENT

602-5.1 Payment is made at the contract unit price per [`gallon (liter)` | `ton (kg)`] for emulsified asphalt prime coat. This price is 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 is made under:

Item P-602-5.1	Prime Coat - per **[** `gallon (liter)` **|** `ton (kg)` **]**

602-6 REFERENCES

602-6.1 This list of publications forms 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 D2399	*Standard Practice for Selection of Cutback Asphalts*
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 Tack Coat

****

Item P-603 is used to promote bonding between the underlying surface and the new asphalt layer. Tack coats are required on all surfaces (horizontal and vertical) that the asphalt mix contacts, horizontal and vertical. Tack coats are required before placement of each lift of asphalt including the first lift when over existing asphalt or concrete. Pay attention to the rate being discussed, residual, emulsion rate, or diluted emulsion rate. When using a virgin binder for tack coat, use the same base PG grade as the asphalt mix and apply at the residual rate for the surface applied to.

****

603-1 DESCRIPTION

603-1.1 This item consists of preparing and treating an asphalt or concrete surface with asphalt material according to these specifications and in reasonably close conformity to the lines shown on the plans. All horizontal and vertical surfaces that the asphalt mix contacts require tack coats. Tack coats are required before the placement of each lift, including the first lift when over existing asphalt or concrete. When using virgin binder for tack coat, use the same base PG grade as used in the asphalt mix, apply at the residual rate as recommend in Table 603-3.4.

603-2 MATERIALS

603-2.1 Asphalt Materials.

The asphalt material must either be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions; or virgin asphalt **[** `PG 64` **]** as specified in American Association of State Highway and Transportation Officials (AASHTO) M320; or a trackless tack as approved for use by the State Department of Transportation (DOT). The emulsified asphalts must not be diluted. The Contractor must provide a copy of the manufacturer's Certificate of Analysis (COA) for the tack coat material to the Resident Project Representative (RPR) before the asphalt material is applied for review and acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for the project's use.

603-3 CONSTRUCTION METHODS

603-3.1 Weather Limitations.

Only apply tack coats when the existing surface is dry, and the atmospheric temperature is 40°F (4°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 RPR may approve waiving the temperature requirements.

603-3.2 Equipment.

The Contractor must provide equipment for heating and applying the tack coat material. Apply the tack coat with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment must be in good working order and not contain any 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 maintains predetermined flow rates and constant pressure during the application process with application speeds under eight miles per hour (13 km per hour) or 700 feet per minute (213 m per minute).

Test the equipment under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area). Truck set-up verification and testing includes, but is 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.

Equip the distributor truck with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck must 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. Start and stop the tack operations on building paper when the distributor is not equipped with an operable quick shut off valve.

Equip the distributor truck to effectively heat and mix the material to the required application temperature. Heating and mixing must be performed according to the manufacturer’s recommendations. Do not overheat or over mix the material. Equip the distributor with a hand sprayer.

Annually calibrate asphalt distributors according to ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency approved by the RPR. Provide a power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied.

603-3.3 Control Strip.

The Contractor must place a minimum of three test strips 100 feet (30 m) by the full width of the distributor to determine the application rate. The test strip application rates must be applied within the shot rates in Table 603-3.4 meeting the required residual rate. The RPR must approve the application rate prior to being used for full production.

603-3.4 Tack Coat Material Application.

1. Sweep the full width of surface to be treated with a power broom and/or power blower removing all loose dirt and other objectionable material immediately before applying the emulsified asphalt tack coat.
2. Uniformly apply the tack coat material with an asphalt distributor at the rates appropriate for the tack coat material, conditions, and surface as specified in Table 603-3.4. Uniformly cover all horizontal and vertical surfaces adjacent to where the asphalt mix is placed.
3. Apply emulsified asphalt tack between **[** `130 - 180°F` **]**.
4. Apply virgin binder tack coat between **[** `275-375°F` **]**.

Table 603-3.4: Tack Coat Application and Residual Rates

Surface Type	Residual Rate, gal/SY [1] (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)	0.06-0.12 (0.27-0.54)
Concrete	0.03-0.05 (0.13-0.23)	0.05-0.08 (0.23-0.36)

[1] Apply virgin binder tack at the residual rate for the surface type.

After application of the tack coat, allow the surface to cure without being disturbed for the time necessary to permit drying and setting of the tack coat. The Contractor must protect the tack coat and maintain the surface until the next course is placed. When the Contractor disturbs the tack coat, reapply the tack coat at the Contractor’s expense.

603-3.5 Freight and Waybills.

The Contractor must submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract with the RPR. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. Do not release the delivery or storage units until the final outage has been taken.

603-4 METHOD OF MEASUREMENT

603-4.1 Measure the **[** `emulsified asphalt material` | `asphalt material` | `trackless tack` **]** for tack coat by the **[** `gallon (liter)` | `ton (kg)` **]**.

Correct the volume, to the volume at 60°F (16°C) according to ASTM D1250. The emulsified asphalt material paid for is the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of tack coat material over 10% the specified application rate for the plan value of square yards is deducted from the measured quantities, except for irregular areas where hand spraying of the tack coat material is necessary.

603-5 BASIS OF PAYMENT

603-5.1 Payment is made at the contract unit price per **[** `gallon (liter)` **|**`ton (kg)` **]** of **[** `emulsified asphalt` **|**`asphalt` **]** material. This price is 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 is made under:

Item P-603-5.1	**[** `Emulsified Asphalt` **|**`Asphalt` **]** Tack Coat - per **[** `gallon (liter)` **|**`ton (kg)` **]**

603-6 REFERENCES

603-6.1 This list of publications forms 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 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*
AASHTO M320	*Standard Specification for Performance-Graded Asphalt Binder*

END OF ITEM P-603

Item P-604 Compression Joint Seals for Concrete Pavements

604-1 DESCRIPTION

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Compression joint seals are commonly used for new or reconstructed concrete pavements. When installed properly they provide a long lasting joint seal. Temperatures of the pavement and atmosphere are not as critical for installation of compression joint seals as for other sealants. However, temperature of the pavement does impact the size of compression sealer needed.

Lower temperatures may be acceptable and sealing proceeds satisfactorily at temperatures lower than 35°F (2°C). Contact manufacturers for recommendations and instructions under expected project installation conditions. Edit these specifications as necessary to tailor specification for joint re-seal projects.

****

604-1.1 This item consists of preformed polychloroprene compression seals used for sealing joints of rigid pavements.

604-2 MATERIALS

604-2.1 Compression Seals.

Compression joint seal materials must be a vulcanized elastomeric compound using polychloroprene as the only base polymer. The material and the manufactured seal must conform to **[** `ASTM D2628` **|**`ASTM D2628 and Corps of Engineers Concrete Research Division (CRD) C548 where jet fuel and/or heat blast resistance is required` **].**

The joint seal must be a labyrinth type seal. The uncompressed depth of the compression seal face that is to be bonded to the joint wall must be greater than the uncompressed width of the seal, except that for seals 1 inch (25 mm) or greater in width, the depth need be only 1 inch (25 mm) or greater. The actual width of the uncompressed seal must be as the joint seal manufacturer recommended for the type and width of joints as shown on the project plans.

The Contractor must provide a copy of the manufacturer's Certificate of Analysis (COA) for the joint seal material delivered to the project. The Resident Project Representative (RPR) must receive and approve the COA before the material is installed. The furnishing of the vendor's certified test report must not be interpreted as a basis for final acceptance. The manufacturer's COA is subject to verification by testing the material delivered for the project's use.

Inspect materials delivered to the job site for defects, unloaded, and stored with a minimum of handling to avoid damage. Provide storage facilities at the job site to protect materials from weather and maintain materials at temperatures recommended by the manufacturer. The RPR samples and retains a representative sample of joint seal material for possible testing.

****

Show joint seal details for all joint types on the plans.

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604-2.2 Lubricant/Adhesive.

Lubricant/adhesive used for the compression elastomeric joint seal must be a one-component compound conforming to ASTM D2835.

604-3 CONSTRUCTION METHODS

604-3.1 Equipment.

The RPR must approve the machines, tools, and equipment used in the work required by this section before the work starts and ensure that the Contractor maintains the machines, tools, and equipment in satisfactory condition at all times.

604-3.1.1 Joint Cleaning Equipment.

604-3.1.1.1 Concrete Saw.

Provide a self-propelled power saw with water-cooled diamond saw blades for cutting joints to the depths and widths specified and for removing filler, existing old joint seal or other material embedded in the joints or adhered to the joint faces.

604-3.1.1.2 Waterblasting Equipment.

Waterblasting equipment must include a trailer-mounted water tank, pumps, high-pressure hose, a wand with safety release cutoff controls, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary water resupply equipment must be of sufficient capacity to permit continuous operations. The pumps, hoses, wand, and nozzle must permit the cleaning of both walls of the joint and pavement surface for a width of at least ½ inch (12 mm) on either side of the joint. The pump must be able to supply a pressure of at least 3,000 psi (20.7 MPa). A pressure gauge mounted at the pump must always show the pressure in lbs per square inch (psi) (kPa) at which the equipment is operating.

604-3.1.1.3 Sandblasting Equipment.

[Sandblasting is not permitted. |Sandblasting equipment must include an air compressor, hose, and a long-wearing venturi-type nozzle of proper size, shape, and opening. The maximum nozzle opening should not exceed ¼ inch (6 mm). The air compressor must be portable and capable of furnishing not less than 150 cubic feet (4200 liters) per minute and maintaining a line pressure of not less than 90 psi (620 kPa) at the nozzle while in use. The compressor must be equipped with traps that maintain the compressed air free of oil and water. The nozzle must have an adjustable guide that holds the nozzle aligned with the joint, about 1 inch (25 mm) above the pavement surface, and directs the blast to clean the joint walls. Adjust the height, angle of inclination, and size of the nozzle as necessary to ensure satisfactory results.]

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Sandblasting may be shown as an option to waterblasting for new pavement installations.

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604-3.1.2 Sealing Equipment.

Equipment used to install the compression seal, must place the compression seal to the prescribed depths within the specified tolerances without cutting, nicking, twisting, or otherwise damaging the seal. The equipment must be a two-axle, four-wheel machine that includes means for compressing and inserting the compression seal into the joint and a reel capable of holding one full spool of compression seal material. The equipment must not stretch or compress the seal more than 2.0% longitudinally during installation. The machine must be an automatic self-propelled engine powered joint seal application equipment. The machine must include a reservoir for the lubricant/adhesive, a device for conveying the lubricant/adhesive in the proper quantities to the sides the preformed seal or the sidewalls of the joint, a reel capable of holding one full spool of compression seal, and a power-driven apparatus for feeding the joint seal through a compression device and inserting the seal into the joint. The equipment must also include a guide to maintain the proper course along the joint being sealed. The machine must be operated by an experienced operator. Hand operated joint seal application equipment may be used for localized areas and for projects less than 500 square yards (450 square meters).

604-4 CONSTRUCTION METHODS

604-4.1 Environmental Conditions.

The ambient temperature and pavement temperature within the joint wall must be at least 35°F (2°C) and rising at the time of installation of the materials, unless lower temperatures allowed by manufacturer. Sealant application is not permitted if moisture or any foreign material is observed in the joint.

604-4.2 Preparation of Joints.

Immediately before installation of the compression joint seal, thoroughly clean the joints to remove all laitance, filler, existing sealer, foreign material, and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed. Cleaning must extend along pavement surfaces at least ½ inch (12 mm) on either side of the joint. After final cleaning and immediately prior to sealing, blow out the joints with oil free dry compressed air and left free of debris and water. Prior to the installation of the joint seal, correct any irregularity in the joint face that would prevent uniform contact between the joint seal.

604-4.2.1 Sawing.

Saw joints to clean sides and to create joints to the width and depth specified on the plans. Immediately following the sawing operation, thoroughly clean the joint faces opening, using a water jet to remove all saw cuttings or debris. Install the compression within three calendar days of the time the joint cavity is sawn. Submit printed copies of manufacturer's instructions **[** `60 days` **]** prior to use on the project. Center the joint seal cavity over the joint line. The nominal width of the sawn joint seal cavity width must be within a tolerance of ±$^1/_{16}$ inch (2 mm).

604-4.2.2 Waterblast Cleaning.

Clean the concrete joint faces and pavement surfaces extending at least ½ inch (12 mm) from the joint edges with waterblasting. Use a multiple pass technique until surfaces are free of dust, dirt, curing compound, or any residue that might prevent ready insertion or uniform contact of the seal and bonding of the lubricant/adhesive to the concrete. After final cleaning and immediately prior to sealing, blow out joints with compressed air and leave joints completely free of debris and water.

604-4.2.3 Sandblast Cleaning.

`[Sandblast cleaning is not permitted. |Clean the concrete joint faces and pavement surfaces extending at least ½ inch (12 mm) from the joint edges, with sandblasting, using a multiple pass technique until surfaces are free of dust, dirt, curing compound, or any residue that might prevent ready insertion or uniform contact of the seal and bonding of the lubricant/adhesive to the concrete. Blow out joints with oil free dry air after final cleaning and immediately prior to sealing until completely free of debris and water.]`

****

Show sandblasting as an option to waterblasting for new pavement installations.

Sandblasting of joints may not be permitted under certain conditions. Blowing sand and dust may either violate atmospheric pollution statutes or may drift into areas where it would be objectionable. When sandblasting is prohibited, cleaning the joints with waterblasting equipment may be used.

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604-4.2.4 Rate of Progress.

Limit cleaning of the joint faces to the linear footage of joint that can be sealed during the same workday.

604-4.3 Control Strip.

Prior to the cleaning and sealing of the joints for the entire project, prepare a control strip at least 200 feet (69 meters) long at the location the RPR designates. Demonstrate the equipment, materials, and construction processes for the preparation and sealing of all types of joints included in the project. Do not start sealing the joints until the RPR approves the control strip installation. If materials or installation do not meet requirements, the Contractor must remove and replace the materials, clean the joints, and install a new joint seal control strip at the Contractors expense.

604-4.4 Installation of the Compression Seal.

604-4.4.1 Time of Installation.

Install seal joints within **[** 3 **]** calendar days of sawing and cleaning the joint seal cavity or a temporary seal to prevent infiltration of foreign material. If rain interrupts the sealing operations, wash and clean the joints with air and be dry before proceeding with installing of the lubricant/adhesive and compression seal.

604-4.4.2 Installation Sequence.

Seal longitudinal joints first, then seal the transverse joints. Transverse joint seals must be continuous from pavement edge to edge. Make intersections monolithic by use of joint seal adhesive and care in fitting the intersection parts together. Remove and replace seals not reaching an intersection with a new seal, as the RPR directed at the Contractor's Expense. Do not use seal extender pieces at intersections.

604-4.4.3 Sealing Joints.

Cover the sides of the joint seal or the sides of the joint with a coating of lubricant/adhesive and the seal installed as specified. Coat butt joints and seal intersections with liberal applications of lubricant/adhesive. Immediately remove lubricant/adhesive spilled on the pavement. Place the joint seal at a uniform depth within the tolerances specified. Place the compression joint seal $^{3}/_{16}$ inch (5 mm), ±⅛ inch (3 mm), below the pavement surface or the bottom of groove for grooved pavements, unless the RPR directed otherwise.

Install the seal in the longest practicable lengths in longitudinal joints. Cut the longitudinal seal at intersections with transverse joints. Wait a minimum of one hour after installation of the longitudinal joint seal before cutting the longitudinal seal at the transverse joint intersections. Make transverse joints continuous across width of pavement. Make adjustments to the installation equipment and procedure if stretch of the installed joint seal exceeds 1%. Remove and replace joint seals when stretch of installed joint seals exceeds 2%. The minimum length of the preformed joint seal at all transverse joints is the pavement width from edge to edge.

604-4.5 Clean-up.

Upon completion of the project, remove all unused materials from the site, remove all lubricant/adhesive on the pavement surface, and leave the pavement in clean condition.

604-4.6 Quality Control (QC) and Acceptance.

604-4.6.1 QC.

Inspect the application equipment to ensure uniform application of lubricant/adhesive to the sides of the compression joint seal or the walls of the joint. Do not use equipment causing cutting, twisting, nicking, excessive stretching or compressing of the compression seal, or improper application of the lubricant/adhesive, until the Contractor determines and corrects the causes of the deficiencies. The Contractor must inspect the seal a minimum of once per 400 feet (120 m) of seal for compliance to the shrinkage or compression requirements and depth and width of installation.

604-4.6.2 QA.

The RPR must confirm that joints cleaned prior to installation of the lubricant/adhesive and the compression joint seal. The RPR checks the seal for stretching or compression every [`1600 feet (480 m)`] using the following procedures:

1. Mark the top surface of the compression seal at one-foot (30 cm) intervals.
2. After installation, measure the distance between the marks on the seal.
3. If the stretching or compression exceeds the specified limit, remove, and replace the seal up to the last correct measurement. All testing and repairs are at the Contractors expense.

604-4.7 Acceptance.

The RPR inspects the joint sealing system (compression seal and lubricant/adhesive) for proper rate of stretch, bonding to the concrete, and deficiencies (cuts, twists, nicks, or other deficiencies). The Contractor must remove and replace any seals exhibiting any defects (cuts, twists, nicks, or other deficiencies) prior to final acceptance, at their expense.

604-5 METHOD OF MEASUREMENT

604-5.1 Measurement.

The quantity of compression joint seals installed and accepted, is determined by the linear feet (meter).

604-6 BASIS OF PAYMENT

604-6.1 Payment.

Payment is made at the contract unit bid prices per linear foot (meter) for the compression joint seals. The unit bid prices include the cost of all labor, materials, the use of all equipment, and tools required to complete the work.

Item 604-6.1	Compression Joint Seals for Concrete Pavements – per linear feet (meter)

604-7 REFERENCES

604-7.1 This list of publications forms 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 D2628	*Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements*
ASTM D2835	*Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements*

Corps of Engineers

CRD C548	*Standard Specification for Jet-Fuel and Heat Resistant Preformed Polychloroprene Elastomeric Joint Seals for Rigid Pavements*

Unified Facilities Criteria (UFC)

UFC 3-250-08FA	*Standard Practice for Sealing Joints and Cracks in Rigid and Flexible Pavements*

END OF ITEM P-604

Item P-605 Joint Sealants for Pavements

****

Edit these specifications as necessary to tailor specification for joint re-seal projects.

See Item P-101 for preparation and sealing of cracks.

The type of joints sealant to be used is based upon geographic location.

****

605-1 DESCRIPTION

605-1.1 This item consists of providing and installing a resilient and adhesive joint sealant material capable of effectively sealing joints in pavement; joints between different types of pavements; and cracks in existing pavement.

605-2 MATERIALS

605-2.1 Joint Sealants.

Joint sealant materials must meet the requirements of **[__]**.

Deliver each lot or batch of sealant to the jobsite in the manufacturer’s original sealed container. Mark each container with the manufacturer’s name, batch or lot number, the safe heating temperature. The container must be accompanied by the manufacturer’s certification stating that the sealant meets the requirements of this specification.

****

The Engineer may specify one or more of the following. (Note: ASTM D7116 limited to use on Portland Concrete Cement (PCC) Aprons only where fueling occurs):

ASTM D5893	**Standard Specifications for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements**
ASTM D6690	***Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements***
ASTM D7116	***Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types for Portland Cement Concrete Pavements***

PCC aprons where fueling occurs may use either ASTM D7116 or ASTM D5893.

****

605-2.2 Backer Rod.

The material furnished must be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant according to ASTM D5249. The backer-rod material must be 25% ±5% larger in diameter than the nominal width of the joint.

605-2.3 Bond Breaking Tapes.

Provide a bond breaking tape or separating material that is a flexible, non-shrinkable, non-absorbing, non-staining, and non-reacting adhesive-backed tape. The material must have a melting point at least 5°F (3°C) greater than the pouring temperature of the sealant being used when tested according to ASTM D789. The bond breaker tape must be approximately ⅛ inch (3 mm) wider than the nominal width of the joint and must not bond to the joint sealant. For light can installation, do not use backup material between items Item P-605 and P-606.

****

The use of a bond breaking separation tape or backup material in the joint may prevent an adverse reaction between incompatible materials, maintain the desired configuration (shape factor of the material), and act as a bond breaker to prevent excessive stresses from being placed on the sealant during pavement movement. Therefore, select the separating or backup material carefully and install to form an effective and durable support for the sealant.

Place separating or blocking material to a depth below the pavement approximately equal to the width of the joint. This is to achieve a shape factor (ratio of the depth of the sealant to the width of the joint) of 1. ASTM D5893 sealants sometimes require a shape factor of 0.5 instead of 1.

This is equivalent to a width-to-depth ratio of 2:1 and requires modifying the standard joint detail. If an ASTM D5893 sealant is to be used, adjust the placement depth of the bond breaking separating tape or backup material, accordingly. Include drawings in the contract drawings to indicate application details.

For installation of light cans, see Advisory Circular (AC) 150/5340-30.

****

605-3 CONSTRUCTION METHODS

605-3.1 Time of Application.

Seal joints as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature must be 50°F (10°C) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint. When used after Item P-606, do not apply P-605 until the P-606 material fully cures.

****

If the pavement must be opened to traffic prior to placement of the sealant, modify this paragraph to require the Contractor to temporarily fill the joint with a jute or nylon rope immediately after the joint is sawn. The rope should be slightly larger than the joint and forced into the joint so the top of the rope is ⅛ inch (3 mm) below the pavement surface. Remove the rope immediately prior to cleaning.

****

605-3.2 Equipment.

Machines, tools, and equipment used in the performance of the work required by this section must be approved before the work is started. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, **[ ]** days prior to use on the project.

[605-3.2.1 Tractor-mounted Routing Tool.

Provide a routing tool, used for removing old sealant from the joints, of such shape and dimensions, mounted on the tractor so it will not damage the sides of the joints. Design the tool so it can be adjusted to remove the old material to varying depths as required. The use of V-shaped tools or rotary impact routing devices is not permitted. Hand-operated spindle routing devices may be used to clean and enlarge random cracks.

605-3.2.2 Concrete Saw.

Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified.

605-3.2.3 Sandblasting Equipment.

[Sandblasting is not permitted. **|** The Contractor must demonstrate sandblasting equipment including the air compressor, hose, guide, and nozzle size, under job conditions, before approval according to paragraph 605-3.3. The Contractor demonstrates, in the Resident Project Representative’s (RPR) presence, that the method cleans but does not damage the joint. **]**

****

Sandblasting joints may not be permitted under certain conditions. Blowing sand and dust may either violate atmospheric pollution statutes or may drift into areas where it would be objectionable. When sandblasting is prohibited, cleaning the joints with a waterblaster or wire brushes may be substituted. Wire brushes usually do not clean as well as the sandblaster or waterblaster and should only be used for small areas. When using wire brushes, give attention to ensure worn brushes are not used and the joints are adequately cleaned.

****

[605-3.2.4 Waterblasting Equipment.

The Contractor must demonstrate waterblasting equipment including the pumps, hose, guide, and nozzle size, under job conditions, before approval according to paragraph 605-3.3. The Contractor must demonstrate, in the RPR’s presence, that the method cleans the joint and does not damage the joint.

****

Waterblasting equipment varies considerably with respect to design of wand, nozzle, water pressure, and water volume, depending upon the manufacturer. Consequently, the effectiveness of a particular set of equipment cannot be predicted.

****

605-3.2.5 **Hand Tools.**

Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces. Hand tools should be carefully evaluated for potential spalling effects prior to approval for use.

605-3.2.6 **Hot-poured Sealing Equipment.**

The unit applicators used for heating and installing hot applied joint sealant materials must be mobile and equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit must be designed so that the sealant circulates through the delivery hose and returns to the inner kettle when not in use.

605-3.2.7 **Cold-applied, Single-component Sealing Equipment.**

The equipment for installing ASTM D5893 single component joint sealants must consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle must be that it extends into the joint to allow sealing from the bottom of the joint to the top. Maintain the approved equipment in good working condition, serviced according to the supplier’s instructions, and unaltered in any way without obtaining prior approval. Small hand-held air-powered equipment (e.g., caulking guns) may be used for small applications.]

****

Delete the paragraphs that do not apply to the project.

****

605-3.3 Preparation of Joints.

Pavement joints for application of material in this specification must be dry, clean of all scale, dirt, dust, curing compound, and other foreign matter. In the RPRs’ presence, the Contractor must demonstrate that the method to saw and clean the joint does not damage it.

605-3.3.1 Sawing.

Saw all joints according to specifications and plan details. Immediately after sawing the joint, completely remove the resulting slurry from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.

605-3.3.2 Clean Joints.

Immediately before sealing, thoroughly clean the joints of all remaining laitance, curing compound, filler, protrusions of hardened concrete, old sealant, and other foreign material from the sides and upper edges of the joint space to be sealed. Accomplish cleaning with [sandblasting | tractor-mounted routing equipment | concrete saw | waterblaster] as specified in paragraph 605-3.2. Clean each joint face and the pavement surface extending a minimum of ½ inch (12 mm) from the joint edge. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more than 3 inches (75 mm) from it. After final cleaning and immediately prior to sealing, blow out the joints with oil free dry compressed air and leave them completely free of debris and water. The joint faces must be surface dry when the seal is applied.

605-3.3.3 Backer Rod.

When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a backer rod according to paragraph 605-2.2 to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backer rod is placed at the specified depth and is not stretched or twisted during installation.

605-3.3.4 Bond-breaking Tape.

Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-breaking tape according to paragraph 605-2.3 to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

605-3.4 Installation of Sealants.

The RPR must inspect and approve joints for proper width, depth, alignment, and preparation, before sealing is permitted. Install sealants according to the following requirements: Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to [⅛ | ¼] inch ([3 | 6] mm) ±$^{1}/_{16}$ inch (2 mm) below the top of pavement surface; or bottom of groove for grooved pavement. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. Using gravity methods or pouring pots is not permitted for the sealant installation. The RPR must authorize traffic before it is permitted over newly sealed pavement. When a primer is recommended by the manufacturer, apply it evenly to the joint faces according to the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

****

The use of a backer rod or bond breaking tapes in the bottom of the joint to be filled is recommended to control the depth of the sealant, to achieve the desired shape factor, and to support the sealant against indentation and sag. Backer rod and bond breaking tapes should be compatible with the sealant should be compressible without extruding the sealant.

****

605-3.5 Control Strip.

Prior to sawing, cleaning and sealing joints for the project the Contractor must demonstrate in the presence of the RPR, the equipment, materials and construction process for installation of sealants. Using the specified equipment, materials and construction processes for joints sawing, preparation and sealing prepare a control strip at least 200 feet (69 meters) long at a location approved by the RPR. If materials or installation do not meet specified requirements the Contractor must remove and replace the materials, clean the joints and install new sealant at the Contractor's expense. Acceptable control strips may be incorporated into the permanent work.

605-3.6 Acceptance.

The RPR will inspect the joint for cure and set, bonding to the joint walls, separation within the sealant, reversion to liquid, entrapped air, and voids. All joints exhibiting any of these deficiencies prior to final acceptance of the project must be removed, the joint cleaned, and joint sealant replaced at the Contractor's expense.

605-3.7 Clean-up.

Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

605-4 METHOD OF MEASUREMENT

605-4.1 Joint sealing material is measured by the **[** `gallon (liter)` **|**`pound (kg)` **|** `linear foot (meter)` **]** of sealant in place, completed, and accepted.

605-5 BASIS OF PAYMENT

605-5.1 Payment for joint sealing material is made at the contract unit price per **[** pound (kg) **|** linear foot (meter) **]**. The price is full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item P-605-5.1	Joint Sealing Filler, **[** per gallon (liter) **|** per pound (kg) **|** per linear foot (meter) **]**

605-6 REFERENCES

605-6.1 This list of publications forms 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 D789	*Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)*
ASTM D5249	*Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints*
[ASTM D5893	*Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements* **]**
[ASTM D6690	*Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt* **]**
[ASTM D7116	*Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types for Portland Cement Concrete Pavements* **]**

****

The Engineer specifies one or more of the ASTMs above to agree with sealant type selected in paragraph 605-2.1.

****

Advisory Circulars (AC)

AC 150/5340-30	*Design and Installation Details for Airport Visual Aids*

END OF ITEM P-605

Item P-606 Sealing Wire and Lights in Pavement

606-1 DESCRIPTION

606-1.1 This specification covers two types of material: a liquid suitable for sealing electrical wire in saw cuts in pavement and for sealing light fixtures or bases in pavement, and a paste suitable for embedding light fixtures in the pavement. Both types of material are two-component filled formulas with the characteristics specified in paragraph 606-2.4. Materials supplied for use with asphalt and/or concrete pavements must be formulated so they are compatible with the asphalt and/or concrete.

****

If the material is to be used on asphalt and/or concrete pavements and it is not formulated for this use, cracking, and separation of the material from sawn wireway kerfs and around light fixtures may occur.

****

606-2 MATERIALS

606-2.1 Curing.

When pre-warmed to 77°F (25°C), mixed, and placed according to manufacturer's directions, the materials must cure at temperatures of 45°F (7°C) or above without the application of external heat.

606-2.2 Storage.

Do not store the adhesive components at temperatures over 86°F (30°C), unless otherwise specified by the manufacturer.

606-2.3 Characteristics.

When mixed and cured according to the manufacturer's directions, the materials must have the following properties in Table 606-2.3.

Table 606-2.3: Property Requirements

Physical or Electrical Property	Minimum	Maximum	ASTM Method
Tensile			
Portland Cement Concrete	1,000 psi (70 kg/square cm)		D638
Asphalt concrete	500 psi (35 kg/square cm)		
Elongation			
Portland Cement Concrete		See note [1]	D638
Asphalt Concrete	50%		D638
Coef. of cub. exp. cu. cm/cu. cm/°C	0.00090	0.00120	D1168
Coef. of lin. exp. cm/cm/°C	0.000030	0.000040	D1168
Dielectric strength, short time test	350 volts/mil.		D149
Arc resistance	125 sec		
Pull-off			
Adhesion to steel	1,000 psi (70 kg/square cm)		
Adhesion to Portland Cement Concrete	200 psi (14 kg/square cm)		
Adhesion to Asphalt Concrete	No test available.		
Adhesion to aluminum	250 psi		

[1] 20% or more (without filler) for formulations to be supplied for areas subject to freezing.

606-2.4 Adhesive Compounds - Contractor's Responsibility.

The Contractor must furnish the vendor's certified test reports for each batch of material delivered to the project. The report must certify that the material meets specification requirements and is suitable for use with [`concrete` | `asphalt concrete`] pavements. The Resident Project Representative (RPR) must receive and accept the report before use of the material. In addition, the Contractor must obtain a statement from the supplier or manufacturer that guarantees the material for one year. The supplier or manufacturer must furnish evidence that the material performed satisfactorily on other projects.

606-2.5 Control Installation.

Prior to proceeding with installation of sealant the Contractor must demonstrate in the RPR's presence that the materials, equipment, and construction processes meet the requirements of this specification and the sealant manufacturer's recommended installation procedures.

606-2.6 Application.

Apply adhesive on a dry, clean surface, free of grease, dust, and other loose particles. The method of mixing and application must be in strict accordance with the manufacturer’s recommendations. When used with Item P-605, such as light can installation, Item P-605 must not be applied until Item P-606 fully cures.

****

Installation methods such as surface preparation, mixing ratios, and pot life are as important to satisfactory performance as the properties of the material itself.

****

606-3 METHOD OF MEASUREMENT

606-3.1 The adhesive compound is measured by the **[** pound (kg) **|** gallon (l) **]** of adhesive as specified, in place, complete and accepted. When required in the installation of an in-runway lighting system or portion of, no measurement is made for direct payment of adhesive, as the cost of furnishing and installing is a subsidiary obligation in the completion of the installation.

606-4 BASIS OF PAYMENT

606-4.1 Payment is made, where applicable, at the contract unit price per **[** pound (kg) **|** gallon (l) **]** for the adhesive. This price is full compensation for furnishing all materials, and for all preparation, delivering, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Item P-606-5.1	Adhesive Compound - per **[** pound (kg) **|** gallon (l) **]**

606-5 REFERENCES

606-5.1 This list of publications forms 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 C192	*Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory*

ASTM D149	*Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies*
ASTM D638	*Standard Test Method for Tensile Properties of Plastics*
ASTM D5329	*Standard Test Methods for Sealants and Fillers, Hot-applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements*

END OF ITEM P-606

Item P-610 Concrete for Miscellaneous Structures

****

For airfield signage bases, light bases, Navigational Aids (NAVAID) foundations, drainage structures, and other miscellaneous airfield concrete other than airfield pavements, Item P-610, Item P-501, or concrete meeting state Department of Transportation (DOT) specifications for structures may be used provided aggregates meet reactivity requirements of Item P-610 or Item P-501.

See Item P-501 for pavements on grade, including slab replacements.

****

610-1 DESCRIPTION

610-1.1 This item consists of concrete and reinforcement, as shown on the plans, prepared, and constructed according to these specifications. This specification is intended for all cast in place concrete on airfield other than airfield pavement. This item is not intended for use on building construction.

610-2 MATERIALS

610-2.1 General.

Materials are subject to inspection and tests at any time during their preparation or use. The source of all materials must be approved by the Resident Project Representative (RPR) before delivery or use in the work. Representative samples of the materials must be submitted by the Contractor for testing. 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 is not permitted unless the aggregate has been screened and washed, and all fine and coarse aggregates stored separately. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates is not permitted.

610-2.1.1 Reactivity.

Test fine aggregate and coarse aggregates used in all concrete separately within six months of the project according to ASTM C1260. Submit test results to the RPR. The aggregate is considered innocuous if the expansion of test specimens, tested according to ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion of either the fine or coarse aggregate specimens is greater than 0.08% at 14 days, but less than 0.20%, use either a minimum of 25% of coal ash or between 40% and 55% of slag cement. Other mitigation measures are acceptable when supported by ASTM C1567 testing. If the expansion is greater than 0.20%, do not use the aggregates. Submit test results for other aggregates for evaluation.

610-2.2 Coarse Aggregate.

The coarse aggregate for concrete must meet the requirements of ASTM C33 and the requirements of Table 610-2.2, Class Designation 5S; and the grading requirements shown in Table 610-2.2, as required for the project.

Table 610-2.2: Coarse Aggregate Grading Requirements

Maximum Aggregate Size	ASTM C33, Table 3 Grading Requirements (Size No.)
1½ inch (37.5 mm)	467 or 4 and 67
1 inch (25 mm)	57
¾ inch (19 mm)	67
½ inch (12.5 mm)	7

610-2.2.1 Coarse Aggregate Susceptibility to Durability (D) Cracking. **[** Not used. **]**

[Coarse aggregate must have a durability factor greater than or equal to 80 per ASTM C666, using either method A or B. The Contractor must submit a current certification and test results to verify the aggregate acceptability. Test results are only accepted from a DOT materials laboratory or an accredited laboratory. Certification and test results not dated, over one year old, or are for different gradations are not accepted.

Crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite, or trap rock are considered as meeting the D-cracking test requirements but must meet all aggregate quality tests specified in Item P-501. **]**

****

Do not use paragraph 610-2.2.1 in areas without a history of D-cracking

Freeze-thaw testing is not required in areas that do not get multiple freeze-thaw cycles. Generally, freeze-thaw testing is not required in International Energy Conservation Code (IECC) (Climate Zones 1-3).

****

610-2.3 Fine Aggregate.

The fine aggregate for concrete must meet all fine aggregate requirements of ASTM C33.

610-2.4 Cementitious Materials.

610-2.4.1 Cement.

Cement must conform to the requirements of **[** ASTM C150, Types I, II or V; ASTM C595 Types IS, IP, IL or IT; ASTM C1157 Types GU, HS, MS, MH or LH **]**.

610-2.4.2 Coal Ash.

Coal ash must meet the requirements of ASTM C618. The Contractor must furnish the previous three most recent, consecutive ASTM C618 reports for each source of coal ash proposed in the concrete mix and furnish additional reports as they become available during the project.

610-2.4.3 Slag Cement (Ground Granulated Blast Furnace (GGBF)).

Slag cement will conform to ASTM C989, Grade 100 or Grade 120.

610-2.4.4 Raw or Calcined Natural Pozzolan.

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N.

[610-2.4.5 Ultrafine Fly Ash and Ultrafine Pozzolan.

UltraFine Fly Ash (UFFA) and UltraFine Pozzolan (UFP) will conform to ASTM C618, Class F or N, and the following additional requirements:

1. The strength activity index at 28 days of age is at least 95% of the control specimens.
2. The average particle size will not exceed 6 microns. **]**

610-2.5 Water.

Water from a drinking water source is suitable for mixing and curing. If water is taken from other sources, it will meet the requirements of ASTM C1602.

610-2.6 Admixtures.

Admixtures will meet the requirements of the following specifications:

610-2.6.1 Air-entraining Admixtures.

Air-entraining admixtures will meet the requirements of ASTM C260 and consistently entrain the air content in the specified ranges under field conditions. The air-entraining agent and any water reducer admixture must be compatible.

610-2.6.2 Chemical Admixtures.

Chemical admixtures must meet the requirements of ASTM C494.

610-2.6.3 Lithium Nitrate.

The lithium admixture must be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 lbs/gallon (1.2 kg/L), and have the approximate chemical form shown in Table 610-2.7.

Table 610-2.7: Lithium Admixture

Constituent	Limit (Percent by Mass)
LiNO3 (Lithium Nitrate)	30 ±0.5
SO4 (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

The lithium manufacturer's representative must verify and certify the lithium nitrate admixture dispensing and mixing operations.

610-2.7 Premolded Joint Material.

Premolded joint filler for isolation joints will conform to the requirements of ASTM D8139 or ASTM D1751 or ASTM D1752. Furnish the filler for each joint in a single piece for the full depth and width required for the joint. If more than one piece is required for a joint, securely fasten the abutting ends must be fastened securely and held accurately to shape by stapling or other positive fastening means.

610-2.8 Joint Filler

The filler for joints must meet the requirements of Item P-605, unless otherwise specified.

610-2.9 Steel Reinforcement.

Reinforcing consists of **[__]** conforming to the requirements of **[__].**

****

The Engineer designates the materials needed for the project:

ASTM A615	***Standard Specification for Deformed and Plain Carbon-Steel Bars 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 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 A184 or A704 Bar mats	
ASTM A1035	***Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement***
ASTM A884	***Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement***

Furnish welded wire fabric in flat sheets only.

Delete this paragraph when not applicable to the project.

****

610-2.10 Materials for Curing Concrete.

Curing materials must conform to **[__]**.

****

The Engineer selects one or more of the following from Table 610-2.10.

Table 610-2.10: Materials for Curing

Item	ASTM
Waterproof Paper	ASTM C171
Clear or White Polyethylene Sheeting	ASTM C171
White-Pigmented Liquid Membrane-Forming Compound, Type 2, Class B	ASTM C309

****

610-3 CONSTRUCTION METHODS

610-3.1 General.

The Contractor furnishes 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, must be of sufficient size to meet the requirements of the work. All work is subject to the RPR's inspection and approval.

610-3.2 Concrete Mixture.

The concrete must develop a compressive strength of **[** 4000 **]** psi **[** 28 MPa **]** in 28 days as determined by test cylinders made according to ASTM C31 and tested according to ASTM C39. The water cementitious ratio must not exceed 0.45 by weight. The air content of the concrete must be **[** 7% **]** ±1% as determined by ASTM C23.

The Contractor must submit the proposed concrete mixture to the RPR at least **[** 7 **]** days prior to concrete placement. The submittal must include the type and amount of aggregates, cementitious materials, water and additives.

****

The Engineer designates the compressive strength. Air content may be adjusted to 4% in areas not subject to freeze-thaw conditions.

****

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 must be mixed and delivered according to the requirements of ASTM C94 or ASTM C685. **Retempering of concrete by adding water or any other material is not permitted.** The rate of delivery of concrete to the job must be sufficient to allow uninterrupted placement of the concrete.

610-3.4 Forms.

Do not place concrete until the RPR inspects and approves all forms and reinforcements. Use forms of suitable material and type, size, shape, quality, and strength to build the structure as shown on the plans. Forms must be true to line and grade and be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. Surfaces of forms must be smooth and free from irregularities, dents, sags, and holes.

Arrange the internal form ties so no metal shows in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. Wet forms with water or with a non-staining mineral oil, immediately before the concrete is placed. Construct forms so removal does not injure the concrete or concrete surface.

610-3.5 Placing Reinforcement.

Accurately place reinforcement as shown on plans. Fasten bars together at intersections. Support reinforcement with approved metal chairs. Firmly hold all reinforcement during concrete placement. The Contractor must supply shop drawings, lists, and bending details.

610-3.6 Embedded Items.

Before placing concrete, firmly and securely embed all items in place as indicated. All embedded items must be clean and free from coating, rust, scale, oil, or any foreign matter. Consolidate concrete around and against embedded items. The embedding of wood is not permitted.

610-3.7 Concrete Consistency.

The Contractor must monitor the consistency of concrete delivered to the project site; collect batch tickets documenting the amount of coarse aggregate, fine aggregate, cement, additives, and water. Provide copies of the batch ticket to the RPR daily.

610-3.8 Placing Concrete.

Place concrete during daylight hours, unless otherwise approved. Do not place concrete until the RPR approves the depth and condition of foundations, the adequacy of forms and falsework, and the placement of the steel reinforcing. Place concrete as soon as practical after mixing. The method and manner of placing avoids segregation and displacement of the reinforcement. When necessary, use troughs, pipes, and chutes as an aid in placing concrete. Do not allow concrete to drop more than 5 feet (1.5m). Place concrete 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.

610-3.9 Vibration.

Consolidate concrete following the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

610-3.10 Joints.

Construct joints as indicated on the plans.

610-3.11 Finishing.

All exposed concrete surfaces must be true, smooth, and free from open or rough areas, depressions, or projections. Bring all concrete horizontal plane surfaces flush to the proper elevation and then the top surface struck-off with a straightedge and floated.

610-3.12 Curing and Protection.

Cure concrete according to the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. Protect concrete 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 85ºF (30 ºC), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

610-4 ACCEPTANCE

610-4.1 Sampling and Testing.

Concrete for each day's placement is accepted based on the compressive strength specified in paragraph 610-3.2. The RPR samples the concrete according to ASTM C172. Test the slump according to ASTM C143; **[** `test air content according to ASTM C231` **]**. Make and cure compressive strength specimens according to ASTM C31; and test according to ASTM C39. The QA testing agency will meet the requirements of ASTM C1077. The Contractor must provide facilities for the initial curing of cylinders.

610-4.2 Defective Work.

Remove and replace, at the Contractors expense, any defective work that cannot be satisfactorily repaired as the RPR determined. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

610-5 METHOD OF MEASUREMENT

610-5.1 Concrete is **[** `measured by the number of cubic yards (cubic meters) based on the batch tickets` **|** `measured by the number of square yards (square meters) based on the dimensions shown on the plans` **|** `lump sum` **|** `considered incidental and no separate measurement is made.` **]** of concrete complete in place and accepted.

610-6 BASIS OF PAYMENT

610-6.1 Payment is made at the contract price **[** `by the number of cubic yards (cubic meters) based on the batch tickets` **|** `by the number of square yards (square meters)` **|** `lump sum` **|** `concrete is considered incidental and no separate payment is made.` **]** This price is 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 is made under:

Item P-610-6.1 Concrete, **[** `per cubic yards (cubic meters)` **|** `per square yards (square` meters) |lump sum |incidental to other work items]

610-7 REFERENCES

610-7.1 This list of publications forms 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 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*)
ASTM C1365	*Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis*

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 Airfield Pavement Marking

****

See AC 150/5340-1, *Standards for Airport Markings*, for additional information on Airport Markings.

****

620-1 DESCRIPTION

620-1.1 This item consists of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, according to 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. See AC 150/5340-1, *Standards for Airport Markings*, for additional information on airfield markings.

620-2 MATERIALS

620-2.1 Materials Acceptance.

The Contractor must furnish manufacturer’s certified test reports, for materials shipped to the project. The certified test reports must include a statement that the materials meet the specification requirements. Submit this certification to the RPR for approval, along with a copy of the paint manufacturer’s surface preparation; marking materials, including adhesion, flow promoting and/or flotation additive; additives for ultra-violet (UV) protection, additives for control of algae and application requirements, prior to the initial application of markings. Use the reports for material acceptance or the RPR may perform verification testing. All material must arrive in sealed containers easily quantifiable for the RPR’s inspection.

620-2.2 Marking Materials.

Table 620-2.2a: Marking Materials

		Paint[1]			Glass Beads[2]	
Location	**Type**	**Color**	**Fed Std. 595 Number**	**Application Rate Maximum**	**Type**	**Application Rate Minimum**
	*	*	*	*	*	*
	*	*	*	*	*	*

[1] See paragraph 620-2.2.1.
[2] See paragraph 620-2.2.2.

****

Make the appropriate selections for paint type, color, Federal Standard (FED STD) 595 Number, application rates, glass bead type, and application rates, and insert into Table 620-2.2a. Asterisks denote insertion points.

****

620-2.2.1 Paint.

Paint must be **[** `waterborne` **|**`epoxy` **|**`methacrylate` **|** `solvent-base` **|**`and` **|**`preformed thermoplastic` **]** according to the requirements of this paragraph. Paint colors must comply with Federal Standard No. 595. **[__]**

****

The Engineer specifies the paint type (s), colors, and glass beads to use for the project and populates Table 620-2.2a with that information. When specifying more than one paint, the plans should clearly indicate paint type, paint color, and bead type required for each marking.

Select the type of paint.

Types: Waterborne, Epoxy, Methacrylate, solvent-base, or preformed Thermoplastic

For waterborne or solvent based paints, specify Type I, II, or III:

- **Type I is intended for locations where slower tracking is not a problem.**
- **Type II is intended for locations where faster curing is desirable.**
- **Type III is intended for locations requiring a thicker, more durable coating.**

1. **Select paint color(s) from Table 620-2.2b.**

Table 620-2.2b: Paint Colors

Paint Color	Fed Std. No 595 Color Number
White	37925
Red	31136
Yellow	33538 or 33655
Black	37038
Pink	One part 31136 to two parts 37925
Green	34108

Use waterborne or solvent base black paint to outline a border at least 6 inches (150 mm) wide around markings on all light-colored pavements. Preformed thermoplastic markings must have a non-reflectorized black border integral to the marking. <u>Select the appropriate application rates for type of paint and bead selected.</u>

Table 620-2.2c: Application Rates for Paint and Glass Beads for Table 620-2.2a

Paint		Glass Beads		
Type	Application Rate Maximum	Type I, Gradation A[1] Minimum	Type III Minimum	Type IV[1] Minimum
Waterborne Type I or II	115 ft^2/gal (2.8 m^2/l)	7 lb/gal (0.85 kg/l)	10 lb/gal (1.2 kg/l)	--
Waterborne Type III	90 ft^2/gal (2.2 m^2/l)	7 lb/gal (0.85 kg/l)	8 lb/gal (1.0 kg/l)	
Waterborne Type III	55 ft^2/gal (1.4 m^2/l)		6 lb/gal (.8 kg/l)	5 lb/gal (.7 kg/l)
Solvent Base	115 ft^2/gal (2.8 m^2/l)	7 lb/gal (0.85 kg/l)	10 lb/gal (1. 2 kg/l)	--
Solvent Base	55 ft^2/gal (2.2 m^2/l)	--	--	5 lb/gal (.7 kg/l)
Epoxy	90 ft^2/gal (2.2 m^2/l)	15 lb/gal (1.8 kg/l)	20 lb/gal (2.4 kg/l)	16 lb/gal (1.9 kg/l)
Methacrylate	45 ft^2/gal (1.1 m^2/l)	15 lb/gal (1.8 kg/l)	20 lb/gal (2.4 kg/l)	16 lb/gal (1.9 kg/l)
Methacrylate Splatter-Profile	24ft^2/gal. (0.6 m^2/l)	8 lb/gal (0.1 kg/l)	10 lb/gal (1.2 kg/l)	10 lb/gal (1.2 kg/l)

Paint		Glass Beads		
Type	**Application Rate Maximum**	**Type I, Gradation A[1] Minimum**	**Type III Minimum**	**Type IV[1] Minimum**
Temporary Marking Waterborne Type I or II	230 ft^2/gal (5.6 m^2/l)	No beads	No beads	No beads

[1] Reduce glass bead application rate for red and pink paint by 2 lb/gal (0.24 kg/l) when using Type I or Type IV beads.

The Engineer specifies the time period in paragraph 620-3.5 in order to allow adequate curing of the pavement surface. The Engineer should contact the paint manufacturer to determine the wait period. A 24- to 30-day waiting period is recommended for all types of paint used for pavement marking. The final application should occur after the waiting period has passed. The final marking application must be at a rate equal to 100% of the full application rate with glass beads.

Markings may be required before paving operations are complete. The Engineer may wish to specify waterborne or solvent-based materials for temporary markings at 30% to 50% of the specified application rates. Glass beads do not adhere well at the low application rates for temporary markings.

CAUTION: Prior to reopening pavements at Part 139 airports, verify that all markings comply with Part 139 requirements. The final marking application must be at a rate equal to 100% of the full application rate with glass beads. Temporary markings not in compliance with Advisory Circular (AC) 150/5340-1, require a NOTAM regarding non-standard marking. For example, temporary markings without beads.

See Engineering Policy Memo 23-03 for guidance on use of preformed thermoplastic markings. Preformed thermoplastic markings (PTMs) may be used for:

- **Surface Painted Hold Signs**
- **Taxiway direction and location markings**
- **Geographic position markings**
- **Vehicular Roadway markings on airfield**
- **Zipper lines**
- **Taxiway edge and center lines**
- **Runway hold lines**
- **Enhanced Taxiway Center lines**

Preformed thermoplastic must yield at least 225 mcd/m^2/lux on white markings at installation and at least 100 mcd/m^2/lux on yellow markings at installation.

Measure retroreflectivity with a portable retroreflectometer according to ASTM E1710 and ASTM D7585. Using a vehicle-mounted retroreflectometer to measure is permitted.

****

[620-2.2.1.1 Waterborne.

Paint must meet the requirements of Federal Specification TT-P-1952F, [Type I | Type II | Type III]. [The acrylic resin used for Type III must be 100% cross linking acrylic as evidenced by infrared peaks at wavelengths 1568, 1624, and 1672 cm-l with intensities equal to those produced by an acrylic resin known to be 100% cross linking.]

[620-2.2.1.2 Epoxy.

Paint must be a two-component, minimum 99% solids type system conforming to the following:

1. **Pigments**. Component A. Percent by weight.
   a. **White**
      - Titanium Dioxide, ASTM D476, Type II must be 18% minimum (16.5% minimum at 100% purity).
   b. **Yellow and Colors**
      - Titanium Dioxide, ASTM D476, Type II must be 14 to 17%.
      - Epoxy resin must be 75 to 79%.
      - Organic yellow, other colors, and tinting as required to meet color standard.
2. **Epoxy Content**. Component A. The weight per epoxy equivalent, when tested according to ASTM D1652 is the manufacturer’s target ±50.
3. **Amine Number**. Component B. When tested according to ASTM D2074 is the manufacturer’s target ±50.

4. **Prohibited Materials.** The manufacturer must certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, or any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

5. **Daylight Directional Reflectance.**

   a. **White:** The daylight directional reflectance of the white paint must not be less than 75% (relative to magnesium oxide), when tested according to ASTM E2302.

   b. **Yellow:** The daylight directional reflectance of the yellow paint must not be less than 55% (relative to magnesium oxide), when tested according to ASTM E2302. The x and y values must be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or be consistent with the tolerance listed below:

x .462	x .470	x .479	x .501
y .438	y .455	y .428	y .452

6. **Accelerated Weathering.**

   a. **Sample Preparation.** Apply the paint at a wet film thickness of 0.013-inch (0.33 mm) to four 3 × 6-inch (8 × 15 cm) aluminum panels prepared as described in ASTM E2302. Air dry the sample 48 hours under standard conditions.

   b. **Testing Conditions.** Test according to ASTM G154 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating four hour UV exposure at 140°F (60°C), and four hours condensate exposure at 104°F (40°C).

   c. **Evaluation.** Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 5 above. Evaluate for conformance with the color requirements.

7. **Volatile Organic Content.** Determine the volatile organic content according to 40 CFR Part 60 Appendix A, Method 24.

8. **Dry Opacity.** Use ASTM E2302. The wet film thickness must be 0.015 inch (0.38 mm). The minimum opacity for white and colors is 0.92.

9. **Abrasion Resistance.** Subject the panels prepared in paragraph 620-2.22.6 to the abrasion test according to ASTM D968, Method A, except that the inside diameter of the metal guide tube is from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters (17.5 lb (7.94 kg)) of unused sand must be used for each test panel. Run test on two test panels, baked and weathered, paint films must require not less than 150 liters (525 lbs (239 kg)) of sand for the removal of the paint films.

10. **Hardness, Shore.** Hardness must be at least 80 when tested according to ASTM D2240. **]**

[620-2.2.1.3 Methacrylate.

Paint must be a two-component, minimum 99% solids-type system conforming to the following:

1. **Pigments.** Component A. Percent by weight.

   a. **White**

      - o Minimum 10% Titanium Dioxide, ASTM D476, type II.
      - o Minimum 18% Methacrylate resin

   b. **Yellow and Colors**

      - o Minimum 1% Titanium Dioxide, ASTM D476, type II.
      - o Organic yellow, other colors, and tinting as required to meet color standard.

  - Minimum 18% Methacrylate resin.

2. **Prohibited Materials.** The manufacturer must certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, or any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

3. **Daylight Directional Reflectance.**

   a. **White:** Minimum 80% daylight directional reflectance (relative to magnesium oxide), when tested according to ASTM E2302.

   b. **Yellow:** Minimum 55% daylight directional reflectance (relative to magnesium oxide), when tested according to ASTM E2302. The x and y values must be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or be consistent with the following tolerances:

x .462	x .470	x .479	x .501
y .438	y .455	y .428	y .452

4. **Accelerated Weathering.**

   a. **Sample Preparation.** Apply the paint at a wet film thickness of 0.013-inch (0.33 mm) to four 3 × 6-inch (8 × 15 cm) aluminum panels prepared as described in ASTM E2302. Air dry the sample 48 hours under standard conditions.

   b. **Testing Conditions.** Test according to ASTM G154 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating four hour UV exposure at 140°F (60°C), and four hours condensate exposure at 104°F (40°C).

   c. **Evaluation.** Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 3 above. Evaluate for conformance with the color requirements.

5. **Volatile Organic Content.** Determine the volatile organic content according to 40 CFR Part 60 Appendix A, Method 24.

6. **Dry Opacity.** Use ASTM E2302. The wet film thickness must be 0.015 inch (0.38 mm). The minimum opacity for white and colors must be 0.92.

7. **Abrasion Resistance.** Subject the panels prepared in paragraph 620-2.2.3.4 to the abrasion test according to ASTM D968, Method A, except that the inside diameter of the metal guide tube must be from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters (17.5 lb (7.94 kg)) of unused sand is used for each test panel. Run the test on two test panels, baked and weathered paint films require not less than 150 liters (525 lbs (239 kg) of sand for the removal of the paint films.

8. **Hardness, Shore.** Hardness must be at least 60 when tested according to ASTM D2240.

9. **Additional Requirements for Methacrylate Splatter Profiled Pavement Marking.** Pavement markings of this type must comply with all above requirements for methacrylate paint, except as noted below.

   a. The thickness of the marking is irregular ranging from 0.000 to 0.250 inches (0.00 to 6.4 mm), applied in a splatter pattern which comprises a minimum of 80% of the visible line (when traveling at 5 mph the line appears to be solid.).

   b. The hardness is 48 Shore D minimum. **]**

[620-2.2.1.4 Solvent-base.

Paint must meet the requirements of Commercial Item Description **[** A-A-2886B Type I, Type II, and Type III **].]**

[620-2.2.1.5 Preformed Thermoplastic Airport Pavement Markings.

Compose markings of ester modified resins in conjunction with aggregates, pigments, and factory produced binders as a finished product. The material must be impervious to degradation by aviation fuels, motor fuels, and lubricants.

1. The markings must be able to be applied in temperatures as low as 35°F without any special storage, preheating, or treatment of the material before application.
   a. Supply the markings with an integral, non-reflectorized black border.
2. Graded Glass Beads.
   a. The material must contain a minimum of 30% intermixed graded glass beads by weight. The intermixed beads must conform to Federal Specification TT-B-1325D, Type I, gradation A and Federal Specification TT-B-1325D, Type IV.
   b. The material must have factory applied coated surface beads in addition to the intermixed beads at a rate of one lb (0.45 kg) (±10%) per 10 square feet (1 square meter).

Table 620-2.2d: Preformed Thermoplastic Bead Gradation

Size Gradation		Retained, %	Passing, %
U.S. Mesh	µm		
12	1700	0 - 2	98 - 100
14	1400	0 - 3.5	96.5 - 100
16	1180	2 - 25	75 - 98
18	1000	28 - 63	37 - 72
20	850	63 - 72	28 - 37
30	600	67 - 77	23 - 33
50	300	89 - 95	5 - 11
80	200	97 - 100	0 - 3

3. **Heating Indicators.** The material manufacturer must provide a method to indicate that the material has achieved satisfactory adhesion and proper bead embedment during application and that the installation procedures have been followed.

4. **Pigments.** Percent by weight.

   a. White:

      - Minimum 10% Titanium Dioxide, ASTM D476, type II

   b. Yellow and Colors:

      - Minimum 1% Titanium Dioxide, ASTM D476, type II
      - Organic yellow, other colors, and tinting as required to meet color standard.

5. **Prohibited Materials.** The manufacturer must certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, or any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

6. **Daylight Directional Reflectance.**

   a. White: Minimum 75% daylight directional reflectance of (relative to magnesium oxide), when tested according to ASTM E2302.

   b. Yellow: Minimum 45% daylight directional reflectance (relative to magnesium oxide), when tested according to ASTM E2302. The x and y values must be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or be consistent with the following tolerances:

x .462	x .470	x .479	x .501
y .438	y .455	y .428	y .452

7. **Skid Resistance.** The surface, with properly applied and embedded surface beads, must

provide a minimum resistance value of 45 BPN when tested according to ASTM E303.

8. **Thickness.** The material must be supplied at a nominal thickness of 65 mil (1.7 mm).

9. **Environmental Resistance.** The material must be resistant to deterioration due to exposure to sunlight, water, salt, or adverse weather conditions and impervious to aviation fuels, gasoline, and oil.

10. **Retroreflectivity.** The material, when applied according to manufacturer's guidelines, must demonstrate a uniform level of nighttime retroreflection when tested according to ASTM E1710.

11. **Packaging.** Protect the material from environmental conditions until installation.

12. **Preformed Thermoplastic Airport Pavement Marking Requirements.**

    a. The markings must be a resilient thermoplastic product with uniformly distributed glass beads throughout the entire cross-sectional area. The markings must be resistant to the detrimental effects of aviation fuels, motor fuels and lubricants, hydraulic fluids, deicers, anti-icers, protective coatings, etc. Lines, legends, and symbols must be able to be affixed to asphalt and/or Portland Cement concrete pavements using a large radiant heater. Colors must be available as required.

    b. The markings must be able to conform to pavement contours, breaks, and faults through the action of airport traffic at normal pavement temperatures. The markings must be able to fully conform to grooved pavements, including pavement grooving per Advisory Circular (AC) 150/5320-12, current version. The markings must have resealing characteristics, such that it is capable of fusing with itself and previously applied thermoplastics when heated with a heat source per manufacturer's recommendation.

c. Multicolored markings must consist of interconnected individual pieces of preformed thermoplastic pavement marking material, which through a variety of colors and patterns, make up the desired design. The individual pieces in each large marking segment (typically more than 20 feet (6 m) long) must be factory assembled with a compatible material and interconnected so that in the field it is not necessary to assemble the individual pieces within a marking segment. Obtaining multicolored effect by overlaying materials of different colors is not acceptable due to resulting inconsistent marking thickness and inconsistent application temperature in the marking/substrate interface.

d. The marking material must set up rapidly, permitting the access route to be re-opened to traffic after application.

e. The marking material must have an integral color throughout the thickness of the marking material. **]**

]

****

Thermoplastic airport markings are subject to an engineering life-cycle cost analysis prior to inclusion in specifications.

****

620-2.3 Reflective Media.

Glass beads for white and yellow paint must meet the requirements for Federal Specification TT-B-1325D **[** Type I, Gradation A **|**Type III **|**Type IV, Gradation A or Gradation B **]**.

Glass beads for red and pink paint must meet the requirements for **[** Type I, Gradation A **|**Type IV, Gradation A or Gradation B **]**.

Treat glass beads with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment. Do not use glass beads in black and green paint. Do not use Type III glass beads in red and pink paint.

****

The Engineer should insert all beads that will be used in the project. When more than one bead type is specified, the plans should indicate the bead type for each marking.

Use Federal Specification TT-B-1325D, Type I, gradation A when remarking on a frequent basis (at least every six months). Type I, gradation A beads typically yield 300 mcd/m²/lux on white markings at installation and 175 mcd/m²/lux on yellow markings at installation.

Federal Specification TT-B-1325D, Type III. Initial readings typically yield 600 mcd/m²/lux on white markings and 300 mcd/m²/lux on yellow markings at installation and once in service, the reflectance values are approximately the same as Type I beads.

Federal Specification TT-B-1325D, Type IV must be used with TT-P-1952F, Type III paint. The glass beads are larger than either Type I or Type III, thus requiring more marking material to properly anchor. The Engineer should consult with the paint and bead manufacturer on the use of adhesion, flow promoting, and/or flotation additives.

Preformed thermoplastic pavement markings should yield at least 225 mcd/m^2/lux on white markings at installation and at least 100 mcd/m^2/lux on yellow markings at installation.

****

620-3 CONSTRUCTION METHODS

620-3.1 Weather Limitations.

Painting must only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations according to paragraph 620-2.1. Discontinue painting operations when the ambient or surface temperatures does not meet the manufacturer's recommendations. Do not apply markings when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Do not apply markings when weather conditions are forecasted to not be within the manufacturers' recommendations for application and dry time.

620-3.2 Equipment.

Equipment must include: equipment needed to clean the existing surface, mechanical marking machine with automatic bead dispensing, and auxiliary hand-painting equipment. The mechanical marker must be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It must produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and apply markings of uniform cross-sections, with clear-cut edges without running or spattering and without over spray. The Contractor must calibrate the equipment for paint and beads daily, in the presence of the RPR.

620-3.3 Surface Preparation.

Immediately before application of the paint, the surface must be dry and free from dirt, grease, oil, laitance, or other contaminates that would reduce the bond between the paint and the pavement. The RPR must approve in advance, using any chemicals or impact abrasives during surface preparation. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water to remove grit or other debris left from the cleaning process.

620-3.3.1 Preparation of New Pavement Surfaces.

`[ Not used. |The area to be painted must be cleaned by broom, blower, water blasting, or by other methods the RPR approved to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface. ]`

620-3.3.2 Preparation of Pavement to Remove Existing Markings.

`[Not used. |Remove existing pavement markings, minimizing damage to the pavement surface by rotary grinding, water blasting, or by other methods the RPR approved. 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.]`

620-3.3.3 Preparation of Pavement Markings Prior to Remarking.

`[ Not used. |Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method the RPR approved. After removal, clean the surface of all residue or debris. ]` Prior to the application of markings, the Contractor must 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 manufacturer's application and surface preparation requirements, must be submitted to the RPR prior to the initial application of markings.

****

Always remove loose markings prior to remarking. Whether or not existing markings need to be removed is up to the Engineer and the Airport Operator. The type of removal method used depends upon whether loose markings or all existing markings need removing. See IPRF Report 05-01 Airfield Marking Handbook Chapter 5 Pavement Marking Removal.

Note for Existing Markings: Make plans to remark when retroreflectance of existing markings after cleaning is:
< 100 mcd/m^2/lux for white or
< 75 mcd/m^2/lux for yellow or
< 10 mcd/m^2/lux for red

****

620-3.4 Layout of Markings.

The proposed markings must be laid out in advance of the paint application. The locations of markings to receive glass beads must be indicated on the plans. **[** `The locations of markings to receive silica sand must show on the plans.` **]**

****

Glass beads improve conspicuity and the friction characteristics of markings.

****

620-3.5 Application.

A period of **[__]** days must elapse between placement of surface course or seal coat and application of the permanent paint markings. Apply paint to the locations and to the dimensions and spacing shown on the plans. Do not apply paint until the RPR approves the layout and surface condition.

****

Select the timeframe between placement of surface course or seal coat and application of the paint based on the type of surface course or seal coat in the project and environment at the project location. The typical timeframe is 30-days for volatiles and moisture vapor to dissipate.

****

The edges of the markings must not vary from a straight line more than ½ inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing must be within the following tolerances.

Table 620-3.5: Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±½ inch (12 mm)
> 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
> 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
> 60 feet (18.3 m)	±3 inch (76 mm)

Mix the paint according to the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 620-2.2a. The addition of thinner is not permitted. Glass beads must be distributed immediately after application of the paint at the locations that require glass beads. Furnish a dispenser that is designed for attachment to the marking machine and suitable for dispensing glass beads. Apply glass beads at the rate shown in Table 620-2.2a. Do not apply glass beads to black paint or green paint. Glass beads must adhere to the cured paint or all marking operations cease until corrections are made. Do not mix different bead types. Continuously monitor embedment and distribution of glass beads.

620-3.6 Application--Preformed Thermoplastic Airport Pavement Markings.

[Preformed thermoplastic pavement markings not used.]

[To ensure minimum single-pass application time and optimum bond in the marking/substrate interface, apply the materials using a variable speed self-propelled mobile heater capable of heating the marking in one pass. The heater must emit thermal radiation to the marking material in a way that the difference in temperature of 2 inches (50 mm) wide linear segments in the direction of heater travel must be within 5% of the overall average temperature of the heated thermoplastic material as it exits the heater.

The material must be able to be applied at ambient and pavement temperatures down to 35°F (2°C) without any preheating of the pavement to a specific temperature. The material must be able to be applied without the use of a thermometer. The pavement must be clean, dry, and free of debris. A non-volatile organic content (non-VOC) sealer with a maximum applied viscosity of 250 centipoise must be applied to the pavement shortly before the markings are applied. The supplier must enclose application instructions with each box/package.]

****

The Engineer makes the appropriate selection for thermoplastic markings.

****

620-3.7 Control Strip.

Prior to the full application of airfield markings, the Contractor must prepare a control strip, a minimum of [50 ft | 25 square yards] of each color and type of paint marking including beads, in the presence of the RPR. The Contractor must demonstrate the surface preparation method and all marking equipment to be used on the project. The marking equipment must demonstrate proper rate of application of paint and proper rate of application, distribution and embedment of glass beads across the full width of the marking. Markings must be evaluated for uniform appearance during darkness prior to acceptance of the control strip. The RPR must approve the control strip prior to full application of markings.

620-3.8 Retro-reflectance.

The Contractor must measure, and provide results to the RPR, reflectance with a reflectometer meeting ASTM E1710. Take a total of 6 readings over a 6 square foot area with 3 readings taken from each direction, perform sets of tests for each [1,000] square ft of each color of marking. The average must be equal to or above the minimum levels of all readings and all readings must be within 30% of each other.

****

Need to specify that sufficient tests are performed to ensure overall compliance and *to determine* if markings are uniform in appearance. White and yellow markings must be tested separately.

****

Table 620-3.8: Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m2/lux		
	White	Yellow	Red
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35

620-3.9 Protection and Cleanup.

Protect markings from damage until dry. Protect all surfaces from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor must remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the RPR's satisfaction. The Contractor must dispose of these wastes in strict compliance with all applicable state, local, federal environmental statutes, and regulations.

620-4 METHOD OF MEASUREMENT

620-4.1 The quantity of surface preparation is **[** the number of square feet (square meters) for each type of surface preparation specified in paragraph 620-3.3 **|** lump sum **]**.

620-4.2 The quantity of markings is **[** by the number of square feet (square meters) of painting **|** by lump sum **]**.

620-4.3 The quantity of reflective media is **[** the number of lbs (km) **|** lump sum **]** of reflective media.

620-4.4 **[** The quantity of temporary markings is **[** the number of square feet (square meters) of painting **|** lump sum price **]** performed according to the specifications and accepted by the RPR. Temporary marking includes surface preparation, application, and complete removal of the temporary marking. **|** Temporary markings not required. **]**

[620-4.5 The quantity of preformed markings is **[** the number of square feet (square meters) of preformed markings **|** lump sum **]]**.

****

Separate pay items for surface preparation, marking, and reflective media is recommended, however on small jobs, lump sum pay items is acceptable.

****

620-5 BASIS OF PAYMENT

620-5.1 This price is full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item complete in place and accepted by the RPR according to these specifications.

620-5.1.1 Payment for surface preparation is made at the contract price for **[** the number of square feet (square meters) for each type of surface preparation specified in paragraph 620-3.3 **|** lump sum **]**.

620-5.1.2 Payment for markings is made at the contract price for [the number of square feet (square meters) of painting and the number of lbs (km) of reflective media | by the number of square feet (square meters) of painting | by lump sum].

620-5.1.3 Payment for reflective media is made at the contract unit price for [the number of lbs (km) of reflective media | lump sum].

620-5.1.4 Payment for temporary markings is made at the contract price for [the number of square feet (square meters) of painting | lump sum price]. This price is full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item. [Temporary markings are not required.]

[620-5.1.5 Payment for preformed markings is made at the contract price for [the number of square feet (square meters) of preformed markings | lump sum price].]

Payment is made under:

Item P-620-5.1a	Surface Preparation [per square foot (square meter)	lump sum]
Item P-620-5.2b	Marking [per square foot (square meter)	lump sum]
Item P-620-5.3c	Reflective Media [per pound (km)	lump sum]
Item P-620-5.4d	Temporary runway and taxiway marking [per square foot	per square meter	lump sum].
[Item 620-5.5.1	Preformed markings per [the number of square feet (square meters) of preformed markings	lump sum price].]

620-6 REFERENCES

620-6.1 This list of publications forms 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 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

Item P-621 Saw-Cut Grooves

****

Saw-cut grooves are recommended for primary and secondary runways at commercial service airports and for a non-commercial service airport if the runway serves turbojet aircraft and the runway length is 5000 feet or more. Coordinate with the local FAA Airports Office for eligibility.

Edit specifications to provide either square cut or trapezoidal cut grooves. Document justification to use trapezoidal grooves in engineers report. Contractors may not have ability to create trapezoidal grooves in all areas. Edit specification to provide for either square cut grooves or trapezoidal cut grooves.

****

621-1 DESCRIPTION

621-1.1 This item consists of constructing saw-cut grooves to minimize hydroplaning during wet weather, providing a skid resistant surface according to these specifications and at the locations shown on the plans, or as directed by the Resident Project Representative (RPR).

621-2 CONSTRUCTION METHODS

621-2.1 Procedures.

The grooves must be continuous for the entire runway length. They must be saw-cut transversely (perpendicular to centerline) in the runway and high-speed taxiway pavement to not less than **[** `10 feet (3 m)` **]** from the pavement edge to allow adequate space for equipment operation.

The saw-cut grooves must meet the following tolerances. The tolerances apply to each day's production and to each piece of grooving equipment used for production. The Contractor is responsible for all controls and process adjustments necessary to meet these tolerances.

Table 621-2.1: Groove Size and Tolerance.

Type		Size (inches)	Tolerances	QA Tolerances[1]		
				at least 90%	at least 60%	no more than 10%
Square	Depth	1/4	± 1/16	≥ 3/16	≥ 1/4	> 5/16

Type		Size (inches)	Tolerances	QA Tolerances[1]		
				at least 90%	at least 60%	no more than 10%
	Width	1/4	± 1/16	≥ 3/16	≥ 1/4	> 5/16
	Spacing	1 1/2	+0 -1/8			
Trapezoidal	Depth	1/4	± 1/16	≥ 3/16	≥ 1/4	> 5/16
	Top Width	1/2	± 1/16	≥ 7/16	≥ 1/2	> 9/16
	Bottom Width	1/4	± 1/16	≥ 3/16	≥ 1/4	> 5/16
	Spacing	2 1/4	+0 -1/8			

[1] Percent of measurements for each set of measurements during production.

621-2.1.1 Alignment Tolerance.

The grooves must not vary more than ±1½ inch (38 mm) in alignment for 75 feet (23 m) along the runway length, allowing for realignment every 500 feet (150 m) along the runway length.

621-2.1.2 Groove Tolerance.

Grooves must meet the tolerances in Table 621-2.1.

Grooves must not be closer than 3 inches (8 cm) or more than 9 inches (23 cm) from transverse joints in concrete pavements. Grooves must not be closer than 6 inches (150 mm) and no more than 18 inches (0.5 m) from in-pavement light fixtures. Where neoprene compression seals have been installed and the compression seals are recessed sufficiently to prevent damage from the grooving operation, grooves may be continued through the longitudinal joints. Where neoprene compression seals have been installed and the compression seals are not recessed sufficiently to prevent damage from the grooving operation, grooves must not be closer than 3 inches (8 cm) or more than 5 inches (125 mm) from the longitudinal joints. Where lighting cables are installed, grooving through longitudinal or diagonal saw kerfs is not be permitted.

****

The 10-foot (3 m) distance from the pavement edge allows adequate space for equipment operation. Grooving to within one or two feet (0.3 to 0.6 m) from the pavement edge may be possible when adequate paved shoulder area is available.

Coordinate grooving limits with the airport Owner and military service when an arresting gear is located on the runway.

The Engineer may require a written report from the Contractor indicating how many times production was adjusted including blade replacement.

Surface variability may require more testing than the minimum of three per day per grooving machine.

****

621-2.2 Environmental Requirements.

Grooving operations are not permitted when freezing conditions prevent the immediate removal of debris and/or drainage of water from the grooved area. Discharge and disposal of waste slurry is the Contractor's responsibility.

621-2.3 Control Strip.

Groove a control strip of two adjacent passes and the width of the [runway] [and rapid exit taxiway]. Conduct the control strip in the presence of the RPR [at the beginning or end of the runway | in an area approved by the RPR]. Conduct a separate control strip for each piece of grooving equipment. Demonstrate the setup and alignment process, the grooving operation, and the waste slurry disposal.

During the control strip take and record six random groove measurements, for each pass, for depth, per zone. Each zone is identified in paragraph 621-3.1. Additionally, per zone, record two measurements each for center-to-center spacing (one measurement between grooves within the same cutting head, and one measurement between two separate passes), width, and alignment, per pass. Conduct a visual inspection for correct groove shape, stable grooves and damaged joint material. Include all measurements in the test section report and average all depth measurements across all zones, per cutting head. Prior to full production the Contractor must construct a control strip that meets the tolerances in paragraph 621-2.1.2.2 for average depth measurement, average width measurement and average center to center spacing. The RPR must approve the control strip before full grooving production.

621-2.4 Existing Pavements.

Bumps, depressed areas, bad or faulted joints, and badly cracked and/or spalled areas in the pavement must not be grooved until such areas are adequately repaired or replaced.

621-2.5 New Pavements.

New asphalt and cement concrete pavements must be allowed to cure for a minimum of 30 days before grooving, to allow the material to become stable enough that grooves can be cut without damaging the pavement. The RPR can waive the 30-day minimum if the grooving Contractor can demonstrate with a control strip that grooving can be performed without spalling, tearing or raveling of the groove edges. Complete all grade corrections prior to grooving. Stop grooving operations if there is spalling, tearing or raveling of the groove edges.

621-2.6 Grooving Machine.

Provide a grooving machine that is power driven, self-propelled, specifically designed and manufactured for pavement grooving, and has a self-contained and integrated continuous slurry vacuum system as the primary method for removing waste slurry. The grooving machine must be equipped with diamond-saw cutting blades, and capable of making at least 18 inches (0.5 m) in width of multiple parallel grooves in one pass of the machine. The cutting blades must be able to cut the grooves to the shape of grooves in one pass of the machine. The cutting head must not contain a mixture of new and worn blades or blades of unequal wear or diameter. Match the blade type and configuration with the hardness of the airfield pavement. Provide wheels on the grooving machine that will not scar or spall the pavement. Provide the machine with devices to control depth of groove and alignment.

Water for the grooving operation must be provided by the Contractor.

621-2.7 Clean-up.

During and after installation of saw-cut grooves, the Contractor must remove from the pavement all debris, waste, and by-products generated by the operations to the RPR’s satisfaction. Cleanup of waste material must be continuous during the grooving operation. Flush debris produced by the machine to the edge of the grooved area or pick it up as it forms. Accomplish all flushing operations in a manner to prevent erosion on the shoulders or damage to vegetation. Dispose of waste material in an approved manner. Do not allow waste material to enter the airport storm sewer system. The Contractor must dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes, and regulations.

621-2.8 Repair of Damaged Pavement.

If grooving is causing excessive spalling, stop grooving and repair pavement as directed by the RPR. Do not resume grooving until adjustments to grooving equipment and/or procedures are approved by the RPR.

[621-2.9 Production Rate.

The Contractor must furnish sufficient equipment to groove [square yards] of pavement [per hour | per day].]

****

The Engineer may wish to specify a production rate depending on schedule. Delete paragraph if not used.

****

621-3 ACCEPTANCE

621-3.1 Acceptance Testing.

Grooves are accepted based on the results of zone testing. The RPR performs all acceptance testing necessary to determine conformance with the groove tolerances specified. Use a tool or mold capable of measuring width and spacing of grooves in increments of ⅙ inch (2 mm). [`For trapezoidal grooves measure the width at pavement surface and width at bottom of groove to the nearest` $^{1}/_{16}$ `inch using a tool or mold.`] Use a tool capable of measuring depth of groove to $^{1}/_{32}$ inch (1 mm).

At least three times during each day of production, the RPR will measure grooves in six zones across the pavement width for each cutting head on each piece of grooving equipment used.

The six zones are:

1. Zone 1L	Centerline to 5 feet (1.5 m) left of centerline
2. Zone 1R	Centerline to 5 feet (1.5 m) right of centerline
3. Zone 2L	5 feet (1.5 m) to 25 feet (7.5 m) left of centerline
4. Zone 2R	5 feet (1.5 m) to 25 feet (7.5 m) right of centerline
5. Zone 3L	25 feet (7.5 m) to edge of grooving left of centerline
6. Zone 3R	25 feet (7.5 m) to edge of grooving right of centerline

At a random location within each zone, measure five consecutive grooves sawn by each cutting head on each piece of grooving equipment for width, depth, and spacing. The five consecutive measurements must be located about the middle blade of each cutting head ±4 inches (100 mm). Make measurements along a line perpendicular to the grooves. Also check the center-to-center spacing of the grooves between passes of the cutting head for each zone. The grooves must meet the tolerances in paragraph 621-3.1 for width, depth and center-to-center spacing.

Adjust production when QA tolerances are not met in any zone.

621-4 METHOD OF MEASUREMENT

621-4.1 The quantity of grooving is the number of square yards (square meters) of grooving performed according to the specifications and accepted by the RPR, per paragraph 621-3.1.

621-5 BASIS OF PAYMENT

621-5.1 Payment for Saw-cut Grooving.

Payment for saw-cut grooving is made at the contract unit price per square yard (square meter) for saw-cut grooving. This price is full compensation for furnishing all materials, and for all preparation, delivering, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item P-621-5.1	Grooving, unit price per square yard (square meter)

621-6 REFERENCES

621-6.1 This list of publications forms 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 150/5320-12	*Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*

END OF ITEM P-621

Part 9 – Surface Treatments

Item P-623 Emulsified Asphalt [Slurry | Spray] Seal Coat

****

The performance of a seal coat product is contingent on the pavement condition at the time of application. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of the distresses, and by determining the pavement condition index (PCI) according to Advisory Circular (AC) 150/5380-7, *Airport Pavement Management Program (PMP)*, and ASTM D5340. A typical asphalt pavement candidate is one with a structural condition index (SCI) deduct value of less than ten and a PCI equal to or greater than 60.

When used on any runway or taxiway where aircraft operate, it must include friction testing. Runways and taxiways require friction tests before opening pavement to aircraft traffic.

When choosing which type of seal coat, consider that the larger the aggregate, the greater the chance for creation of foreign object debris (FOD). The slurry seal will not stop shrinkage and other large thermal cracks from reflecting back through the new slurry surface.

This specification has two options:

(1) Emulsified Asphalt Spray Seal. Emulsified Asphalt Spray Seal is a polymer modified emulsified asphalt with or without a sand aggregate. This seal coat is approved for use on all pavements, without weight restrictions. When spray seal is used on pavements where aircraft operate, it must have an aggregate. The spray seal without aggregate may be used on blast pads and shoulders.

(2) Emulsified Asphalt Slurry Seal. Emulsified Asphalt slurry seal may be appropriate on pavements serving aircraft under 60,000 lbs (27216 kg). Slurry seal uses a thicker, aggregate-rich mix while seal coating is a thinner, smoother application.

The Engineer must verify the selected materials comply with federal, state, and local authority requirements.

****

623-1 DESCRIPTION

623-1.1 This item consists of the application of a polymer modified, asphalt emulsion seal coat composed of an emulsion of binders prepared from crude petroleum, mineral fillers, water, and polymer, mixed with or without aggregate, applied to an existing, previously prepared asphalt surface.

623-1.2 Spray Seal Application Rate per Square Yard (Square Meter).

623-1.2.1 Spray Seal Application Rate.

Apply the approximate amounts of seal coat per square yard (square meter), as provided in Table 623-1.2a. Actual application rates vary within the range specified to suit field conditions, which the Resident Project Representative (RPR) must approve from the control strip. A minimum of two coats of spray seal are required. When possible, apply the second seal coat perpendicular to the direction of the first seal coat.

Table 623-1.2.1: Spray Seal Application Rate

	Two Coat Application	Three Coat Application
First Coat	[0.10 - 0.20]	[0.10 - 0.20]
Second Coat	[0.10 - 0.20]	[0.10 - 0.20]
Third Coat	-	[0.08 - 0.15]
Total Application	0.20 - 0.40	0.28 - 0.55

****

The material quantities in Table 623-1.2a cover an average range of conditions. The Engineer should select the application rate reflecting the local condition of the pavement such as surface texture, porosity, and age of the asphalt pavement to be sealed.

If the pavement requires additional coats, application rates must not exceed 0.20 gal/yd^2/coat (0.91 liters/m^2/coat).

****

623-1.2.2 Slurry Seal Application Rate.

Apply the approximate amounts of slurry seal per square yard (square meter) t, as provided in Table 623-1.2b, Slurry Seal Application Rate. The actual application rates vary within the range specified to suit field conditions. The RPR must approve from the control strip test areas.

Table 623-1.2.2: Slurry Seal Application Rates

Mix Measurement	Type IA (pounds)	Type I (pounds)
Mixture per square yard	8 - 12	10 - 16

623-2 MATERIALS

623-2.1 Aggregate.

623-2.1.1 Spray Seal.

The aggregate must consist of sound, durable, crushed igneous type stone (crushed basalt, granite, trap rock, etc.), clean washed masonry sand, or clean washed manufactured silica sand, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from coatings of clay, organic matter, and other deleterious materials. The aggregate must have a minimum Mohs hardness of 6. Gradation must be 20/30 or 40/70 mesh.

623-2.1.2 Slurry Seal.

Aggregate must be 100% crushed manufactured sand, slag, crusher fines, crushed stone, or a combination. The aggregate for slurry seals must meet the requirements in Tables 623-2.1a and 623-2.1b.

Table 623-2.1a: Aggregate Characteristics

Test	Standard	Range
Fractured Faces		100%
Sand Equivalent	ASTM D2419	> 45
Loss	ASTM C131	< 35%
Sodium Soundness[1]	ASTM C88	≤ 12%
Magnesium Sulfate Soundness[1]	ASTM C88	≤ 20%

[1] Only need to run either Sodium Soundness or Magnesium Soundness. Report results after five cycles.

The combined aggregate must conform to the gradation in Table 623-2.1b when tested according to ASTM C136 and ASTM C117.

Table 623-2.1b: Gradation of Aggregates

Sieve Size	Percent by Weight Passing Sieve	Production Tolerances
	Type *	
⅜ inch (9.5 mm)	*	±3%
No. 4 (4.75 mm)	*	±3%
No. 8 (2.36 mm)	*	±5%
No. 16 (1.18 mm)	*	±5%
No. 30 (600 µm)	*	±5%
No. 50 (300 µm)	*	±3%
No. 100 (150 µm)	*	±2%
No. 200 (75 µm)	*	±2%
Residual asphalt content percent dry weight of aggregate	*	

****

The Engineer selects the gradation and inserts it in Table 623-2.1b.

Table 623-2.1b: Gradation of Aggregates

Sieve Size	Percent by Weight Passing Sieve	
	Type I	**Type IA**
⅜ inch (9.5 mm)	100	100
No. 4 (4.75 mm)	100	98 - 100
No. 8 (2.36 mm)	90 - 100	85 - 95
No. 16 (1.18 mm)	65 - 90	50 - 75
No. 30 (600 µm)	40 - 65	30 - 50
No. 50 (300 µm)	25 - 42	18 - 35
No. 100 (150 µm)	15 - 30	10 - 21
No. 200 (75 µm)	10 - 20	5 - 10
Residual asphalt content percent dry weight of aggregate	10% - 16%	9% - 13.5%

Table 623-2.1b – Gradation of Aggregates. Projects with specified coarser aggregate gradations report problems with excessive tire wear. The coarser Type IA gradation provides considerable skid resistance and may be considered for most projects. Tire wear appears to be related to the amount of material passing the #4 (4.75 mm), and retained on, the #8 (2.36 mm)

sieve; with no more than 10-15% retained on the #8 (2.36 mm) sieve to minimize tire wear while maintaining sufficient friction.

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623-2.2 Emulsion Properties.

623-2.2.1 Polymer modified asphalt emulsion spray seal. Spray seal coat fortified with fillers created from binders prepared from crude petroleum must meet the properties in Table 623-2.2a.

Table 623-2.2a: Polymer Modified Asphalt Emulsion Spray Seal Properties[1]

Property	Method	Characteristics	
		Minimum	Maximum
Density at 77°F (25°C), lb/gal (g/mL)	ASTM D244	9 (1.0)	12 (1.5)
Residue by evaporation, %	AASHTO T59	44	65
Water content, %	AASHTO T59	35	56
Ash content of residue, %	AASHTO T111	40	60
Uniformity		Uniform homogeneous consistency.	
Wet film continuity		No separation, coagulation, or settlement that cannot be overcome by moderate agitation.	
Resistance to heat		No blistering, sagging, or slipping.	
Resistance to water		No loss of adhesion and no blistering or tendency to re-emulsify.	
Flash point		No tendency to flash.	
Flexibility		No flaking, cracking, or loss of adhesion to the substrate.	
Polymer modification		Minimum 3% by weight of asphalt binder, maximum 5%	

[1] For water content testing, use ASTM Test Method D95. For flash point testing, use 93 95 Test Method D93. For other properties, use AASHTO T59 and T111

The Contractor must provide a copy of the manufacturer's Certificate of Analysis (COA) for material delivered to the project. If the asphalt emulsion is diluted at other than the manufacturer's facility, the Contractor must provide a supplemental COA from an independent laboratory verifying the asphalt emulsion properties. The RPR must receive and approve material before it is applied. The furnishing of the vendor's certified test report for the asphalt material must not be interpreted as a basis for final acceptance.

The Contractor must submit samples of the emulsion proposed for use. The manufacturer's COA may be subject to verification by testing of the material delivered for the project's use. The manufacturer must choose the type of polymer used for modification of the spray seal. The polymer modifier must be incorporated in the manufacturing process. The Contractor must submit manufacturer's technical data, the manufacturer's certification indicating that the polymer meets the requirements of the specification, and the manufacturer's approval of its use, to the RPR. Add a minimum of 3% polymer, by weight of the asphalt binder, to the spray or slurry seal.

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Polymers improve the coating's final properties. These properties can include durability, drying time, color uniformity, and/or length of cure time. Polymers may also be used to modify the wet mixture's viscosity to improve aggregate suspension.

The type of polymer used should be specified by the asphalt emulsion seal coat manufacturer.

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623-2.2.2 Polymer Modified Slurry Seal Emulsified Asphalt. The emulsified asphalt must conform to the requirements of ASTM D3628. The cement mixing test is waived for these slurry type emulsions. The type of emulsified asphalt is either anionic or cationic, whichever is best suited to the aggregate and job conditions to be encountered.

The Contractor must provide a copy of the manufacturer's COA for the emulsified asphalt delivered to the project. If the asphalt emulsion is diluted at other than the manufacturer's facility, the Contractor must provide a supplemental COA from an independent laboratory verifying the asphalt emulsion properties. Add a minimum of 3% polymer to the emulsion. The COA must be provided to, and the RPR must approve before applying the emulsified asphalt. The manufacturer's COA may be subject to verification by testing the material delivered for the project's use.

623-2.3 Water.

Water from a drinking water source is suitable for mixing. Water from other sources must meet the requirements of ASTM C1602. Water must be within a temperature range of 60°F-80°F.

623-3 COMPOSITION

623-3.1 Job Mix Formula (JMF).

623-3.1.1 Spray Seal.

The mix design is developed by the manufacturer and consists of asphalt emulsion, aggregate, a minimum 3% polymer, and water.

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Spray seals applied to runways, taxiways, and parking aprons require 2-4 lbs of aggregate per gallon of polymer modified emulsion. Liquid only applications can be used on shoulders and blast pads.

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623-3.1.2 Slurry Seal.

A laboratory experienced in designing must develop slurry seal mixes and submit a signed copy by the Contractor to the RPR at least ten days prior to the start of operations. Do not place any slurry seal for payment until the RPR approves a mix design.

The laboratory report (mix design) must indicate the proportions of aggregates, mineral filler (minimum and maximum), water (minimum and maximum), polymer (%), and asphalt emulsion based on the dry aggregate weight. It must report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effects). The mix design is in effect until the RPR modifies it in writing. If the sources of materials change, establish a new mix design before the new material is used.

****

The main items of design in emulsified asphalt slurry seals are aggregate gradation, emulsified asphalt content, and consistency of the mixture. The aggregates, emulsified asphalt, and water should form a creamy-textured slurry that, when spread, flows ahead of the strike-off squeegee. This allows the slurry to flow down and fill in the pavement cracks before the strike-off passes over. Technical Bulletin (TB) No. 111, *Outline Guide Design Procedure for Slurry Seal*, and publication *A-105 Recommended Performance Guideline for Emulsified Asphalt Surry* Seal published by the International Slurry Surfacing Association (ISSA) contains information to aid designers of slurry mixes.

****

623-3.2 Mix Design Submittal.

The Contractor must submit to the RPR a complete mix design on the materials proposed for use, prepared, and certified by an approved laboratory for approval. Verify the compatibility of the aggregate, emulsion, mineral filler, and other additives by the mix design. Make the mix design with the same aggregate and grade of emulsified asphalt the Contractor provides on the project. At a minimum, Table 623-3.1 provides the required tests and values needed.

Table 623-3.1: Slurry Mix Tests

ISSA TB No.	Description	Specification
ISSA TB-100	Wet track abrasion loss one hour soak	50 g/ft^2 Max (538 g/m^2)
ISSA TB-115	Determination of Slurry System Compatibility	Pass

623-4 CONSTRUCTION METHODS

623-4.1 Worker Safety.

The Contractor must obtain a Safety Data Sheet (SDS) for both the asphalt sealer product and require workers to follow the manufacturer's recommended safety precautions. The Contractor must understand and follow all additional industry standard safety precautions regarding the storage and applications of asphalts.

623-4.2 Control Strips.

Prior to full production, the Contractor must prepare a minimum of two control strips, at varying application rates to demonstrate the material, equipment, construction process and to determine the application rate and number of coats. Strips must be a minimum of 200 feet long by a minimum of 12 feet wide on representative sections of pavement, as recommended by the RPR. If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

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For surface treatments on runway and rapid exit taxiway surfaces, include before and after testing for skid resistance.

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[Before beginning the control strip, determine the skid resistance of the existing pavement at the location where the control strip will be placed with continuous friction measuring equipment (CFME). Place control strips and `after the surface treatment has cured perform another skid resistance tests at approximately the same location as the test done on the existing pavement. Do not permit aircraft on the runway or taxiway control strips until the Contractor validates that its surface friction meets or exceeds the Maintenance Planning levels provided in AC 150/5320-12,` *`Measurement, Construction, and Maintenance of Skid-resistant Airport Pavement Surfaces`*`, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME.]`

If the control strip should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment, and place additional control strips. Do not begin full production until the RPR accepts the control strip. The surface preparation, personnel, materials, equipment, method of operation and rate of application used on the acceptable control strip must be used during production.

623-4.3 Weather Limitations.

Only apply the seal coat when the existing pavement surface is dry and the weather is not foggy or rainy, or the humidity will not allow proper curing, or the wind velocity prevents the uniform application of the material. Do not apply seal coat when dust or sand is blowing or when rain is anticipated within eight hours of application completion. The atmospheric temperature and the pavement surface temperature must both be above 50°F (10°C) and rising and is expected to remain above 50°F (10°C) for 24 hours, unless the RPR directs otherwise. If emulsion gets on any building, light, sign, or pavement marking, promptly clean. If cleaning is not to the RPR's satisfaction, the Contractor must replace any light, sign or marking with equivalent equipment at no cost to the Owner.

623-4.4 Equipment and Tools.

The Contractor must furnish all equipment, tools, and machinery necessary for the performance of the work.

623-4.4.1 Spray Seal Distributors.

Distributors or spray units used for the seal coat application must be self-propelled and capable of uniformly applying 0.15-0.55 gallons per square yard of material, or the width of application. Distributors must be equipped with removeable manhole covers, tachometers, pressure gauges, and volume measuring devices. The mixing tank must have a mechanically powered full sweep mixer with sufficient power to move and homogenously mix the entire content of the tank. The distributor must be equipped with a positive placement pump so constant pressure can be maintained to the spray nozzles.

623-4.4.2 Spray Seal Mixing Equipment.

The mixing unit must be able to accurately deliver a predetermined proportion of aggregate, water, and polymer modified asphalt emulsion to the mixing charger, and of continuously discharging a uniform, thoroughly, mixed product. The mixing unit must have the capability of discharging the material to the spreader box or applicator without segregation.

623-4.4.3 Spray Seal Spreading Equipment.

The equipment used to apply the seal coat, must have continuous agitation or mixing capabilities to maintain homogeneous consistency of the seal coat throughout the application process. Spray equipment must be able to mix and spray seal coat with aggregate added. Self-propelled squeegee equipment with mixing capability must have at least two squeegee or brush devices (one behind the other) to ensure adequate distribution and penetration of seal coat surface treatment into pavement surface. Hand squeegees and brushes are acceptable in areas where the use of mechanized equipment is not practicable. Use a power broom or blower for removing loose material from the surface prior to spray seal application.

623-4.4.4 Slurry Mixing Equipment.

The machine must be specifically designed and manufactured to lay slurry seal. Mix the material with either a truck mounted or continuous run self-propelled slurry seal mixing machine. Either type machine must be able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, and water to a revolving mixer and discharge the mixed product on a continuous flow basis. The machine must have a minimum capacity to mix and apply 5 tons (4500kg) of slurry. Calibrate proportioning devices prior to placing the slurry seal.

If continuous run equipment is used, the machine must be equipped to allow the operator full control of the forward and reverse speeds of the machine during application of the slurry seal, with a self-loading device, with opposite side driver stations, all part of original equipment manufacturer (OEM) design.

Pre-wet the aggregate immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber must be able to thoroughly blend all ingredients. Equip the mixing machine with a fines feeder that provides an accurate metering or method to introduce a predetermined proportion of mineral filler into the mixer as the aggregate is fed into the mixer.

Equip the mixing machine with a water pressure system and fog-type spray bar adequate for complete fogging of the surface with 0.05 to 0.10 gallons water per square yard (0.23 to 0.45 liter per square meter) preceding the spreading equipment.

623-4.4.5 Slurry Spreading Equipment.

Uniformly spread the mixture using a conventional surfacing spreader box attached to the mixer. Provide a front seal to ensure no loss of the mixture at the surface contact point. The rear seal acts as the final strike-off and must be adjustable. Design and operate the spreader box and rear strike-off to produce a free flow of material of uniform consistency. The spreader box must provide suitable means to shift the box to compensate for variations in the pavement geometry. A burlap drag or other approved screed may be attached to the rear of the spreader box to provide a uniform mat.

623-4.5 Asphalt Pavement Surface Preparation

Clean the pavement surface immediately prior to placing the seal coat so that it is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease by scrubbing with a detergent, then wash thoroughly with clean water. Any additional surface preparation, such as crack repair, must be according to Item P-101.

[623-4.5.1 New Asphalt Pavement Surfaces.

Allow new asphalt pavement surfaces to cure so no concentration of oils is on the surface. A period of at least 30 days at 70°F (21°C) daytime temperatures must elapse between the placement of a hot mixed asphalt concrete surface course and the seal coat application.

Perform a water-break-free test to confirm that the surface oils have degraded and dissipated. (Cast approximately one gallon (4 liters) of clean water out over the surface. The water should sheet out and wet the surface uniformly without crawling or showing oil rings.) If signs of crawling or oil rings are apparent on the pavement surface, allow time for additional curing and retesting of the pavement surface prior to treatment.]

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If the application is on new pavement surfaces, include paragraph 623-4.5.1 above.

****

623-4.6 Emulsion Mixing.

The Contractor must ensure the mixture is homogeneous without balling or lumping. Continue to agitate the seal coat mixture in the mixing tank prior to and during application so that a consistent mix is available for application. Small additional increments of water may be needed to provide a workable consistency, but in no case is the water content to exceed the specified amount.

623-4.7 Application of Seal Coat.

623-4.7.1 Spray Seal.

1. Apply the spray seal coat with at least two coats of material. The first coat must be dry prior to the second coat application, or subsequent coats if more than two coats are being applied. If possible, apply the second coat perpendicular to the first coat.
2. During all applications, protect the surfaces of adjacent structures from spatters or marring. Promptly clean any seal cost material that gets on structures, lights, or signs. If cleaning is not satisfactory to the RPR, the Contractor must replace any light, sign, or marker with equivalent equipment at no cost to the Owner.
3. Traffic is not permitted until the seal coat has thoroughly cured for approximately 24 hours.
4. Lightly broom or squeegee areas of ponds or puddles greater than ½ inch (12 mm) until the surface is free of excess material.

623-4.7.2 Slurry Seal.

1. Pre-wet the surface ahead of the slurry spreader box by fogging at a rate that dampens the surface with no apparent standing water.
2. The slurry mixture must reach the desired consistency when exiting the mixer.
3. Do not over or underload the spreader box. Carry enough slurry in the spreader box so that complete coverage of all surface voids and cracks is obtained. Feed sufficient slurry into the spreader box to keep a full supply across the full width of the box. Do not allow the mixture to overflow the sides of the spreader box.
4. Tow the spreader box at a slow and uniform rate not to exceed 5 miles per hour (8 km per hour).
5. Do not allow lumping, balling, unmixed aggregate, or segregation of emulsion and fines from the coarse aggregate. If the coarse aggregate settles to the bottom of the mix, remove the slurry from the pavement surface. Do not allow the emulsion to break in the spreader box.
6. The finished surface must not have more than four tear or drag marks greater than ½-inch (12 mm) wide and 4 inches (100 mm) long in any 12-foot (3.7-m) by 22-foot (25-square meter) section. It must not have any tear or drag marks greater than 1 inch (25 mm) wide and 3 inches (15 mm) long. The finished surface must not have any transverse ripples of ¼-inch (6 mm) or more in depth, as

measured with a 12-foot (3.7 meter) straightedge laid upon the surface.

7. Lap edges of adjacent lanes a minimum of 2 inches (50 mm) with a maximum of 4 inches (100 mm) to provide complete sealing at the overlap.

8. Construction, longitudinal, and transverse joints must be neat and uniform without buildup, uncovered areas, or unsightly appearance. All joints must not have any more than ¼-inch (6 mm) difference in elevation when measured across with a 12-foot (3.7 meter) straightedge.

9. Roll slurry seal with a minimum of two full coverage passes of a self-propelled pneumatic tire roller capable of exerting minimum contact pressure of 50 lb/square inch, equipped with a water spray system as soon as the surface will support a roller without damage to the surface.

10. Protect the fresh slurry seal application with barricades and markers and permit to dry for four to 24 hours, depending on weather conditions. Repairs for any damage to uncured slurry are at the Contractor's expense.

11. In areas where the spreader box cannot be used, apply the slurry with a hand squeegee.

12. Upon completion of the work, the seal coat must not have any holes, bare spots, or cracks through which liquids or foreign matter could penetrate to the underlying pavement. The finished surface must present a uniform and skid resistant texture satisfactory to the RPR. Remove all wasted and unused material and all debris from the site prior to final acceptance.

13. Upon completion of the project, the Contractor must sweep the finished surface with a conventional power rotary broom, to remove any potential loose material from the surface. Dispose of the material removed by sweeping in a manner satisfactory to the RPR.

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The cured slurry must have a homogeneous appearance, fill all cracks, adhere firmly to the surface, and have a skid resistant texture. The slurry seal will not stop shrinkage and other large thermal cracks from reflecting back through the new slurry surface.

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623-5 QUALITY CONTROL (QC)

623-5.1 Application Rate.

The rate of application of the asphalt emulsion must be verified at least twice, daily. The Contractor must furnish the RPR the results daily.

623-6 MATERIAL ACCEPTANCE

623-6.1 Friction Test Runway and Rapid Exit Taxiways.

[Not used. | Friction tests according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, must be accomplished on all runway and rapid exit taxiways that received a seal coat. The Contractor must coordinate testing with the RPR who is provided the opportunity to be present during testing.

Each test includes performing friction tests at 40 mph and 60 mph (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline. Do not permit aircraft on the runway or rapid exit taxiway until testing validates that surface friction is at or above the maintenance planning friction levels in AC 150/5320-12, Table 3-2 when tested at speeds of 40 and 60 mph (65 and 95km/h), wet with approved CFME. Areas are not acceptable for traffic or payment until they are at or above the maintenance planning friction levels.]

The Contractor must provide the RPR a written report of friction test results.

623-7 METHOD OF MEASUREMENT

623-7.1 Asphalt [Slurry | Spray] Seal Coat.

The quantity of [slurry | spray] seal coat is the number of square yards [square meters] of material applied according to the plans and specifications, and accepted by the RPR.

[623-7.2 Friction testing is lump sum for all required friction testing.]

623-8 BASIS OF PAYMENT

623-8.1 Payment for [Slurry | Spray] Seal Coat.

Payment is made at the contract unit price per square yard [square meter] for the [slurry | spray] seal coat applied. This price is full compensation for all surface preparation, furnishing all materials, delivery, and application of these materials, for all labor, equipment, tools, and incidentals necessary to complete the item control strip.

[623-8.2 Friction testing - lump sum.]

Payment is made under:

Item P-623-8.1	Emulsified Asphalt [Slurry | Spray] Seal Coat – per square yard [square meter]

623-9 REFERENCES

623-9.1 This list of publications forms 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 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-M (No. 200) Sieve In Mineral Aggregates By Washing*
ASTM C131	*Standard Specification For Solvent Release Sealants*
ASTM C136	*Standard Practice For Constant-Amplitude, Axial, Tension-Tension Cyclic Fatigue Of Continuous Fiber-Reinforced Advanced Ceramics At Ambient Temperatures*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D93	*Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester*
ASTM D95	*Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation*

ASTM D244	*Standard Test Methods and Practices for Emulsified Asphalts*
ASTM D2419	*Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate*
ASTM D3628	*Standard Practice for Selection and Use of Emulsified Asphalts*
ASTM D5340	*Standard Test Method for Airport Pavement Condition Index Surveys*

International Slurry Surfacing Association (ISSA)

ISSA A-105	*Recommended Performance Guidelines for Emulsified Asphalt Slurry Seal*
ISSA TB-100	*Laboratory Test Method for Wet Track Abrasion of Slurry Surfacing Systems*
ISSA TB-106	*Slurry Seal Consistency Template*
ISSA TB-115	*Test Method for Determination of Slurry System Compatibility*

Advisory Circulars (AC)

AC 150/5380-7	*Airport Pavement Management Program (PMP)*

Code of Federal Regulations (CFR)

29 CFR 1910.1200	*Occupational Safety and Health Standards, Toxic and Hazardous Substances, Hazard Communication*
40 CFR	*Protection of Environment*

END OF ITEM P-623

Item P-628 Gilsonite Surface Treatments

628-1 DESCRIPTION

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The performance of a seal coat product is contingent on the pavement condition at the time of application. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of the distresses, and by determining the pavement condition index (PCI) according to AC 150/5380-7, *Airport Pavement Management Program (PMP),* and ASTM D5340. A typical asphalt pavement candidate is one with a structural condition index (SCI) deduct value of less than ten and a PCI equal to or greater than 60.

When used on any pavement where aircraft operate, it must include friction testing. Friction tests are required on runways and taxiways before pavement can be opened to aircraft traffic.

When choosing which type of seal coat, consider that the larger the aggregate, the greater the chance for foreign object debris (FOD) creation.

This specification covers the requirements for cationic polymer modified emulsified gilsonite-modified asphalt surface treatments.

Asphalt Seal Coat products assist in pavement preservation by reducing the rate of pavement oxidation.

Diluted – A cationic gilsonite-modified emulsion with either two-parts concentrated asphalt material to one-part hot water (2:1) or one-part concentrated asphalt material to one-part hot water (1:1), with polymer (minimum 1% to up to 3% by volume) and with an aggregate option (up to 0.5 pound per square yard).

Concentrated – A cationic gilsonite-modified concentrate emulsion (no dilution), with polymer (minimum 5.0% by volume) and aggregate (1.5 lbs to 3.5 lbs per square yard).

Diluted treatments are suitable for all runways with the application of suitable aggregate to maintain adequate surface friction.

Concentrated treatments may be used on all runways serving aircraft less than 60,000 lbs (27,200 kg). Use on RW serving aircraft greater than 60,000 lbs or on RW with grooving requires FAA approval with a MOS.

Both diluted and concentrated treatments are suitable for airfield secondary and tertiary pavements including taxiways, shoulders, overruns, roads, and parking areas, as well as other general applications.

When limited time is available for curing of seal coat, Item P-628-R Gilsonite Modified Asphalt Rapid Cure Seal Coat is an option if permitted by local and state environmental requirements. See Item P-628-R Gilsonite Modified Asphalt Rapid Cure Seal Coat.

Note: Curing time is impacted by temperature and humidity. Curing time under recommended weather conditions is 4-24 hours. High humidity may extend curing time.

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628-1.1 This item consists of the spray application of a cationic emulsified gilsonite-modified asphalt surface treatment composed of an emulsion of natural and refined asphalt materials, polymer additive, and water, with the simultaneous application of a suitable aggregate to maintain adequate surface friction to areas designated on the project plans. The terms seal coat, asphalt sealer, and surface treatment are interchangeable.

****

The Engineer must indicate locations on the plans for each treatment application, including dilution rate (if diluted) and aggregate use. Aggregate is required on all surfaces where aircraft will operate.

The surface treatment's performance is contingent on the pavement condition at application time. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of its distresses, and determining the pavement condition index (PCI), according to AC 150/5380-7, *Airport Pavement Management Program (PMP),* and ASTM D5340. A typical asphalt pavement candidate is one with a structural condition index (SCI) deduct value of less than 10 and PCI greater than 50, depending on weathering and raveling distresses.

Concentrated: Typically apply concentrated treatment when the surface has moderate to high severity weathering, raveling, highly distressed surfaces, as defined by ASTM D5340; generally, when PCI is equal to or greater than 50 on a scale of 100, and an average surface texture depth of at least two mm (ASTM E965 per a Sand Patch Test result of approximately eight inches to 15 inches via 100 milliliters of filler media).

2:1 Diluted: Typically apply 2:1 diluted treatment when the surface has low to moderate weathering, as defined by ASTM D5340, moderately distressed surfaces, and on grooved runways; generally, when PCI is greater than 60.

1:1 Diluted: Typically apply 1:1 dilution on new or dense pavement or to pavements with low to no weathering.

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628-2 MATERIALS

628-2.1 Gilsonite-Modified Asphalt.

The asphalt material base residue must not contain any less than 20% gilsonite, or uintaite, and not contain any tall oil pitch or coal tar material. Concentrate asphalt emulsion (undiluted, with no polymer) will meet the properties in Table 628-2.1a.

Table 628-2.1a: Asphalt Emulsion Properties

Properties	Specification	Limits		
		Concentrate	**2:1**	**1:1**
Saybolt Furol Viscosity [1]	ASTM D7496	20 – 100 sec	20 – 100 sec	20 – 100 sec
Rotational Paddle Viscometer [1]	ASTM D7226	80 – 250 mPa	80 – 250 mPa	80 – 250 mPa
Residue by Distillation or Evaporation	ASTM D6997, ASTM D6934	56% (min)	38% (min)	28.5% (min)
Sieve Test	ASTM D6933	0.1% (max)	0.1% (max)	0.1% (max)
24-hour Stability	ASTM D6930	1% (max)	1% (max)	1% (max)
5-day Settlement Test	ASTM D6930	5.0% (max)	5.0% (max)	5.0% (max)
Particle Charge [2]	ASTM D7402	Positive, 5.5 pH (max)	Positive, 5.5 pH (max)	Positive, 5.5 pH (max)

[1] Only one test is required: Rotational Paddle Viscometer or Saybolt Furol Viscosity. Viscosity at 77°F (25°C).

[2] [pH may be used in lieu of the particle charge test, which is sometimes inconclusive in slow setting, asphalt emulsions.]

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The Engineer must select the polymer rate(s) for the project.

For diluted treatments, the minimum rate is 1% polymer (polymer latex volume by asphalt emulsion volume). Additional polymer may be added at the Engineer's discretion based on the subject pavements.

Additional polymer provides increased durability, color retention, and other benefits. Note: Increased polymer rates may require more aggregate to attain minimum friction safety levels. Consult the emulsion manufacturer for more information.

For concentrated treatments, the minimum rate is 5% polymer.

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The cationic asphalt emulsion must not contain any less than 20% gilsonite, or uintaite, and **[** 3.5% **]** percent polymer. The polymer-modified emulsion residue must meet the properties in Table 628-2.1b.

Table 628-2.1b: Tests on Polymer Modified Residue from Distillation or Evaporation [1]

Properties	Specification	Limits
Solubility in TCE	ASTM D2042	97.5% minimum
Viscosity at 135°C	ASTM D4402	2000 cPs maximum
Softening Point °C	ASTM D36	50 minimum
Penetration 25°C, dmm	ASTM D5	15 – 50
Elastic Recovery 25°C	ASTM D6084	25% - 75%
Ductility 25°C, cm	ASTM D113	10 – 50
Chemical Composition	ASTM D2007 [2]	
Saturates		10% maximum
Aromatics		15% minimum
Polar Resin Compounds		25% minimum
Asphaltenes		15% to 25%

[1] Recover residue via ASTM D6934, ASTM D6997, ASTM D6934, ASTM D7994, or ASTM D7403(b).

[2] ASTM D2007/D4124. Alternate method for SARA analysis: asphaltenes and maltenes separated in n-heptane, maltene fractions determined via TLC-FID (iatroscan).

628-2.2 Polymer.

The manufacturer must certify that the polymer possesses the appropriate characteristics to perform well in the surface treatment system. The polymer must meet the properties in Table 628-2.2.

Table 628-2.2: Polymer Properties

Properties	Limits
Solids Content, % by weight	47 to 65
Weight, lbs/gal (kg/L)	8.0 to 9.6 (1.07-1.17)
pH	3.0 to 5.5
Particle Charge	Cationic
Mechanical Stability	Excellent
Film Forming Temperature, °C	0°C, minimum
Tg, °C	10°C, maximum

The manufacturer must provide a copy of the Certificate of Analysis (COA) for the polymer used in the treatment. The Contractor includes the COA with the emulsified asphalt COA when submitting to the RPR.

****

If concentrated treatment, select [`The asphalt emulsion must not be diluted.`].

If diluted treatment, delete [`Do not dilute the asphalt emulsion`]. Select the dilution rate(s) for the various treatment area(s) and note the dilution rate per area(s) on the plans.

Recommended dilution rate is 1:1 for most pavements, new pavements, and pavements with low or no weathering distress. 2:1 is recommended for rough or coarse surfaces or where pavement is highly oxidized or cracked.

Curing time is impacted by temperature and humidity. Curing times are generally 8-24 hours under recommended application conditions. Extend curing times with high humidity conditions.

****

628-2.3 Asphalt Emulsion Dilution.

[Do not dilute the asphalt emulsion.]

[The asphalt emulsion, when diluted by volume [two parts concentrated asphalt material to one-part hot water (2:1) | one-part concentrated asphalt material to one-part hot water (1:1)]. Diluted asphalt emulsion must pass pumping stability, by pumping one pint (475 ml) of emulsion through a ¼-inch (6 mm) gear pump operating 1750 rpm for ten minutes with no significant separation or coagulation.]

The Contractor must provide a copy of the manufacturer’s COA for the emulsion delivered to the project. The Contractor must provide the RPR the COA, who must approve it before applying the emulsion. The manufacturer’s COA may be subject to verification by testing the emulsion delivered for the project’s use. If the emulsion is not delivered directly from the manufacturer to the project, the Contractor is responsible for verifying asphalt emulsion properties.

****

For concentrated treatment, the pumping test is not required.

****

628-2.4 Water.

[Not Applicable |Water from a drinking water source is suitable for mixing and curing. Water from other sources must meet the requirements of ASTM C1602. Water used in making and diluting the emulsion must meet the `requirements in Table 628-2.4. Water must be a minimum of 140°F (60°C) prior to adding to emulsion. ]`

Table 628-2.4: Water Properties

Properties	Limits
Calcium Hardness	90 ppm
Magnesium Hardness	15 ppm
Deleterious iron, sulfates, and phosphates	7ppm maximum
Organic Byproducts	Less than 1ppm

628-2.5 Storage for Asphalt Emulsion Treatments.

Store and handle the asphalt material between 50°F - 160°F (10°C - 70°C). When temperatures are below 50°F, store the asphalt material in a heated tank. Storing diluted emulsions onsite may require agitation to restore proper consistency.

628-2.6 Aggregate.

The aggregate must be a manufactured, dry, clean, dust and dirt free, sound, durable, and angular-shaped aggregate. The aggregate must meet the aggregate characteristics and gradations indicated in Tables 628-2.6a and 628-2.6b.

Table 628-2.6a: Aggregate Characteristics

Test	Standard	Range
Fractured Faces		100%
SiO2		55% minimum
CaO		3% maximum
Micro-Deval	ASTM D7428	15% max
Magnesium Sulfate Soundness	ASTM C88	5% max
Aggregate Angularity	ASTM C1252 – Test Method A	42% min
Moisture Content (%)	ASTM C566	2% max
Bulk Dry Specific Gravity	ASTM C128	2.6 – 3.0
Absorption (%)	ASTM D2216	3% max
Mohs Hardness	Mohs Scale	7 min

Table 628-2.6b: Aggregate Gradation

	Diluted 1:1 or 2:1	Concentrated
Sieve Designations (square openings)	Percent Retained by Weight	Percent Retained by Weight
8	0	0
14	0-4	0-2
16	0-8	0-13
20	0-35	
30	20-50	55-85
40	10-45	
50	0-20	0-6
70	0-5	0-2
100	0-2	

[1] When tested according to ASTM C136 and ASTM C117:

[2] Locally available aggregate or abrasive material that ±3% of the gradation requirements is acceptable when the RPR approved with concurrence by the emulsion manufacturer.

628-2.7 Job Mix Design.

The Contractor must submit the job mix with material properties of gilsonite modified asphalt, polymer and aggregates. Mix design should indicate dilution rate of asphalt, amount of polymer and aggregate as well as application rate.

628-3 COMPOSITION AND APPLICATION RATE

628-3.1 Material Application Rates.

Table 628-3.1 provides the approximate amounts of materials per square yard (meter) for the asphalt surface treatments. Actual application rates vary within the range specified to suit field conditions and the RPR approved and verified during control strip construction.

Table 628-3.1: Material Application Rates

Dilution	Liquid Asphalt Quantity gal/yd² (l/m²)	Aggregate Quantity lb/yd² (kg/m²)
[__]	[__] ([__])	[__] ([__])

****

The quantities of material shown in Table 628-3.1 cover an average range of conditions. The Engineer selects dilution, liquid asphalt quantity range, and aggregate quantity for inclusion in Table in 628-3.1.

Table 628-3.1: Treatment Application Rates

Treatment Dilution	**Liquid Asphalt Quantity gal/yd² (l/m²)**	**Polymer Quantity % by volume**	**Aggregate Quantity lb/yd² (kg/m²)**	**Application Unit (guide for 608-4.3 selection)**
2:1	0.08-0.17 (0.36-0.77)	1% to 3.5%	0.20-0.50 (0.11-0.27)	Distributor / Combi
1:1	0.08-0.17 (0.36-0.77)	1% to 3.5%	0.20-0.50 (0.11-0.27)	Distributor / Combi
Concentrate	0.15-0.26 (0.68-1.18)	Minimum 5%	1.50-3.50 (0.81-1.90)	Combi Only

Note: Combi = Combination Synchronous Asphalt Distributor and Aggregate Spreader.

The Engineer should consider local conditions including surface texture, porosity, climate, traffic, age of the asphalt pavement when selecting the treatment, and the application rates of the emulsion and aggregate. For example:

- **2:1 Dilution is recommended for grooved pavements, course surfaces with low to medium weathering and raveling distresses, or lightly to moderately oxidized pavements.**
- **1:1 Dilution is recommended for new or dense pavements and pavements with low to no weathering distresses.**
- **Concentrated is recommended for pavements with medium to high weathering, raveling, and oxidation, where a heavier treatment is beneficial. Concentrated is not recommended for grooved pavements.**

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For projects with application of the asphalt surface treatment on runway and high-speed exit taxiway, the Engineer must document skid resistance according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, prior to full application.

The test areas and control strips afford the Contractor and RPR an opportunity to determine the mixture's quality, in place, as well as the equipment's performance.

Climate and weather conditions may significantly affect cure time and the time necessary to achieve acceptable friction results.

If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

****

628-3.2 Control Strips.

Prior to full production, the Contractor must prepare a minimum of two control strips at varying application rates to demonstrate the material, equipment, and construction process and to determine the application rate and number of coats. Strips must be a minimum of 200 feet long by a minimum of 12 feet wide on representative sections of pavement, as recommended by the RPR. If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

****

For surface treatments on runway and rapid exit taxiway surfaces. Include before and after testing for skid resistance.

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[Before beginning the control strip, determine the skid resistance of the existing pavement at the location where the control strip will be placed with continuous friction measuring equipment (CFME). Place control strips and after the surface treatment has cured perform another skid resistance tests at approximately the same location as the test done on the existing pavement. Do not permit aircraft on the runway or taxiway control strips until the Contractor validates that its surface friction meets or exceeds the Maintenance Planning levels provided in AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-resistant Airport Pavement Surfaces*, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME.]

If the control strip should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment, and place additional control strips. Do not begin full production until the RPR accepts the control strip. The surface preparation, personnel, materials, equipment, method of operation and rate of application used on the acceptable control strip must be used during production.

628-4 CONSTRUCTION METHODS

628-4.1 Worker Safety.

The Contractor must have Safety Data Sheet (SDS) for both the liquid asphalt material and aggregate and require personnel to follow the manufacturer's recommended safety precautions.

628-4.2 Weather Limitations.

628-4.2.1 Apply the surface treatment when the existing pavement surface is dry and when the weather is not foggy, rainy, or windy.

628-4.2.2 Do not apply material in strong winds that interfere with the uniform application of the material(s), when dust or sand is blowing, or when rain is anticipated within eight hours of application completion.

628-4.2.3 Do not apply unless the atmospheric temperature and the pavement surface temperature are both at or above, 60°F (16°C) and rising.

628-4.2.4 Do not apply the treatment to pavement anticipated to have traffic within 72 hours when pavement temperatures are expected to exceed 130ºF (54°C).

628-4.2.5 During application, account for wind drift. Cover existing buildings, structures, runway edge lights, taxiway edge lights, informational signs, retro-reflective markings, and in-pavement duct markers, as necessary to protect against overspray before applying the emulsion. If emulsion gets on any light or marker fixture, promptly clean the fixture. If cleaning is not to the RPRs satisfaction, the Contractor must replace any light, sign, or marker with equivalent equipment at no cost to the Owner.

628-4.3 Equipment and Tools.

The Contractor furnishes all equipment, tools, and machinery necessary for the performance of the work. The Contractor must furnish a current calibration certification for the application machine from a State DOT or other authority the RPR approved.

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See "Application Unit (guide for 628-4.3 selection)" in the table located in the COMPOSITION AND APPLICATION RATE Engineer's Note.

****

628-4.3.1 Application Unit.

[`Use a Combination Synchronous Asphalt Distributor and Aggregate Spreader unit` **|**`Use either a Distributor Truck unit or a Combination Synchronous Asphalt Distributor and Aggregate Spreader` **]** for this project.

628-4.3.2 Distributor Truck or Combined Unit.

1. Apply the emulsion with a computer rate-controlled asphalt distributor. The distributor will effectively heat and mix the material to the required temperature prior to application, according to the manufacturer's recommendations. The equipment must be in good working order, as verified by the RPR, and the tanks will not contain any contaminants or diluents.
2. The apparatus for liquid spraying will include full circulation spray bars, pump rpm gauge, volume measuring device, integral heater (thermostatically controlled), and a hand hose attachment suitable for application of the emulsion manually to cover areas inaccessible to the distributor.
3. The distributor will have an easily accessible thermometer that constantly monitors the temperature of the emulsion and have an operable mechanical tank gauge used to cross-check computer accuracy.
4. The distributor must equipped with a 12-foot (3.7-m) minimum spray bar with individual nozzle control and be capable of specific application rates in the range of 0.05 to 0.30 gallons per square yard (0.15 to 0.90 liters per square meter).
5. Spray bar tips must be clean, free of dried asphalt, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that maintains predetermined flow rates and constant pressure during the application process with application speeds under 8 miles per hour (13 km per hour) or 700 feet per minute (213 m per minute).
6. Proper set-up before use. The Contractor will provide verification of truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application per nozzle manufacturer, spray-bar height and pressure and pump speed appropriate for the viscosity and temperature of sealer material, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order.

628-4.3.3 Aggregate Spreader Unit.

The asphalt distributor must be equipped with an aggregate spreader mounted to the distributor that can apply aggregate to the emulsion in a single pass operation without driving through wet emulsion, with the aggregate being applied within 3 to 6 feet of the emulsion spray.

1. The aggregate spreader must be equipped with a variable control system capable of uniformly distributing the aggregate at the specified rate at varying application widths and speeds and be adjusted to produce an even and accurate application of specified aggregate.
2. The distributor truck mounted aggregate spreader must have a minimum hopper capacity of 3,000 lbs (1361 kg) of aggregate which may be used for treatments with a maximum aggregate application rate of 0.5 lb/yd^2 (0.27 kg/m^2).

628-4.3.4 Combination Synchronous Asphalt Distributor and Aggregate Spreader.

Use combination synchronous asphalt distributor and aggregate spreader for treatments when aggregate application rate is greater than 0.5 lb/yd^2(0.27 kg/m^2). The application machine must be specifically designed for fine aggregate distribution and equipped to spread the aggregate via a computer rate-controlled aggregate distribution apparatus, integral to the asphalt distributor, and proper aggregate gate-controlled apparatus capable of uniformly distributing the aggregate at the specified rate at varying application widths (zero to 15 feet) and speeds, at readily determined and controlled rates from 0.5 to 4 lbs of aggregate per square yard (meter) of surface. The aggregate spreader must have a minimum hopper capacity of 20,000 lbs (9,000 kilograms) of the specified aggregate.

628-4.3.5 Power Broom/Blower.

Provide a power broom or blower to remove loose material from the surface immediately before application of the surface treatment.

628-4.4 Pavement Surface Preparation.

Clean the pavement surface immediately prior to applying the treatment so the pavement is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease from the pavement by scrubbing with a detergent, washing thoroughly with clean water, and then treating areas with a spot primer. Any additional surface preparation, such as crack repair, must be according to Item P-101. The RPR confirms with the Contractor that the pavement is properly prepared for an application.

[`628-4.4.1    New Pavement Surface Preparation.`

Allow new asphalt pavement surfaces to cure, so that there is no concentration of oils on the surface.

The RPR performs a water-break-free test to confirm that the surface oils degraded and dissipated before the Contractor's mobilization. This test is done by casting approximately 1 gallon (4 liters) of clean water out over the surface; the water should sheet out and wet the surface uniformly without crawling or showing oil rings. If signs of crawling or oil rings are apparent on the pavement surface, allow additional time for additional curing and retesting of the pavement surface prior to treatment. A full pavement water-flush and 24-hour dry is recommended, prior to placing the seal coat. Consult the emulsion manufacturer.]

****

If concentrated treatment, select [`Not Applicable`] for 608-4.5. If diluted treatment, delete [`Not Applicable`]; select appropriate dilution.

****

628-4.5 Emulsion Mixing.

[Not Applicable. | Mix the application emulsion according to emulsion manufacturer's recommendations blending asphalt material concentrate, water, and polymer. Always add heated water to asphalt material concentrate, never add concentrated liquid asphalt to heated water.

Mix one-part heated water to [two parts | one part] asphalt material, by volume.

When polymer is added onsite, add it to the warm emulsion and circulate for 15 to 20 minutes. After mixing, inspect to ensure the emulsion is sufficiently mixed and ready for application. The material should not have a milky appearance and be free of asphaltic clumps, pools, or streaks of discoloration. The RPR verifies that all onsite mixing procedures are followed appropriately.]

628-4.6 Asphalt Surface Treatment Application.

Apply the asphalt surface treatment with the same equipment, procedures, and rate as approved by the RPR with the control strip. Limited hand spraying of asphalt is acceptable in irregular shaped areas. The treatment should be applied at a temperature between 140°F (60°C) and 160°F (71°C), unless the RPR approved with concurrence of emulsion manufacturer.

628-4.7 Aggregate Application

Spread aggregate uniformly over the asphalt material in a single pass at the rate determined with the control strip simultaneous with the liquid asphalt material application. Spread the aggregate the same width as the asphalt material. In areas where hand work is necessitated, apply the aggregate before the liquid asphalt material begins to break. If aggregate is broadcast on untreated pavement, prior to the next application pass, the Contractor must clean areas of excess or loose aggregate and remove it from the project site.

628-4.8 Brooming Considerations.

Lightly broom or squeegee areas of ponds or puddles greater than ½-inch (12 mm) until the pavement surface is free of excess material. Protect the surfaces of adjacent structures from spattering or marring.

628-5 QUALITY CONTROL

628-5.1 Application Rate.

The rate of application of the surface treatment must be verified at least twice, daily. The Contractor must furnish the RPR the results daily.

628-6 MATERIAL ACCEPTANCE

628-6.1 Friction Test Runway and Rapid Exit Taxiways.

[Not used. |Friction tests according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, must be accomplished on all runway and rapid exit taxiways that have received a seal coat. The Contractor must coordinate testing with the RPR and provide the RPR the opportunity to be present during testing.

Each test includes performing friction tests at 40 mph and 60 mph (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline.

Do not permit aircraft on the runway or rapid exit taxiway until the testing validates that surface friction is at, or above, the maintenance planning friction levels in AC 150/5320-12, Table 3-2, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME. Areas are not acceptable for payment until surface friction is at or above the maintenance planning friction levels.

The Contractor must provide the RPR a written report of friction test results.]

628-7 METHOD OF MEASUREMENT

628-7.1 Gilsonite Surface Treatments.

The quantity of gilsonite surface treatments is measured by the square yards [square meters] of material applied according to the plans and specifications and accepted by the RPR.

[628-7.2 Friction Testing lump sum for all required friction testing.]

628-8 BASIS OF PAYMENT

628-8.1 Payment.

Payment is made at the number of square yard (square meter) of material applied according to the plans and specifications and accepted by the RPR.

[628-8.2 Payment Friction Testing

Payment is made at the contract unit price per lump sum for friction testing and all work required to meet AC 150/5320-12.

Payments are made under:

P-628-8.1	Gilsonite Surface Treatments - per square yard [square meter].
[P-628-8.2	Runway and Angled Exit Taxiway Friction Testing - per lump sum | Not required].

****

Edit brackets for project. Add additional Pay Items as necessary for multiple treatment areas and dilution rates shown on the plans per 608-3.1 Material Application Rates and 608-3.2 Test areas and control strips.

****

628-9 REFERENCES

628-9.1 This list of publications forms 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 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 C128	*Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate*
ASTM C136	*Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*
ASTM C566	*Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying*
ASTM C1252	*Standard Test Methods for Uncompacted Void Content of Fine Aggregate*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D5	*Standard Test Method for Penetration of Asphalt Materials*
ASTM D36	*Standard Test Method for Softening Point of Bitumen*
ASTM D113	*Standard Test Method for Ductility of Bituminous Materials*
ASTM D2007	*Standard Test Method for Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum-Derived Oils by the Clay-Gel Absorption Chromatographic Method*
ASTM D2042	*Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene*
ASTM D2216	*Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*
ASTM D4402	*Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer*
ASTM D5340	*Standard Test Method for Airport Pavement Condition Index Surveys*

ASTM D6930	*Standard Test Method for Settlement and Storage Stability of Emulsified Asphalts*
ASTM D6933	*Standard Test Method for Oversized Particles in Emulsified Asphalts (Sieve Test)*
ASTM D6934	*Standard Test Method for Residue by Evaporation of Emulsified Asphalt*
ASTM D6997	*Standard Test Method for Distillation of Emulsified Asphalt*
ASTM D7402	*Standard Practice for Identifying Cationic Emulsified Asphalts*
ASTM D7428	*Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus*
ASTM D7226	*Standard Test Method for Determining the Viscosity of Emulsified Asphalts Using a Rotational Paddle Viscometer*
ASTM D7496	*Standard Test Method for Viscosity of Emulsified Asphalt by Saybolt Furol Viscometer*

Advisory Circulars (AC)

AC 150/5320-12	*Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*
AC 150/5320-17	*Airfield Pavement Surface Evaluation and Rating (PASER) Manuals*
AC 150/5380-6	*Guidelines and Procedures for Maintenance of Airport Pavements*

END OF ITEM P-628

Item P-628-R Gilsonite Rapid Cure Surface Treatment

628-R-1 DESCRIPTION

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The performance of a seal coat product is contingent on the pavement condition at the time of application. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of the distresses, and by determining the pavement condition index (PCI) according to Advisory Circular (AC) 150/5380-7, *Airport Pavement Management Program (PMP),* and ASTM D5340. A typical asphalt pavement candidate is one with a structural condition index (SCI) deduct value of less than ten and a PCI equal to or greater than sixty.

When used on any pavement where aircraft operate, it must include friction testing. Friction tests are required on runways and taxiways before pavement can be opened to aircraft traffic.

When choosing which type of seal coat, consider that the larger the aggregate, the greater the chance for creation of foreign object debris (FOD).

Prior to the use of Item P-628-R, the Engineer must check with federal, state, and local authorities on the use of products that contain volatile organic compounds (VOC). Asphalt seal coat products assist in pavement preservation through reducing the rate of pavement oxidation.

This specification covers the requirements for a rapid cure gilsonite-asphalt surface treatment. P-628-R is designed for use as an alternative to Item P-628 type treatment on pavements which could otherwise accept a standard Item P-628, but must be accomplished under more restrictive site conditions such as night-time work, short operational windows, etc., requiring a rapid cure.

Aggregate must be added to P-628-R when used on pavements where aircraft operate.

P-628-R may be applied to:

- **Pavements in fair or better condition as defined in ASTM D5340 or AC 150/5320-17, *Airfield Pavement Surface Evaluation and Rating (PASER) Manuals.***
- **Low to moderate weathered surfaces as defined by ASTM D5340.**
- **New asphalt pavement.**

The material properties in Item P-628-R include approximately twice the amount of gilsonite asphalt as Item P-628, which provides a seal coat initially

harder and more durable. The typical curing time, under recommended application conditions, is one to three hours.

The Engineer must verify the selected materials comply with federal, state, and local authority requirements.

****

628-R-1.1 This item consists of the spray application of a cationic emulsified gilsonite-modified asphalt surface treatment composed of an emulsion of natural and refined asphalt materials and light oils with the simultaneous application of a suitable aggregate to maintain adequate surface friction to areas designated on the project plans. The terms seal coat, asphalt sealer, and surface treatment are interchangeable.

The terms seal coat, asphalt sealer, and asphalt material are interchangeable throughout this specification. The term asphalt means natural and refined asphalt materials in this specification.

628-R-2 MATERIALS

628-R-2.1 Aggregate.

The fine-aggregate material must be a dry, clean, sound, durable, angular shaped, with highly textured surfaces, manufactured specialty abrasive aggregate. The RPR must approve the aggregate and meet the following gradation limits when tested according to ASTM C136.

Table 628-R-2.1a: Aggregate Characteristics

Test	Standard	Range
Fractured Faces		100%
SiO2		55% minimum
CaO		3% maximum
Micro-Deval	ASTM D7428	15% maximum
Magnesium Sulfate Soundness	ASTM C88	2% maximum
Aggregate Angularity	ASTM C1252 – Test Method A	45% minimum
Moisture Content (%)	ASTM C566	2% maximum
Bulk Dry Specific Gravity	ASTM C128	2.6 – 3.0
Absorption (%)	ASTM D2216	3% maximum
Mohs Hardness	Mohs Scale	Seven, minimum

Table 628-R-2.1b: Aggregate Material Gradation Requirements

Sieve Designation	Percent Retained by Weight
No. 8	0
No. 14	0-2
No. 16	0-13
No. 30	55-85
No. 50	0-6
No. 70	0-2

The Contractor provides a Certification of Analysis (COA) showing analysis and properties of the material delivered for the project’s use. The Contractor’s certification may be subject to verification by testing the material delivered for the project’s use.

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The gradations in the table represent the limits in determining aggregate suitability for use in the RapidCure asphalt surface treatment. The aggregate gradation used, within the limits designated in the table, should provide sufficient friction levels to meet or exceed the maintenance planning Friction Level in Table 3-2, “Friction Level Classification for Runway Pavement Surfaces” of AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces.*

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628-R-2.2 Asphalt Material.

The asphalt material base residue must contain no less than 40% gilsonite, or uintaite, and not contain any tall oil pitch or coal tar material. The material must be compatible with asphalt pavement The solvent-based rapid cure material will meet the properties in Table 628-R2.2a.

Table 628-R-2.2a: Properties for Asphalt Sealing Material

Properties	Specification	Limits
Kinematic Viscosity at 140°F (60°C)	ASTM D4402	10-30 cSt
Percent Residue by Distillation	ASTM D402	30-45%

Table 628-R-2.2b: Tests on Residue from Distillation

Properties	Specification	Limits
Penetration at 77°F (25°C)	ASTM D5	2-12 dmm
Softening Point	ASTM D36	180-200
Solubility in 1,1,1 Trichloroethylene	ASTM D2042	99% min.
HCI Precipitation Value		18-25

The Contractor provides a copy of the manufacturer's COA for the asphalt sealer delivered to the project. If the asphalt sealer is diluted at other than the manufacturer's facility, the Contractor must provide a supplemental COA from an independent laboratory verifying the asphalt sealer properties. The Contractor must provide the RPR the COA and await approval before applying the asphalt material. Furnishing the vendor's certified test report for the asphalt material is not interpreted as a basis for final acceptance. The manufacturer's COA is subject to verification by testing the material delivered for the project's use.

The material may be stored at ambient temperature for long periods of time if necessary. Storage will follow industry standard recommendations due to the flammability of the material; avoid sparks and open flames to come into contact with the material or any gasses that might be escaping the storage vessel.

628-R-3 COMPOSITION AND APPLICATION RATE

628-R-3.1 Application Rate.

The approximate amounts of materials per square yard (square meter) for the asphalt surface treatment is indicated in the application rate for the treatment areas shown on the plans. The actual application rates vary within the range specified, as necessary, to suit field conditions and is the rate determined with the control strip.

Table 628-R-3.1: Application Rate

Dilution Rate	Quantity of Sealer gal/yd^2 (l/m^2)	Quantity of Aggregate lb/yd^2 (kg/m^2)
N/A	0.08-0.15 (0.36-0.68)	0.40-0.50 (0.11-0.22)

****

The quantities of material shown in Table 628-R-3.1 cover an average range of conditions. The quantity of aggregate, and the rate of rapid cure seal coat material spread should take into consideration local conditions and

experience. The Engineer should select the rate(s) reflecting the local condition of the pavement such as surface texture, porosity, and age of the asphalt pavement to be sealed.

A higher rate is recommended for grooved, rough or course surfaces, or where the pavement is highly oxidized or badly cracked.

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628-R-3.2 Control Areas and Control Strips.

Prior to full production, the Contractor must prepare a minimum of two control strips, at varying application rates to demonstrate the material, equipment, construction process and to determine the application rate and number of coats. Strips must be a minimum of 200 feet long by a minimum of 12 feet wide on representative sections of pavement, as recommended by the RPR. If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

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For surface treatments on runway and rapid exit taxiway surfaces. Include before and after testing for skid resistance.

****

[Before beginning the control strip, determine the skid resistance of the existing pavement at the location where the control strip will be placed with continuous friction measuring equipment (CFME). Place control strips and after the surface treatment has cured perform another skid resistance tests at approximately the same location as the test done on the existing pavement. Do not permit aircraft on the runway or taxiway control strips until the Contractor validates that its surface friction meets or exceeds the Maintenance Planning levels provided in AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-resistant Airport Pavement Surfaces*, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME.]

If the control strip should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment, and place additional control strips. Do not begin full production until the RPR accepts the control strip. The surface preparation, personnel, materials, equipment, method of operation and rate of application used on the acceptable control strip must be used during production.

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For projects calling for application of the asphalt surface treatment on runway and high-speed exit taxiway, the Engineer documents skid resistance according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, prior to full application.

The test areas/sections afford the Contractor and the Engineer an opportunity to determine the quality of the mixture in place.

If operational conditions preclude placement of a control strip on the pavement to be seal coated, it may be applied on a pavement with similar surface texture.

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628-R-4 CONSTRUCTION METHODS

628-R-4.1 Worker Safety.

The Contractor must obtain a Safety Data Sheet (SDS) for both the asphalt sealer product and aggregate and require workers to follow the manufacturer’s recommended safety precautions. All additional industry standard safety precautions regarding the storage and applications of solvent-based asphalts should be understood and followed by the Contractor.

628-R-4.2 Weather Limitations.

628-R-4.2.1 Apply the surface treatment when the existing pavement surface is dry and when the weather is not foggy, rainy, or windy.

628-R-4.2.2 Do not apply material in strong winds that interfere with the uniform application of the material(s), or when dust or sand is blowing, or when rain is anticipated within 8 hours of application completion.

628-R-4.2.3 Do not apply unless the atmospheric temperature and the pavement surface temperature are both at or above, 55°F (14°C) and rising.

628-R-4.2.4 Do not apply the treatment to pavement that will have traffic within 72 hours when pavement temperatures are expected to exceed 160ºF (71°C).

628-R-4.2.5 During application, account for wind drift. Cover existing buildings, structures, runway edge lights, taxiway edge lights, informational signs, retro-reflective markings, and in-pavement duct markers as necessary to protect against overspray before applying the emulsion. If emulsion gets on any light or marker fixture, promptly clean the fixture. If cleaning is not to the RPR’s satisfaction, the Contractor must replace any light, sign, or marker with equivalent equipment at no cost to the Owner.

628-R-4.3 Equipment and Tools.

The Contractor must furnish all equipment, tools, and machinery necessary for the performance of the work.

628-R-4.3.1 Pressure Distributor.

Apply the sealer with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment must be in good working order and not contain any 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 sealer. 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 miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute). The Contractor must provide verification of truck set-up (via a test-shot area), including but not limited to nozzle tip size appropriate for application per nozzle manufacturer, spray-bar height and pressure and pump speed appropriate for the viscosity and temperature of sealer material, 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 must be equipped with a 12-foot (3.7-m), minimum, spray bar with individual nozzle control. The distributor truck must be able to specify application rates in the range of 0.05 to 0.25 gallons per square yard (0.15 to 0.80 liters per square meter). These rates must be computer-controlled rather than mechanical. The distributor truck must have an easily accessible thermometer that constantly monitors the temperature of the sealer and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. The distributor truck must effectively mix the material prior to application. The distributor must be equipped with a hand sprayer to spray the sealer in areas not accessible to the distributor truck.

628-R-4.3.2 Aggregate Spreader.

The asphalt distributor truck must be equipped with an aggregate spreader mounted to the distributor truck that can apply aggregate to the sealer in a single pass operation without driving through wet sealer. The aggregate spreader must be equipped with a variable control system capable of uniformly distributing the aggregate at the specified rate at varying application widths and speeds. The aggregate spreader must be adjusted to produce an even and accurate application of specified aggregate. Prior to any seal coat application, calibrate the aggregate spreader onsite to ensure acceptable uniformity of spread. The RPR must observe the calibration and verify the results. Re-calibrate the aggregate spreader each time the aggregate rate is changed either during the application of test strips or production. The aggregate spreader must have a minimum hopper capacity of 3,000 lbs (1361 kg) of aggregate. Push-type hand spreaders are allowed for use around lights, signs, and other obstructions, if necessary.

628-R-4.3.3 Power Broom/Blower.

Provide a power broom and/or blower for removing loose material from the surface to be treated.

628-R-4.3.4 Equipment Calibration.

Asphalt distributors must be calibrated within the same construction season according to ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency the RPR approves.

628-R-4.4 Asphalt Pavement Surface Preparation

Clean pavement surface immediately prior to placing the seal coat so that it is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease from the asphalt pavement by scrubbing with a detergent, washing thoroughly with clean water, and treating these areas with the oil spot primer. Any additional surface preparation, such as crack repair, must be according to Item P-101, paragraph 101-3.6.

628-R-4.5 Asphalt Sealer Application.

Apply the asphalt sealer using a pressure distributor upon the properly prepared, clean, and dry surface at the production rate the RPR approves from the test area/sections evaluation for each treatment area. Apply material at same temperature used with control strip. Do not heat the material above 100°F.

Pavement surfaces which have excessive runoff due to amount of material being applied or excessive surface grade must be treated in two or more applications so the two applications, when combined, result in the production application rate. Do not apply the second application until the prior application of material penetrates the pavement.

If low spots and depressions greater than ½ inch (12 mm) in depth in the pavement surface cause result in ponding or puddling of the applied materials, lightly broom or squeegee the surface with a brush type squeegee. Continue brooming or squeegee until the pavement surface is free of any pools of excess material. Ponding and/or puddling must not cause excessive pavement tackiness and/or additional distress. Protect the surfaces of adjacent structures from spatters or mars. Do not discharge asphalt materials beyond the limits of areas to be treated.

Caution. Heating asphalt binders of any kind always constitutes some degree of hazard. The most hazardous of these are cutback asphalts because of the highly volatile solvents used. Care must be taken not to allow any spark or open flame to come in contact with the cutback asphalt or the gases from cutback asphalt due to the low flash point. It is the Contractor’s responsibility to understand and adhere to these standards in regard to staying within the recommended application temperatures of this material and at all times during production.

628-R-4.6 Aggregate Application

Immediately following the application of the asphalt sealer uniformly spread aggregate in a single pass, at the rate determined from the test area/sections evaluation for each designated application area. Apply the sealer material and aggregate simultaneously in a single pass operation, so not to drive through the applied fresh sealer. Spread the aggregate to the same width of application as the asphalt material. Do not apply in such thickness as to cause blanketing.

Sprinkling of additional aggregate material and spraying additional asphalt material over areas that show up having insufficient cover or bitumen, must be done by hand whenever necessary. In areas where hand work is necessitated, apply the aggregate before the sealant begins to break. Minimize aggregate from being broadcast and accumulating on the untreated pavement adjacent to an application pass. Prior to the next application pass, the Contractor cleans areas of excess or loose aggregate and remove from project site.

628-R-5 QUALITY CONTROL (QC)

628-R-5.1 Quality Control.

The Contractor must verify the application rate of emulsion and aggregate at least two times daily in the presence of the RPR. Provide daily documentation of QC testing to the RPR.

628-R-6 MATERIAL ACCEPTANCE

628-R-6.1 Friction Test Runway and Rapid Exit Taxiways. [`Not used.`]

[`Not used.` | `Friction tests according to AC 150/5320-12,` *`Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces`*`, must be accomplished on all runway and rapid exit taxiways that received a seal coat. The Contractor must coordinate testing with the RPR and provide the RPR the opportunity to be present during testing.`

`Each test includes performing friction tests at 40 mph and 60 mph (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline.`

`Do not permit aircraft on the runway or rapid exit taxiway until the testing validates that surface friction is at or above the maintenance planning friction levels in AC 150/5320-12, Table 3-2, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet with approved CFME. Areas` are not acceptable for payment until surface friction is at or above the maintenance planning friction levels.

The Contractor must provide the RPR a written report of friction test results.]

628-R-7 METHOD OF MEASUREMENT

628-R-7.1 Asphalt Surface Treatment.

The quantity of gilsonite rapid cure surface treatment is the number of square yards [square meters] of material applied according to the plans and specifications and accepted by the RPR. s

[**628-R-7.2** Friction Testing lump sum for all required friction testing.]

628-R-8 BASIS OF PAYMENT

628-R-8.1 Payment Asphalt Surface Treatment

Payment is made at the contract unit price per square yard [square meter] for the gilsonite rapic cure surface treatment applied and the RPR accepted, and the contract unit price per lump sum for runway friction testing. This price is full compensation for all surface preparation, furnishing all materials, delivery, and application of these materials, for all labor, equipment, tools, and incidentals necessary to complete the item.

[628-R-8.2 Payment Friction Testing

Payment is made at the contract unit price per lump sum for friction testing.]

Payment is made under:

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Edit brackets for project. Add additional Pay Items as necessary for multiple treatment areas shown on the plans per paragraph 628-R-3.1.

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Item P-628-R-8.1 Asphalt Surface Treatment – per square yard [square meter]

[Item P-628-R-8.2 Friction Testing – per lump sum]

628-R-9 REFERENCES

628-R-9.1 This list of publications forms 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 C88	*Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate*
ASTM C128	*Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate*
ASTM C136	*Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates*
ASTM C566	*Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying*
ASTM C1252	*Standard Test Methods for Uncompacted Void Content of Fine Aggregate*
ASTM D5	*Standard Test Method for Penetration of Asphalt Materials*
ASTM D36	*Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)*
ASTM D402	*Standard Test Method for Distillation of Cutback Asphalt*
ASTM D2042	*Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene*
ASTM D2216	*Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*
ASTM D2995	*Standard Practice for Estimating Application Rate of Bituminous Distributors*
ASTM D4402	*Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer*
ASTM D5340	*Standard Test Method for Airport Pavement Condition Index Surveys*
ASTM D7428	*Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus*

Advisory Circulars (AC)

AC 150/5320-12	*Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*

AC 150/5320-17	*Airfield Pavement Surface Evaluation and Rating (PASER) Manuals*
AC 150/5380-6	*Guidelines and Procedures for Maintenance of Airport Pavements*
AC 150/5380-7	*Airport Pavement Management Program (PMP)*

END OF ITEM P-628-R

Item P-629 Thermoplastic Coal Tar Emulsion – Micro-Surface

629-1 DESCRIPTION

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The performance of a seal coat product is contingent on the pavement condition at the time of application. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of the distresses, and by determining the pavement condition index (PCI) according to Advisory Circular (AC) 150/5380-7, *Airport Pavement Management Program (PMP*), and ASTM D5340. A typical asphalt pavement candidate is one with a structural condition index (SCI) deduct value of less than 10 and a PCI equal to or greater than 60.

When used on any runway or taxiway pavement where aircraft operate it must include friction testing. Friction tests are required on runways and taxiways before pavement can be opened to aircraft traffic.

When choosing which type of seal coat consider that the larger the aggregate the greater the chance for foreign object degree (FOD) to be created. The micro-surface will not stop shrinkage and other large thermal cracks from reflecting back through the new surface.

May be used on areas that need a fuel resistant coating.

Sealcoat with aggregate: May be used on all runway and taxiway pavements serving aircraft less than 100,000 lbs (45,359 kg). May be used on all aprons. Use on runway or taxiway pavements greater than 100,000 lbs (45,359 kg) requires FAA approval with an MOS. May be used on any pavements where aircraft do not operate including shoulders, overruns, roads, and parking areas.

A thermoplastic coal tar emulsion micro-surface without aggregate can be considered for use on pavements with low to moderate weathered surfaces, as defined by ASTM D5340. The thermoplastic coal tar emulsion sealcoat may be applied to pavements in fair or better condition, as defined in ASTM D5340 or AC 150/5320-17, *Airfield Pavement Surface Evaluation and Rating (PASER) Manuals.*

The Engineer must verify the selected materials comply with federal, state, and local authority requirements.

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629-1.1 This item consists of an application of a thermoplastic coal tar emulsion – micro-surface, applied to an existing, previously prepared asphalt surface. Thermoplastic resin coal tar emulsion micro-surface provides a durable, skid resistant and fuel-resistant surface. Thermoplastic coal tar emulsion products assist in pavement preservation through reducing the rate of pavement oxidation. The application of the surface treatment must be according to these specifications and conform to the dimensions shown on the plans, or as directed by the Engineer.

629-2 MATERIALS

629-2.1 Thermoplastic Coal Tar Emulsion.

The emulsion material is a thermoplastic coal tar emulsion composed of plastic resin and emulsified coal tar pitch. The thermoplastic coal tar emulsion must be manufactured as a complete product and tested at the manufacturing plant for material certification. The cured thermoplastic coal tar emulsion sample must pass the fuel-resistance test according to Appendix A.

629-2.2 Manufacturer's Certifications.

The Contractor furnishes the manufacturer's Certification of Analysis (COA) that all thermoplastic coal tar emulsion shipped to the project meets the following testing requirements.

Table 629-2.2: Thermoplastic Coal Tar Emulsion Properties

Property	Standard	Requirement
Water content	ASTM D5727	≤ 58%
Ash of Residue	ASTM D5727	≤ 15%
Flexibility	ASTM D5727	1 rating
Resistance to Kerosene	ASTM D5727	Pass with no loss of adhesion and no softening of film
Softening Point	ASTM D36	> 212°F (100°C)

629-2.3 Water.

Water from a drinking water source is suitable for mixing. Water from other sources must meet the requirements of ASTM C1602. The temperature of the water added during mixing must be at least 40°F (4°C).

629-2.4 Handling and Storage.

Agitate all emulsion stored on-site at least once per day for a minimum of 15 minutes. Maintain the distributor or applicator, pumps, and all tools in satisfactory working condition. Spray bar nozzles, pumps, or other equipment can be cleaned mechanically or with clean water.

629-2.5 Health, Safety, and Environment.

The Contractor must provide a complete Safety Data Sheet (SDS) according to U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Regulations (Standards – 29 Code of Federal Regulation (CFR)), 1910.1200 which establishes the requirement and minimum information for the SDS for hazardous materials. The SDS, Section II, must include the Chemical Abstracts Service (CAS) registry numbers for all applicable hazardous ingredients in the coal tar emulsion product. The Contractor must provide the manufacturer's certification that the product complies with the CFR Title 40 – Protection of Environment. The manufacturer's certification must address compliance for Air Programs, Part 59, National Volatile Organic Compound Emission Standards for Consumer and Commercial Products (for the airport location) and Water Programs, Part 116, Designation of Hazardous Substances.

629-3 COMPOSITION AND APPLICATION

629-3.0 Thermoplastic Coal Tar Emulsion

[`Micro-Surface Type A` | `Micro-Surface Type B` | `Micro-Surface Type C` **]**.

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If treatment to be used where fuel resistance is required, need to submit results of fuel resistance testing per Appendix A.

Type A Aggregate Thermoplastic Coal Tar Emulsion Micro-Surface can generally be used for:

- **Existing pavements that are moderately rough and raveled and require a substantially improved surface profile or wearing surface.**
- **Pavements that may require improvement of skid-resistance.**
- **Areas that require wear protection, oxidation protection and chemical/fuel resistance.**

Type B Aggregate Thermoplastic Coal Tar Emulsion Micro-Surface can be used for:

- **Existing pavements that are raveled or smooth and require an improved surface profile or wearing surface.**
- **Pavements that may require improvement of skid-resistance.**
- **Areas that require wear protection, oxidation protection and chemical/fuel resistance.**

Type C Aggregate Thermoplastic Coal Tar Emulsion Micro-Surface can generally be used for:

- **Pavements that may require improvement of skid-resistance.**
- **Areas that require wear protection, oxidation protection and chemical/fuel resistance.**

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629-3.1 Mixture Design.

Based on the data in this specification, and prior to the start of operations, the Contractor must submit the proportions of thermoplastic coal tar emulsion and aggregate [`and results of fuel resistant testing in accordance with Appendix A`] to the RPR. Submit a copy of the mix design and test data required by this specification to the RPR for approval along with the above information. Table 629-3.1 provides the approximate amounts of materials per square yard (square meter) for the micro-surface treatment.

Table 629-3.1: Application Rate

Aggregate Type	Aggregate Composition [1] lbs/gal (kg/l)	Mixture Application Rate [2] lb/yd^2 (kg/m^2)
A	22-24 (2.63 - 2.87)	8 (4.34)
B	20-22 (2.39 - 2.63)	6.5 (3.53)
C	18-20 (2.16 - 2.40)	4 (2.17)

1. Mix aggregate (lbs) homogeneously with the thermoplastic coal tar emulsion (gallons).
2. Minimum application rate of uncured thermoplastic coal tar emulsion micro-surface.

629-3.2 Aggregate.

629-3.2.1 Aggregate Types A and B.

The aggregate consists of sound, durable, crushed igneous type stone (crushed basalt, granite, trap rock, etc.), free from films of matter that would prevent thorough coating and bonding with the asphalt material and coatings of clay, organic matter, and other deleterious materials. The percentage of wear must not be greater than 35% when tested according to ASTM C131. The aggregate must meet the gradation in Table 629-3.2 for Types A and B when tested according to ASTM C136. The Contractor must provide the RPR with a certification showing particle size analysis and properties of the material delivered for the project's use.

629-3.2.2 Aggregate Type C.

The aggregate consists of sound, durable crushed igneous type stone (crushed basalt, granite, trap rock, etc.), clean washed masonry sand, or clean washed manufactured silica sand, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from coatings of clay, organic matter, and other deleterious materials. The aggregate must have a minimum Mohs hardness of 6. The aggregate must meet the gradation in Table 629-3.2 when tested according to ASTM C136. The Contractor must provide the RPR with a certification showing particle size analysis and properties of the material delivered for the project's use.

Table 629-3.2: Aggregate Material Gradation Requirements

Sieve Designation (square openings)	Percentage by Weight Passing Sieves			Contractor Final Gradation	Job Control Tolerance[1]
	Type A	Type B	Type C		
No. 4 (4.75 mm)	100	100	100	*	0
No. 8 (2.36 mm)	75-95	95-100	98-100	*	±2%
No. 16 (1.18mm)	50-75	65-95	85-100	*	±2%
No. 30 (600 µm)	30-65	35-65	50-90	*	±2%
No. 50 (300 µm)	20-50	20-45	10-55	*	±2%
No. 100 (150 µm)	15-25	5-25	0-20	*	±1%
No. 200 (75 µm)	5-20	0-20	0-20	*	±1%

[1] The "Job Control Grading Band Tolerances" must be applied to "Contractor's Final Gradation" to establish the job control grading band.

629-3.3 Equipment and Tools.

629-3.3.1 Mobile Mixing Machine.

The mobile mixing machine must be a truck-mounted mobile mixing plant with a towed-type spreader box. It must have a water tank and water pump capable of delivering a constant volume of water. The mobile mixing machine must have an agitated storage tank for the thermoplastic coal tar emulsion and a non-shearing pump with variable rate of flow for the delivery of this material. The mobile mixing machine will have a hopper for holding aggregate, supplying this material to the mixing chamber by a conveyor belt. The rate of aggregate delivery must depend upon the pump's speed.

The mobile mixing machine must have a continuous flow mixing unit capable of delivering predetermined quantities of thermoplastic coal tar emulsion, aggregate, and if necessary, water, to the mixing chamber and discharging the thoroughly mixed material on a continuous basis. The mobile mixing machine must deliver the materials to the mixing chamber in a constant proportion in a manner not dependent on a power plant or vehicle speed. The machine must be equipped with a water spray bar capable of fogging the pavement surface to aid in the application process. Attached to the mobile mixing machine is a mechanical-type squeegee distributor, equipped with flexible material in contact with the surface to provide a uniform surface. The spreader box may have an adjustable width.

629-3.3.2 Prime Coat Distributor.

The prime coat distributor is either a truck-mounted 300 to 3,000-gallon (1136 to 11356 liter) tank or a trailer-mounted unit with a 300 to 1000-gallon tank (1136 to 3785 liters) containing suitably driven mixing blades to combine predetermined quantities of thermoplastic emulsion and water into a homogeneous mixture. It must be equipped with a non-shearing pump capable of delivering material to a spray wand or spray bar.

629-3.3.3 Auxiliary Equipment.

Other tools or equipment such as power brooms, power blowers, air compressors, hand brooms, hand squeegees, etc., are provided as required.

629-3.3.4 Calibration.

The Contractor furnishes all equipment, materials, and labor necessary to calibrate the equipment. Calibrate equipment with the materials to be used to ensure it will produce and apply a mix conforming to the JMF.

629-3.4 Control Strip.

Prior to full production, the Contractor must prepare a minimum of two control strips, at varying application rates to demonstrate the material, equipment, construction process and to determine the application rate and number of coats. Strips must be a minimum of 200 feet long by a minimum of 12 feet wide on representative sections of pavement, as recommended by the RPR. If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

****

For surface treatments on runway and rapid exit taxiway surfaces. Include before and after testing for skid resistance.

****

[Before beginning the control strip, determine the skid resistance of the existing pavement at the location where the control strip will be placed with continuous friction `measuring equipment (CFME). Place control strips and after the surface treatment has cured perform another skid resistance tests at approximately the same location as the test done on the existing pavement. Do not permit aircraft on the runway or taxiway control strips until the Contractor validates that its surface friction meets or exceeds the Maintenance Planning levels provided in AC 150/5320-12,` *`Measurement, Construction, and Maintenance of Skid-resistant Airport Pavement Surfaces`*`, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME.]`

If the control strip should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment, and place additional control strips. Do not begin full production until the RPR accepts the control strip. The surface preparation, personnel, materials, equipment, method of operation and rate of application used on the acceptable control strip must be used during production.

629-4 CONSTRUCTION METHODS

629-4.1 Worker Safety.

The Contractor must obtain a SDS for both the thermoplastic coal tar emulsion product and aggregate and require workers to follow the manufacturer’s recommended safety precautions.

629-4.2 Weather Limitations.

Do not apply the material when the impending weather conditions do not permit proper drying or when the pavement temperature is below 45°F (7°C). If the air temperature will not reach 50°F (10°C), or overnight temperature will drop below 32°F (0°C), the Contractor may not apply the material at the risk of not drying properly. During application of thermoplastic coal tar emulsion surface treatment, account for wind drift. Cover runway edge lights, taxiway edge lights, informational signs, retro-reflective marking, and in-pavement duct markers, as necessary, to protect against overspray before applying the emulsion. If thermoplastic coal tar emulsion gets on any light or marker fixture, promptly clean the fixture. If cleaning is not satisfactory to the Engineer, the Contractor must replace any light, sign, or marker with equivalent equipment at no cost to the Owner.

629-4.3 Asphalt Pavement Surface Preparation.

Clean the pavement surface prior to placing the surface treatment so it is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease by spot burning or scrubbing with a detergent, then wash thoroughly with clean water. Any additional surface preparation, such as crack repair, must be according to Item P-101.

629-4.4 Application of Thermoplastic Emulsion Micro-Surface.

629-4.4.1 Primer Coat Application.

After preparation of the pavement and Engineer acceptance, apply a tack primer coat to the pavement surface where the micro-surface treatment is being applied. Apply a tack primer coat of thermoplastic coal tar emulsion diluted with 50% water at the rate of 0.05 gallons of mix per square yard (0.23 l/m^2).

629-4.4.2 Micro-surface Application.

Pre-wet the surface by fogging ahead of the spreader box. Water used in pre-wetting the surface must be applied at such a rate that the entire surface is damp in front of the spreader box. If temperatures are in the colder acceptable range, the rate of fogging may be decreased. Apply the mixture at the rate established with the control strip. The mixture must exhibit a uniform, even consistency when deposited on the surface, and no additional elements can be added. The spreader box must carry enough mixture, at all times, so that even distribution is obtained. Clumped or unmixed aggregate is not permitted. Segregation of the emulsion and aggregate fines from the coarse aggregate is not permitted. Upon completion of the work, the thermoplastic coal tar emulsion micro-surface must be uniform in texture without any bare spots. In areas where the spreader box cannot be used, apply the thermoplastic coal tar emulsion micro-surface by a means of a hand squeegee.

629-4.5 Curing.

Allow a minimum of 24 hours after the application, before opening to traffic or painting. Any damage to the uncured mixture caused by the Contractor is the Contractor’s responsibility to repair.

629-5 QUALITY CONTROL (QC)

629-5.1 Field Composite Mix Sampling.

The Contractor must take samples daily of the composite mix of thermoplastic coal emulsion and aggregate directly from the pug mill of the mobile mixing machine into a sealed one-gallon container. The minimum weight of composite mix must be:

- Type A Micro-Surface Composite Mix – Minimum 14 lbs per gallon
- Type B Micro-Surface Composite Mix – Minimum 13.5 lbs per gallon
- Type C Micro-Surface Composite Mix – Minimum 13 lbs per gallon

629-5.2 Contractor Qualifications.

The Contractor must provide Contractor qualifications for applicators, personnel, and equipment. The Contractor must also provide documentation from the thermoplastic emulsion manufacturer that the Contractor is certified to apply the thermoplastic coal tar emulsion surface treatment.

629-5.3 Friction Test Runway and Rapid Exit Taxiways.

[`Not used.` **|** Friction tests according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, must be accomplished on all runway and rapid exit taxiways that have received a seal coat. The Contractor must coordinate testing with the RPR and provide the RPR the opportunity to be present during testing.

Each test includes performing friction tests at 40 mph and 60 mph (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline.

Do not permit aircraft on the runway or rapid exit taxiway until the testing validates that surface friction is at or above the maintenance planning friction levels in AC 150/5320-12, Table 3-2, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet with approved CFME. Areas are not acceptable for payment until they surface friction is at or above the maintenance planning friction levels.

The Contractor must provide the RPR a written report of friction test results. **]**

629-6 MATERIAL ACCEPTANCE

629-6.1 Material Acceptance.

The thermoplastic coal tar emulsion micro-surface will have a uniform texture without any bare spots.

629-7 METHOD OF MEASUREMENT

629-7.1 Measurement.

The Thermoplastic Coal Tar Emulsion **[** `Micro-Surface Type A` **|** `Micro-Surface Type B` **|** `Micro-Surface Type C` **]** is measured by the square yard (square meter) of the area indicated on the contract drawings or the RPR designates.

629-8 BASIS OF PAYMENT

629-8.1 Payment.

Payment is made at the contract unit price per square yard (square meter) for the Thermoplastic Coal Tar Emulsion **[** `Micro-Surface Type A` **|** `Micro-Surface Type B` **|** `Micro-Surface Type C` **].** This price is full compensation for the Contractor for furnishing all materials and for all labor, equipment tools, and incidentals necessary to complete the thermoplastic coal tar emulsion product installation, including mix design and data sheets stipulated in these specifications.

Payment is made under:

Item P-629-8.1	Thermoplastic coal tar emulsion **[** `Micro-Surface Type A` **|** `Micro-Surface Type B` **|** `Micro-Surface Type C` **]**
[`Item P-629-8.2`	`Friction Testing – per lump sum` **|** `Not required` **]**

629-9 REFERENCES

629-1.1 This list of publications forms 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 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 C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D36	*Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)*
ASTM D140	*Standard Practice for Sampling Bituminous Materials*
ASTM D5340	*Standard Test Method for Airport Pavement Condition Index Surveys*
ASTM D5727	*Standard Specification for Emulsified Refined Coal Tar (Mineral Colloid Type)*

Advisory Circulars (AC)

AC 150/5320-12	*Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*
AC 150/5320-17	*Airfield Pavement Surface Evaluation and Rating (PASER) Manuals*

Code of Federal Regulations (CFR)

29 CFR Part 1910.1200	Hazard Communication
40 CFR	Protection of the Environment

APPENDIX A LABORATORY FUEL RESISTANCE TEST

1. Scope. This method determines the resistance of the emulsion to kerosene.
2. Apparatus.
   a. Two 6 × 6-inch (150 × 150 mm) square 16-gauge sheet metal masks with a 100 by 100 mm 4 by 4-inch square center removed.
   b. One 6 × 6-inch (150 × 150 mm) unglazed white ceramic tile with an absorption rate of 10-18% (according to ASTM C67/C67M).
   c. Brass ring, 2-inches (50 mm) in diameter and 50 mm (2 inches) high.
   d. Kerosene meeting requirements of ASTM D3699.
   e. Silicone rubber sealant or fast-setting epoxy.
3. Procedure.
   a. Immerse the ceramic tile in distilled water for a minimum of ten minutes.
   b. Remove excess water from the tile to produce a damp surface before applying the emulsion.
   c. Using the mask described in paragraph 2.a above, apply one layer of the emulsion (mixed as specified). Spread even with the top of the mask using a spatula or other straight edge.
   d. Allow the sample to cure for 24 hours at 24°C + 1° (77°F + 2°) and 50 + 10% relative humidity.
   e. If a two-layer application is specified, position a second mask on top of the first mask. Apply a second coat of thermoplastic emulsion mixture. Spread even with the top of the second mask.
   f. Cure as in step 3.d.
   g. After curing, affix the brass ring to the seal coat on the tile with silicone rubber or epoxy.
   h. Fill the brass ring with kerosene. Add a small amount of coloring to the kerosene. The coloring may be necessary to determine if the kerosene breached the emulsion surface.
   i. After 24 hours, remove the kerosene from the brass ring, blot dry and immediately examine the film for softness and loss of adhesion. Immediately after the film is examined, break the tile in half, exposing that part of the tile whose film was subjected to the kerosene.
   j. Evaluate for penetration of kerosene through the sealer and loss of adhesion.
4. Report. Report the results as pass or fail. Visible evidence of leakage through or discoloration in the tile constitutes test failure.
5. Criterion. A "pass" rating in the fuel resistance test is required.

END OF ITEM P-629

Item P-629-S Thermoplastic Coal Tar Emulsion – Spray Sealcoat

629-S-1 DESCRIPTION

****

The performance of a seal coat product is contingent on the pavement condition at the time of application. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of the distresses, and by determining the pavement condition index (PCI) according to Advisory Circular (AC) 150/5380-7, *Airport Pavement Management Program (PMP*), and ASTM D5340. A typical asphalt pavement candidate is one with a structural condition index (SCI) deduct value of less than ten and a PCI equal to or greater than 60.

When used on any runway or taxiway pavement where aircraft operate it must include friction testing. Friction tests are required on runways and taxiways before pavement can be opened to aircraft traffic.

When choosing which type of seal coat consider that the larger the aggregate the greater the chance for foreign object degree (FOD) to be created.

May be used on areas that need a fuel resistant coating.

Sealcoat without aggregate: May be used on blast pads and shoulders.

Sealcoat with aggregate: For use on all pavements.

A thermoplastic coal tar emulsion sealcoat can be considered for use on pavements with low to moderate weathered surfaces, as defined by ASTM D5340. The thermoplastic coal tar emulsion sealcoat may be applied to new asphalt pavement and pavements in fair or better condition, as defined in ASTM D5340 or AC 150/5320-17, *Airfield Pavement Surface Evaluation and Rating (PASER) Manuals.*

The Engineer must verify the selected materials comply with federal, state, and local authority requirements.

****

629-S-1.1 This item consists of an application of a thermoplastic coal tar emulsion applied to an existing, previously prepared asphalt surface. Thermoplastic coal tar emulsion products provide a durable, fuel-resistant surface where pavements are subjected to fuel spills. Thermoplastic coal tar emulsion products assist in pavement preservation through reducing the rate of pavement oxidation. The application of the surface treatment must be according to these specifications and conform to the dimensions shown on the plans or as the Resident Project Representative (RPR) directed.

629-S-2 MATERIALS

629-S-2.1 Thermoplastic Coal Tar Emulsion.

The emulsion material must be a thermoplastic coal tar emulsion made up of plastic resin and emulsified coal tar pitch. The thermoplastic coal tar emulsion must be manufactured as a complete product and tested at the manufacturing plant for material certification. The cured thermoplastic coal tar emulsion sample must pass the fuel-resistance test according to Appendix A.

629-S-2.2 Manufacturer’s Certifications.

The Contractor must furnish the manufacturer’s Certification of Analysis (COA) that all thermoplastic coal tar emulsion shipped to the project meets the following testing requirements.

Table 629-S-2.2: Thermoplastic Coal Tar Emulsion Properties

Property	Standard	Requirement
Water content	ASTM D5727	≤ 58%
Ash of Residue	ASTM D5727	≤ 15%
Flexibility	ASTM D5727	1 rating
Resistance to Kerosene	ASTM D5727	Pass with no loss of adhesion and no softening of film
Softening Point	ASTM D36	> 212°F (100°C)

629-S-2.3 Water.

Water from a drinking water source is suitable for mixing. Water from other sources will meet the requirements of ASTM C1602. The temperature of the water added during mixing must be at least 40°F (4°C).

629-S-2.4 Handling and Storage.

All emulsion stored on-site must be agitated at least once per day for a minimum of 15 minutes. Maintain the distributor or applicator, pumps, and all tools in satisfactory working condition. Spray bar nozzles, pumps, or other equipment can be cleaned mechanically or with clean water.

629-S-2.5 Health, Safety, and Environment.

The Contractor must provide a complete Safety Data Sheet (SDS) according to U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Regulations (Standards – 29 Code of Federal Regulation (CFR), 1910.1200, which establishes the requirement and minimum information for the SDS for hazardous materials. The SDS, Section II, must include the Chemical Abstracts Service (CAS) registry numbers for all applicable hazardous ingredients in the coal tar emulsion product. The Contractor must provide the manufacturer’s certification that the product complies with the CFR Title 40 – Protection of Environment. The manufacturer’s certification must address compliance for Air Programs, Part 59, National Volatile Organic Compound Emission Standards for Consumer and Commercial Products (for the airport location) and Water Programs, Part 116, Designation of Hazardous Substances.

629-S-3 COMPOSITION AND APPLICATION

629-S-3.0 Thermoplastic Coal Tar Emulsion Sealcoat [with |without] sand aggregate.

629-S-3.1 Mixture Design.

Based on the data in this specification, the Contractor must submit the proportions of thermoplastic coal tar emulsion and aggregate proposed for use to the RPR for approval prior to the start of operations.

Table 629-S-3.1a: Application Rate Without Aggregate

Composition	Application Rate gal/yd^2 (L/m^2)
75% thermoplastic coal tar emulsion and 25% water (±5%)	0.15-0.25 (0.081-0.136)

Table 629-S-3.1b: Application Rate With Aggregate

Application Coat(s)	Aggregate Composition [1] lbs/gal (kg/L)	Mix Application Rate [2] Per Coat gal/yd^2 (L/m^2)	Total Mix Application Rate [ii] gal/yd^2 (L/m^2)
One	6 (0.72)	0.20-0.30 (0.76-1.14)	0.20-0.30 (0.76-1.14)
Two	3 (0.36)	0.10-0.15 (0.38-0.57)	0.20-0.30 (0.76-1.14)

1. Mix Aggregate (lbs) with the undiluted thermoplastic coal tar emulsion (gals).
2. Minimum application rate of uncured thermoplastic coal tar emulsion sealcoat.

629-S-3.2 Aggregate.

Use a dry, clean, dust and dirt free, sound, durable, angular shaped manufactured specialty sand, such as that used as an abrasive, with a minimum Mohs hardness of 6. The Contractor must submit manufacturer's technical data and a manufacturer's certification indicating that the specialty sand meets the requirements of the specification to the RPR prior to bid. The RPR must approve the aggregate and meet the gradation limits in Table 629-S-3.2.

Table 629-S-3.2: Aggregate Material Gradation Requirements

Sieve Designation (square openings)	Percentage by Weight Retained	Percentage by Weight Passing	Contractors Final Gradation	Job Control Tolerance[1]
No. 20 (850 µm)	0	100	*	±0%
No. 30 (600 µm)	0	100	*	±2%
No. 40 (425 µm)	0-2	98-100	*	±2%
No. 50 (300 µm)	38-42	58-62	*	±2%
No. 70 (212 µm)	41-47	15-21	*	±2%
No. 100 (150 µm)	9-12	0-3	*	±2%
No. 140 (106 µm)	0-3	0	*	±1%
No. 200 (75 µm)	0	0	*	±0%
Finer than No. 200	0	0	*	±0%

1. Apply the “Job Control Grading Band Tolerances” to the “Contractor’s Final Gradation” to establish the job control grading band.

The Contractor must provide a certification showing particle size analysis and properties of the material delivered for the project’s use.

****

The gradations in the table represent the limits in determining aggregate suitability for use in the thermoplastic coal tar emulsion sealcoat. The sand gradation used, within the limits designated in the table, must provide sufficient friction levels to meet or exceed the Maintenance Planning Friction Level in Table 3-2, “Friction Level Classification for Runway Pavement Surfaces” of AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces.*

****

629-S-3.3 Equipment and Tools.

629-S-3.3.1 Sealcoat Distributor.

The sealcoat distributor must be either a truck- or trailer-mounted 300 to 3,000-gallon (1136 to 11356 liter) tank, containing suitably driven mixing blades to combine predetermined quantities of thermoplastic emulsion, aggregate if specified. And, if necessary, to combine water into a homogeneous mixture. It must be equipped with a diaphragm style pump capable of delivering a constant volume of material to a spray wand or spray bar.

629-S-3.3.2 Auxiliary Equipment.

Provide other tools or equipment such as power brooms, power blowers, air compressors, hand brooms, hand squeegees, etc., as required.

629-S-3.3.3 Calibration.

The Contractor furnishes all equipment, materials, and labor necessary to calibrate the equipment. The equipment must be calibrated to ensure it produces and apply a mix conforming to the JMF. Commercial equipment should be provided with a method of calibration by the manufacturer. Make all calibrations with the approved job materials prior to applying the sealcoat to the pavement.

629-S-3.4 Control Strip.

Prior to full production, the Contractor must prepare a minimum of two control strips, at varying application rates to demonstrate the material, equipment, construction process and to determine the application rate and number of coats. Strips must be a minimum of 200 feet long by a minimum of 12 feet wide on representative sections of pavement, as recommended by the RPR. If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

****

For surface treatments on runway and rapid exit taxiway surfaces. Include before and after testing for skid resistance.

****

[Before beginning the control strip, determine the skid resistance of the existing pavement at the location where the control strip will be placed with continuous friction measuring equipment (CFME). Place control strips and after the surface treatment has cured perform another skid resistance tests at approximately the same location as the test done on the existing pavement. Do not permit aircraft on the runway or taxiway control strips until the Contractor validates that its surface friction meets or exceeds the Maintenance Planning levels provided in AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-resistant Airport Pavement Surfaces*, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME.]

If the control strip should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment, and place additional control strips. Do not begin full production until the RPR accepts the control strip. The surface preparation, personnel, materials, equipment, method of operation and rate of application used on the acceptable control strip must be used during production.

629-S-4 CONSTRUCTION METHODS

629-S-4.1 Worker Safety.

The Contractor must obtain a SDS for both the thermoplastic coal tar emulsion product and aggregate and require workers to follow the manufacturer’s recommended safety precautions.

629-S-4.2 Weather Limitations.

Do not apply the material when the impending weather conditions will not allow proper drying or when the atmospheric or pavement temperature is below 45°F (7°C), unless the RPR directs otherwise. During application of thermoplastic coal tar emulsion surface treatment, account for wind drift. Cover runway edge lights, taxiway edge lights, informational signs, retro-reflective markings, and in-pavement duct markers as necessary, to protect against overspray before applying the emulsion. If thermoplastic coal tar emulsion surface treatment gets on any light or marker fixture, promptly clean the fixture. If cleaning is not to the RPR’s satisfaction the Contractor must replace any light, sign, or marker with equivalent equipment at no cost to the Owner.

629-S-4.3 Asphalt Pavement Surface Preparation

Clean the pavement surface immediately prior to placing the surface treatment so it is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease by scrubbing with a detergent, then wash thoroughly with clean water. Any additional surface preparation, such as crack repair, must be according to Item P-101.

629-S-4.4 Application.

If multiple coats are specified, allow each coat to dry and cure initially before applying any subsequent coats. The initial drying is complete when water has evaporated from the applied mixture, resulting in the coating being able to sustain light foot traffic. Pavement surfaces having excessive surface grade, which could lead to excessive runoff, must be treated in two or more applications at the specified application rate at no additional cost to the Owner.

If low spots and depressions greater than ½ inch (12 mm) in depth in the pavement surface cause ponding or puddling of the applied materials, broom the pavement surface with a broom drag. Continue brooming until the pavement surface is free of any pools of excess material. Ponding and/or puddling must not cause excessive pavement softening and/or additional distress. During all applications, protect the surfaces of adjacent structures to prevent being spattered or marred. Do not discharge thermoplastic coal tar emulsion materials into borrow pits or gutters.

629-S-6 MATERIAL ACCEPTANCE

629-S-6.1 Friction Tests.

[Not used. | Friction tests according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, must be accomplished on all runway and rapid exit taxiways that have received a seal coat. The Contractor must coordinate testing with the RPR and provide the RPR the opportunity to be present during testing.

Each test includes performing friction tests at 40 mph and 60 mph, (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline.

Do not permit aircraft on the runway or rapid exit taxiway until the testing validates that surface friction is at or above the maintenance planning friction levels in AC 150/5320-12, Table 3-2, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME. Areas are not acceptable for payment until they surface friction is at or above the maintenance planning friction levels.

The Contractor must provide the RPR a written report of friction test results.].

629-S-7 METHOD OF MEASUREMENT

629-S-7.1 Measurement.

The Thermoplastic Coal Tar Emulsion [Sealcoat with Sand Aggregate | Sealcoat without Sand Aggregate] is measured by the square yard (square meter) of the area indicated on the contract drawings or the Engineer designated.

629-S-8 BASIS OF PAYMENT

629-S-8.1 Payment.

Payment is made at the contract unit price per square yard (square meter) for the Thermoplastic Coal Tar Emulsion **[** `Sealcoat with Sand Aggregate` **|** `Sealcoat without Sand Aggregate` **]**. This price is full compensation for furnishing all materials and all labor, equipment tools, and incidentals necessary to complete the thermoplastic coal tar emulsion product installation, including mix design and data sheets and testing stipulated in these specifications.

Payments are made under:

Item P-629-S-8.1	Thermoplastic coal tar emulsion **[** `Sealcoat with Sand Aggregate` **|** `Sealcoat without Sand Aggregate` **]** – per square yard **[** `square meter` **]**.
[`Item P-629-S-8.2`	`Runway and High-Speed Exit Taxiway Friction Testing – per lump sum` **|** `Not required` **]**.

629-S-9 REFERENCES

629-S-9.1 This list of publications forms 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 D36	*Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)*
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 C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D140	*Standard Practice for Sampling Bituminous Materials*
ASTM D5340	*Standard Test Method for Airport Pavement Condition Index Surveys*
ASTM D5727	*Standard Specification for Emulsified Refined Coal Tar (Mineral Colloid Type)*

Advisory Circulars (AC)

AC 150/5320-12	*Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*
AC 150/5320-17	*Airfield Pavement Surface Evaluation and Rating (PASER) Manuals*

Code of Federal Regulations (CFR)

29 CFR Part 1910.1200	*Hazard Communication*
40 CFR	*Protection of the Environment*

APPENDIX A LABORATORY FUEL RESISTANCE TEST

1. Scope. This method determines the resistance of the emulsion to kerosene.
2. Apparatus.
    a. Two 6 × 6-inch (150 × 150 mm) square 16-gauge sheet metal masks with a 4 × 4-inch square (100 × 100 mm) center removed.
    b. One 6 × 6-inch (150 × 150 mm) unglazed white ceramic tile with an absorption rate of 10-18% (according to ASTM C67/C67M).
    c. Brass ring, 2 inches (50 mm) in diameter and 2 inches (50 mm) high.
    d. Kerosene meeting requirements of ASTM D3699.
    e. Silicone rubber sealant or fast-setting epoxy.
3. Procedure.
    a. Immerse the ceramic tile in distilled water for a minimum of ten minutes.
    b. Remove excess water from the tile to produce a damp surface before applying the emulsion.
    c. Using the mask described in paragraph 2.a above, apply one layer of the emulsion (mixed as specified). Spread even with the top of the mask using a spatula or other straight edge.
    d. Allow the sample to cure for 24 hours at 24°C + 1° (77°F + 2°) and 50 + 10% relative humidity.
    e. If a two-layer application is specified, position a second mask on top of the first mask. Apply a second coat of thermoplastic emulsion mixture. Spread evenly with the top of the second mask.
    f. Cure as in step 3.d.
    g. After curing, affix the brass ring to the seal coat on the tile with silicone rubber or epoxy.
    h. Fill the brass ring with kerosene. Add a small amount of coloring to the kerosene. The coloring may be necessary to determine if the kerosene breached the emulsion surface.
    i. After 24 hours, remove the kerosene from the brass ring, blot dry, and immediately examine the film for softness and loss of adhesion. Immediately after the film is examined, break the tile in half, exposing that part of the tile whose film was subjected to the kerosene.
    j. Evaluate for penetration of kerosene through the sealer and loss of adhesion.
4. Report. Report the results as pass or fail. Visible evidence of leakage through or discoloration in the tile constitutes test failure.
5. Criterion. A "pass" rating in the fuel resistance test is required.

END OF ITEM P-629-S

Item P-630 Refined Coal Tar Surface Treatment

630-1 DESCRIPTION

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This surface treatment is for apron locations serving aircraft 60,000 lbs (27216 kg) or less that need a fuel resistant surface treatment. Note Item P-401 with a fuel resistant binder, or Item P-629, Item P-629-S, Item P-635 are also options for fuel resistant treatments.

Consult local and state environmental/safety regulations. Many locations prohibit the use of coal tar products. The Engineer must verify the selected materials comply with federal, state, and local authority requirements.

****

630-1.1 This item consists of a mixture of emulsified asphalt, mineral aggregate, and water properly proportioned, mixed, and spread on an asphalt pavement surface. The purpose of this refined coal tar emulsion product is to provide a fuel-resistant surface where pavements are subjected to fuel spills. The application of the surface treatment must be according to these specifications and conform to the dimensions shown on the plans, or as the Resident Project Representative (RPR) directed.

630-1.2 General.

This item must consist of a mixture of refined coal tar emulsion, mineral aggregate, additives, and water properly proportioned, mixed, and applied as a slurry seal on new or existing (aged) asphalt concrete pavement.

630-2 MATERIALS

630-2.1 Refined Coal Tar Emulsion.

A refined coal tar emulsion prepared from a high temperature refined coal tar conforming to the requirements of ASTM D490 for grade 11-12. The use of oil and water gas tar is not permitted. The refined coal tar emulsion must conform to all requirements of ASTM D5727. The cured refined coal tar emulsion must pass the fuel-resistance test according to Appendix A.

The Contractor must provide a copy of the manufacturer’s Certificate of Analysis (COA) for the emulsified asphalt delivered to the project. If the asphalt emulsion is diluted at other than the manufacturer’s facility, the Contractor provides a supplemental COA from an independent laboratory verifying the asphalt emulsion properties.

The COA must be provided to, and approved by, the RPR before applying the emulsified asphalt. Furnishing the vendor's certified test report for the asphalt material is not a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project for the project's use.

630-2.1.1 Health, Safety, and Environment.

The Contractor must provide a complete Safety Data Sheet (SDS) according to U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Regulations (Standards – 29 CFR), 1910.1200 which establishes the requirement and minimum information for the Material Safety Data Sheet (MSDS) for hazardous materials. The MSDS, Section II, must include the Chemical Abstracts Service (CAS) registry numbers for all applicable hazardous ingredients in the coal tar emulsion product. The Contractor must provide the manufacturer's certification that the product complies with the Code of Federal Regulation (CFR) Title 40 – Protection of Environment. The manufacturer's certification must address compliance for Air Programs, Part 59, National Volatile Organic Compound Emission Standards for Consumer and Commercial Products (for the airport location) and Water Programs, Part 116, Designation of Hazardous Substances.

630-2.2 Aggregate.

The aggregate must be washed, dry, silica sand, or boiler slag free of dust, trash, clay, organic materials, or other deleterious substances. The aggregate must be either a 20/40 or 30/70 sand gradation. The refined coal tar emulsion supplier must give written approval of the aggregate used in the mix design.

630-2.3 Additive.

As specified by the coal tar emulsion manufacturer.

****

Additives are one or more ingredients that can be added to a specific refined coal tar emulsion, water, and/or sand mixture to improve the coatings final properties. These properties include durability, fuel resistance, drying time, color uniformity, and/or length of cure time. Additives may also be used to modify the wet mixture's viscosity to improve aggregate suspension.

The type of additive to be used should be specified by the coal tar emulsion manufacturer and depends on the final desired properties.

The Engineer should specify the desired properties.

****

630-2.4 Water.

Water from a drinking water source is suitable for mixing. Water from other sources must meet the requirements of ASTM C1602. Water used in mixing or curing must be at least 50ºF (10ºC). The pH of the water must conform to the requirements of the coal tar emulsion manufacturer.

630-2.5 Crack Sealant.

Crack sealant must be certified for compatibility with the refined coal tar emulsion by the manufacturer of the refined coal tar emulsion and RPR approved.

630-2.6 Oil Spot Primer.

Oil spot primer must be certified for compatibility with the refined coal tar emulsion by the manufacturer of the refined coal tar emulsion and RPR approved.

630-2.7 Pavement Primer.

Pavement primer must be certified for compatibility with the refined coal tar emulsion by the manufacturer of the refined coal tar emulsion, and RPR approved.

630-3 COMPOSITION AND APPLICATION

630-3.1 Composition.

The refined coal tar emulsion seal coat consists of a mixture of refined coal tar emulsion, additives, water, and aggregate, and proportioned as shown Table 630-3.2. The composition must have written approval of the coal tar emulsion manufacturer.

630-3.2 Mixture Design.

The Contractor must submit the recommended formulation of water, emulsion, additives, aggregate, and application rate proposed for use to a testing laboratory together with sufficient materials to verify the formulation at least **[__]** days prior to the start of operations. The mix design must be within the range shown in Table 630-3.2. Do not produce a seal coat for payment until a mix has been approved by the RPR. The formulation must pass the fuel resistance test in Appendix A of this specification. Submit the mixture design and recommended application rate to the RPR. Mixture design must include amounts of water, emulsion, additives, aggregate, and results of laboratory testing on materials and mixture.

****

Improper formulations of coal tar pitch emulsion seal produce coatings that crack prematurely or do not adhere properly to the pavement surface. A minimum of five days is recommended for job mix approval.

****

Table 630-3.2: Mixture Composition Per 100 Gallons (379 Liters) of Refined Coal Tar Emulsion

Application	Refined Coal Tar Emulsion Gallons (Liters)	Water Gallons (Liters)	Aggregate lb (km)	Formula Rate of Application of Mix per Square Yard (Square Meter)	
				Minimum Gallons (Liters)	Maximum Gallons (Liters)
	Prime Coat (where required) as Specified by the Coal Tar Emulsion Manufacturer				
First Seal Coat	100 (379)	25-30 (95-114)	300-500 (136-228)	0.12 (0.54)	0.17 (0.77)
Second Seal Coat	100 (379)	25-30 (95-114)	300-500 (136-228)	0.12 (0.54)	0.17 (0.77)

****

The numbers shown in the table represent the maximum recommended range of values. In all cases, the refined coal tar emulsion supplier is to gives written approval of specific composition numbers to be used in the mix design.

Some specifications covering this type of coating allowed sand loadings in excess of 10 lbs per gallon (1.2 kg/L) of refined coal tar emulsion. These coatings have not performed well in the field due to poor fuel resistance and loss of adhesion and are not recommended.

Additional coats may be specified for greater durability.

****

630-3.3 Application Rate.

Application rates are not to exceed 0.17 gal/yd2/coat (0.77 liters/m2/coat), and at no time are total coats to exceed 0.51 gal/yd2 (2.3 liters/m2).

630-3.4 Control Strip.

Prior to full production, the Contractor must prepare a minimum of two control strips, at varying application rates to demonstrate the material, equipment, construction process and to determine the application rate and number of coats. Strips must be a minimum of 200 feet long by a minimum of 12 feet wide on representative sections of pavement, as recommended by the RPR. If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

****

For surface treatments on runway and rapid exit taxiway surfaces. Include before and after testing for skid resistance.

****

[Before beginning the control strip, determine the skid resistance of the existing pavement at the location where the control strip will be placed with continuous friction measuring equipment (CFME). Place control strips and after the surface treatment has cured perform another skid resistance tests at approximately the same location as the test done on the existing pavement. Do not permit aircraft on the runway or taxiway control strips until the Contractor validates that its surface friction meets or exceeds the Maintenance Planning levels provided in AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-resistant Airport Pavement Surfaces*, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME. **]**

If the control strip should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment, and place additional control strips. Do not begin full production until the RPR accepts the control strip. The surface preparation, personnel, materials, equipment, method of operation and rate of application used on the acceptable control strip must be used during production.

****

The control strip affords the Contractor and the Engineer an opportunity to determine the quality of the mixture in place, as well as the equipment's performance.

The application rate depends on the surface texture.

If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

The only test required on the composite mix placed in the field is the viscosity test. The fuel resistance test may be specified; however, this test takes 96 hours to run.

****

630-4 CONSTRUCTION METHODS

630-4.1 Weather Limitations.

Do not apply the seal coat when the surface is wet or when the humidity or impending weather conditions will not allow proper curing. Only apply the seal coat when the atmospheric and pavement temperature is 50°F (10°C) and rising and is expected to remain above 50°F (10°C) for 24 hours, unless otherwise directed by the RPR.

630-4.2 Equipment and Tools.

The Contractor furnishes all equipment, tools, and machinery necessary for the performance of the work.

630-4.2.1 Distributors.

Distributors or spray units used for the spray application of the seal coat must be self-propelled and capable of uniformly applying 0.12 to 0.55 gallons per square yard (0.54 to 2.5 liters per square meter) of material over the required width of application. Equip distributors with removable manhole covers, tachometers, pressure gauges, and volume-measuring devices. The mix tank will have a mechanically powered, full-sweep, mixer with sufficient power to move and homogeneously mix the entire contents of the tank. Equip the distributor with a positive placement pump so that a constant pressure can be maintained on the mixture to the spray nozzles.

630-4.2.2 Mixing Equipment.

The mixing machine must have a continuous flow mixing unit capable of accurately delivering a predetermined proportion of aggregate, water, and emulsion, and of discharging the thoroughly mixed product on a continuous basis. The mixing unit must be able to thoroughly blend all ingredients together and discharge the material to the spreader box without segregation. During the entire mixing and application process, no breaking, segregating, or hardening of the emulsion, nor balling or lumping of the aggregate is permitted. Continue agitating the seal coat mixture in the mixing tank at all times prior to and during application so that a consistent mix is available for application.

630-4.2.3 Spreading Equipment.

Uniformly spread the mixture using a conventional surfacing spreader box attached to the mixer. A front seal must be provided to ensure no loss of the mixture at the surface contact point. The rear seal will act as the final strike-off and must be adjustable. The spreader box and rear strike-off must be designed and operated to produce a free flow of material of uniform consistency. The spreader box must provide suitable means to shift the box to compensate for variations in the pavement geometry. A burlap drag or other approved screed may be attached to the rear of the spreader box to provide a uniform mat.

630-4.2.4 Hand Squeegee or Brush Application.

The use of hand spreading application is restricted to places not accessible to the mechanized equipment. Material applied by hand will meet the same standards as that applied by machine.

630-4.2.5 Calibration.

The Contractor must furnish all equipment, materials, and labor necessary to calibrate the equipment. It must be calibrated to ensure that it will produce and apply a mix that conforms to the JMF. Commercial equipment should be provided with a method of calibration by the manufacturer. Make all calibrations with the approved job materials prior to applying the seal coat to the pavement. Submit the calibration test results to the RPR.

630-4.3 Preparation of Asphalt Pavement Surfaces.

Clean pavement surface immediately prior to placing the seal coat by sweeping, flushing well with water leaving no standing water, or a combination of both, so that it is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease that has not penetrated the asphalt pavement by scraping or by scrubbing with a detergent, then wash thoroughly with clean water. After cleaning, treat these areas with the oil spot primer. Any additional surface preparation, such as crack repair, is according to Item P-101.

630-4.4 Application of Slurry Seal Surface Treatment.

Apply the surface treatment at the rate as determined in paragraph 630-3.4. Allow each coat to dry and cure initially before applying any subsequent coats. The initial drying allows evaporation of water of the applied mixture, resulting in the coating being able to sustain light foot traffic. The initial curing enables the mixture to withstand vehicle traffic without damage to the seal coat.

Apply the second coat in the same manner as outlined for the first coat. The finished surface must present a uniform texture. Allow the final coat to dry a minimum of eight hours in dry daylight conditions before opening to traffic. Where marginal weather conditions exist during the eight-hour drying time, additional drying time is required. The supplier specifies the length of time. Check the surface after the additional drying time for trafficability before opening the section to vehicle traffic. Where marking is required, the paint must meet the requirements of Item P-620 and be compatible with the seal coat and as recommended by the coal tar emulsion manufacturer.

630-5 QUALITY CONTROL

630-5.1 Records.

The Contractor must maintain an accurate record of each batch of materials used in the formulation of the seal coat and provide the documentation to the RPR daily.

630-6 METHOD OF MEASUREMENT

630-6.1 Refined Coal Tar Surface Treatment.

The quantity of surface treatment is measured by the square yards **[** `square meters` **]** of material applied according to the plans and specifications and accepted by the RPR.

630-7 BASIS OF PAYMENT

630-7.1 Payment is made at the contract unit price per square yard **[** `square meter` **]** for the surface treatment applied and the RPR accepted. This price is full compensation for all surface preparation, furnishing all materials, delivery, and application of these materials, for all labor, equipment, tools, and incidentals necessary to complete the item control strip.

Payment is made under:

Item P-630-7.1	Refined Coal Tar Emulsion for Slurry Coat - per **[** `square yard (square meter)` **]**

630-8 REFERENCES

630-8.1 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 C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D490	*Standard Specification for Road Tar*
ASTM D5727	*Standard Specification for Emulsified Refined Coal Tar (Mineral Colloid Type)*

Code of Federal Regulations (CFR)

29 CFR Part 1910.1200	*Hazard Communication*
40 CFR	*Protection of the Environment*

APPENDIX A LABORATORY FUEL RESISTANCE TEST

1. Scope. This method determines the resistance of the emulsion to kerosene.
2. Apparatus.
    a. Two 6 × 6-inch (150 × 150 mm) square 16-gauge sheet metal masks with a 4 × 4-inch square (100 × 100 mm) center removed.
    b. One 6 × 6-inch (150 × 150 mm) unglazed white ceramic tile with an absorption rate of 10-18% (according to ASTM C67/C67M).
    c. Brass ring, 2 inches (50 mm) in diameter and 2 inches (50 mm) high.
    d. Kerosene meeting requirements of ASTM D3699.
    e. Silicone rubber sealant or fast-setting epoxy.
3. Procedure.
    a. Immerse the ceramic tile in distilled water for a minimum of ten minutes.
    b. Remove excess water from the tile to produce a damp surface before applying the emulsion.
    c. Using the mask described in paragraph 2.a above, apply one layer of the emulsion (mixed as specified). Spread evenly with the top of the mask using a spatula or other straight edge.
    d. Allow the sample to cure for 24 hours at 24°C + 1° (77°F + 2°) and 50% + 10% relative humidity.
    e. If a two-layer application is specified, position a second mask on top of the first mask. Apply a second coat of thermoplastic emulsion mixture. Spread evenly with the top of the second mask.
    f. Cure as in step 3.d.
    g. After curing, affix the brass ring to the seal coat on the tile with silicone rubber or epoxy.
    h. Fill the brass ring with kerosene. Add a small amount of coloring to the kerosene. The coloring may be necessary to determine if the kerosene breached the emulsion surface.
    i. After 24 hours, remove the kerosene from the brass ring, blot dry, and immediately examine the film for softness and loss of adhesion. Immediately after the film is examined, break the tile in half, exposing the part of the tile whose film was subjected to the kerosene.
    j. Evaluate for penetration of kerosene through the sealer and loss of adhesion.
4. Report. Report the results as pass or fail. Visible evidence of leakage through, or discoloration in the tile, constitutes test failure.
5. Criterion. A "pass" rating in the fuel resistance test is required.

END OF ITEM P-630

Item P-632 Asphalt Pavement Rejuvenation

632-1 DESCRIPTION

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Asphalt pavement rejuvenation is for use on any pavements on which aircraft do not operate including shoulders, overruns, roads, and parking areas. It may be used on airport pavements, except runways and acute-rapid exit taxiways, at airports serving aircraft less than 60,000 lbs (27216 kg).

Asphalt pavement rejuvenation, commonly called a "fog seal," can be considered for use on pavements with low to moderate weathered surfaces, as defined by ASTM D5340.

Prior to the use of P-632, the Engineer must check with federal, state, and local authorities on the use of products containing volatile organic compounds (VOC) and/or coal tar. The Engineer must verify the selected materials comply with authority requirements. The Engineer must verify the selected materials comply with federal, state, and local authority requirements.

****

632-1.1 This item consists of a rejuvenator properly proportioned, mixed, and spread on an asphalt pavement surface, roads, and other general applications. The application of the rejuvenator must be according to these specifications and conform to the dimensions shown on the plans or as the Resident Project Representative (RPR) directed.

The term "rejuvenation product" carries the same connotation as the term "rejuvenator" or "rejuvenator/sealer." The term "rejuvenation product" is used throughout this specification for the purpose of recognizing rejuvenation performance for each class of rejuvenation products.

632-1.2 Asphalt Pavement Rejuvenation.

This item governs the application of an asphalt pavement rejuvenation product applied to a previously placed asphalt surface according to these specifications, as shown on the plans, or as the RPR directed. The purpose of this product is rejuvenation of the upper ⅜ inch (9 mm) of oxidized or otherwise aged asphalt binder without causing an unacceptable reduction in the friction characteristics (skid resistance) of the pavement section. Additionally, the rejuvenation product should not introduce unacceptable pavement distresses such as raveling, high temperature deformation (rutting), or loss of strength. The rejuvenation product should not contribute to accelerated deterioration of the pavement.

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Project Selection. The performance of a rejuvenation product is contingent on the pavement condition at the time of application. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of the distresses, and determining the pavement condition index (PCI), according to ASTM D5340. A typical asphalt pavement candidate for rejuvenation is one without structural load associated distresses (or has provisions to correct these distresses), and with low to moderate environmental, temperature associated distresses. The recommended corrected PCI should be equal to or greater than 70 to qualify as a candidate for asphalt rejuvenation.

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632-2 MATERIALS

632-2.1 Rejuvenation Product.

632-2.1.1 The rejuvenation product must be able to achieve the minimum changes in the asphalt binder properties shown in Tables 632-2.1a or 632-2.1b. after proper application and field exposure.

632-2.1.2 The binder extracted per ASTM D2172, Method A, and recovered per ASTM D1856 or ASTM D5404 from samples of the upper ⅜ inch (9 mm) of the surface of the treated pavement, must exhibit the percent decrease in absolute viscosity or complex viscosity and corresponding phase angle increase, listed in Tables 632-2.1a or 632-2.1b, when compared to the values from adjacent untreated samples from the same pavement in the prescribed timeframe.

632-2.1.3 The submittal must include, from previous projects, independent laboratory test results accredited by an American Association of State Highway Transportation Officials (AASHTO) Materials Reference Laboratory (AMRL). The test results should verify the ability of the proposed rejuvenation product to achieve the minimum changes in asphalt binder properties shown in Tables 632-2.1a or 632-2.1b.

Table 632-2.1a: Asphalt Pavement Three Years or Less in Age

Item	Property of Recovered Binder [1]	Requirement	Test Method
1	Absolute Viscosity $_{60°C}$, P	≥ 25% Decrease[2]	ASTM D2171
2a	Complex Modulus $_{60°C}$, G*		AASHTO T315
2b	Viscosity $_{60°C}$, $\eta = G^*/\acute{\omega}$ Pa·s		
2c	Phase Angle $_{60°C}$, δ,°	Report	

Table 632-2.1b: Asphalt Pavement More Than Three Years in Age

Item	Property of Recovered Binder [1]	Requirement	Test Method
1	Absolute Viscosity $_{60^\circ C}$, P	≥ 40% Decrease [1]	ASTM D2171
2a	Complex Modulus $_{60^\circ C}$, G*, kPa		AASHTO T315
2b	Viscosity $_{60^\circ C}$, $\eta^* = G^*/\acute{\omega}$ Pa·s		
2c	Phase Angle $_{60^\circ C}$, δ,°	Report	

[1] Procedures: Sample collection for application and acceptance as noted in this specification. Sample weights and measure by ASTM D3549; Extraction by ASTM D2172, Method A using toluene (conditioning to remove moisture will not be accomplished); Recovery by ASTM D1856 (Abson) or ASTM D5404 (Roto-Vap); and binder extraction, recovery, and testing within 48 hours of obtaining pavement cores or equivalent surface area samples.

632-2.1.4 The Contractor provides a copy of the manufacturer's Certificate of Analysis (COA) for the emulsified asphalt delivered to the project. If the asphalt emulsion is diluted at other than the manufacturer's facility, the Contractor provides a supplemental COA from an independent laboratory verifying the asphalt emulsion properties.

The RPR must receive and approve the COA before the emulsified asphalt is applied. Do not interpret furnishing of the vendor's certified test report for the asphalt material as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for the project's use.

632-2.2 Rejuvenation Documentation/Certification.

632-2.2.1 Performance.

The submittal must include documentation of previous use and test data conclusively demonstrating that the rejuvenation product has been used successfully for a period of two or more years by other user agencies; and that the asphalt rejuvenation product has proven to perform in a manner equivalent to this specification, as demonstrated through field testing by an independent testing laboratory, as to the required change in the recovered asphalt binder properties. Submit testing data indicating such product performance from at least two projects representative of two different asphalt mix designs, each tested for a minimum of two years to ensure reasonable longevity of the treatment, as well as product consistency. Present performance documentation from a geographically similar climatic region of the United States as that of this project, e.g., wet-warm, wet-cool, dry-warm, and dry-cool, and contain data specified in paragraph 632-2.1.3.

632-2.2.2 Friction Characteristics.

[Not required. |The Contractor must submit to the RPR friction tests, from previous airport projects which used the rejuvenation product in a similar environment, according to Advisory Circular (AC) 150/5320-12, at 40 mph (65 km/h) wet, showing, as a minimum; friction value of pavement surface prior to sealant application; two values, tested between 24 and 96 hours after application, with a minimum of 24 hours between tests; and one value tested at no less than 180 days or greater than 360 days after the application.

The results of the two tests between 24 and 96 hours indicate friction is increasing at a rate to obtain similar friction value of the pavement surface prior to application. The long-term test must not indicate any apparent adverse effect with time relative to friction values and existing pavement surface. The Contractor must submit to the RPR a list of airports meeting the above requirements, as well as technical details on application rates, aggregate rates, and the point-of-contact (POC)at these airports to confirm use and success of sealer. Submit friction tests from no less than one of the airports on the list. Each set of tests described above, must be from one project. The RPR will not approve submittals without the required friction performance. Friction tests performed on this project cannot be used as a substitute of this requirement. **]**

632-2.2.3 Health, Safety, and Environment.

The Contractor must provide a complete Safety Data Sheet (SDS) according to U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Regulations (Standards – 29 Code of Federal Regulation (CFR), 1910.1200 establishing the requirement and minimum information for the SDS for hazardous materials. The SDS, Section II, includes the Chemical Abstracts Service (CAS) registry numbers for all applicable hazardous ingredients in the rejuvenation product. The Contractor must provide the manufacturer’s certification that the rejuvenation product complies with the CFR Title 40 – Protection of Environment. The manufacturer’s certification must address compliance for Air Programs, Part 59, National Volatile Organic Compound Emission Standards for Consumer and Commercial Products (for the airport location) and Water Programs, Part 116, Designation of Hazardous Substances.

632-3 APPLICATION RATE

632-3.1 Control Areas and Control Strips.

The Contractor must place a series of test areas/sections at application rates, as judged necessary by the manufacturer, to establish the appropriate project application rates for the specific product. As a minimum, a test area/section is required for each different asphalt mix design identified in the project. Separate control strips by a minimum of 200 feet between sections. Utilize the same equipment and method of operation utilized on the control area(s) and/or control strip(s) as utilized on the remainder of the work.

The Contractor must select test areas/sections to obtain pavement cores or saw cut “slabs” (equivalent surface area samples) according to paragraph 632-6.3. Take the pavement cores or equivalent surface area samples after application of the rejuvenation control strips is fully cured. Test the pavement cores according to Tables 632-2.1a or 632-2.1b., Items 1 and 2a, and paragraph 632-2.1 for the purpose of determining a recommendation for the rejuvenation product application rates. The Contractor is responsible for all sampling and testing associated with the control strips.

For runway and taxiway surfaces, the Contractor must place control strips to determine skid resistance. Determine the skid resistance of the existing pavement for each test areas/section with a continuous friction measuring equipment (CFME). Test areas must be a minimum of 300 feet (90 m) long by 12 feet (3.6 m) wide, or width of anticipated application, whichever is greater. The area to be tested must be located on a representative section of the pavement to receive the surface treatment the RPR designated. Place the test areas/sections under similar field conditions as anticipated for the actual application. The skid resistance test after application should be at approximately the same location as the test done on the existing pavement. The Contractor may begin testing the skid resistance of control strips after the asphalt surface treatment fully cures. Do not permit aircraft on the runway or taxiway control strips until such time as the Contractor validates that its surface friction meets the minimum friction levels in AC 150/5320-12, Table 3-2, when tested at speeds of 40 and 60 mph (65 and 95km/h), wet with approved CFME.

Do not begin full production without the RPR’s approval of an appropriate application rate(s). Pay for acceptable test areas/sections according to paragraph 632-8.1. Remove and replace any pavement test areas/sections damaged by the surface treatment the RPR directed at the Contractor’s expense.

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For projects calling for application of the surface treatment on runway and taxiway, the Engineer documents skid resistance according to Advisory Circular (AC) 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, prior to full application.

The test areas/sections afford the Contractor and the Engineer an opportunity to determine the quality of the mixture in place, as well as the equipment’s performance. Climate/weather conditions may significantly

affect cure time, e.g., the time necessary to achieve acceptable friction results. If operational conditions preclude placement of a control strip on the pavement to be seal coated, it may be applied on a pavement with similar surface texture.

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632-3.2 Approval.

The Contractor and the RPR must examine the control strips 24 hours after treatment to determine if the entire rejuvenation product penetrated the surface. Application rates not fully penetrating the pavement surface after 24 hours are not acceptable. The Contractor determines the application rates for full production Contractor and the RPR approves, based on the control strips and control strip data from paragraph 632-3.1.

632-4 CONSTRUCTION

632-4.1 Worker Safety.

The rejuvenation product must be handled with caution. The Contractor must obtain a SDS for the rejuvenation product and require workers to follow the manufacturer's recommended safety precautions.

632-4.2 Weather Limitations.

Only apply the rejuvenation product when the existing surface is dry, and the weather forecast is according to the manufacturer's recommendations for application and curing. Do not apply the rejuvenation product during inclement weather or when rain or freezing temperatures are anticipated within 24 hours before or after application. At their discretion, the RPR may suspend the job or require remedial action, as deemed necessary, if weather conditions interfere with application and/or curing.

During application, account for wind drift. Cover existing buildings, structures, runway edge lights, taxiway edge lights, informational signs, retro-reflective markings, and in-pavement duct markers, as necessary to protect against overspray before applying the rejuvenation product. If the rejuvenation product gets on any light or marker fixture, promptly clean the fixture. If cleaning is not to the RPRs satisfaction, the Contractor must replace any light, sign, or marker with equivalent equipment at no cost to the Owner.

632-4.3 Equipment.

The Contractor furnishes all equipment and hardware necessary for the performance of the work. Require that the rejuvenation product be delivered in dedicated tankers and/or containers with agitating equipment and filters, per manufacturer's recommendations. The distributor must be designed and equipped according to the manufacturer's recommendations, but include as a minimum, the following characteristics:

1. Adequate heating capability for rapid heating of the rejuvenator to the proper application temperature.
2. A positive displacement pump capable of pumping low viscosity material and providing a preselected constant pressure to deliver the specified rates of application.
3. A full circulation spray bar and applicator that maintains proper nozzles, and provides the specified rate of application.
4. A hooded spray bar and applicator that maintains proper nozzle height.
5. A positive shut-off for the spray bar and a hand spray (with hose) equipped with a positive shut-off at the spray gun.
6. A thermometer installed in the distributor tank to measure the temperature of the rejuvenation product at the time of the application.
7. A speedometer calibrated to a minimum of tenths of miles per hour.
8. A chart listing the capacity of the tank (in gallons (liters)) for each 1 inch (25 mm) of depth. Also include a chart showing speed/pressure application rates.

632-4.4 Asphalt Pavement Surface Preparation.

Clean the pavement surface immediately prior to placing the seal coat so that it is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease from the asphalt pavement by scrubbing with a detergent, washing thoroughly with clean water, and treating these areas with the oil spot primer. Any additional surface preparation, such as crack repair, must be according to Item P-101.

632-4.5 Application of Rejuvenation Product.

632-4.5.1 Following preparation and subsequent inspection of the surface and consideration for skid resistance, uniformly apply the rejuvenation product over the surface to be treated at the approved rate with an allowable variation from the approved rate of application of ±5%, according to ASTM D2995.

632-4.5.2 Apply materials at the temperature recommended by the manufacturer.

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To obtain uniform application of the material on the surface treated at the junction of previous and subsequent applications, spread heavy paper or cardboard or equivalent technique on the surface at a sufficient distance back from the ends of each application so the material may be started and stopped on the paper.

Immediately after application, remove the building paper and properly dispose. Areas missed by the distributor must be properly treated with the

hand spray. Following application of the rejuvenation product, do not disturb the surface for a period of at least 24 hours.

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632-4.5.3 Other rejuvenation product application procedures include:

632-4.5.3.1 Calibration Test.

The Contractor furnishes all equipment, materials, and labor necessary to calibrate the asphalt distributor or other application equipment. Adjust calibration with approved job materials and prior to applying the rejuvenation product to the prepared surface. Calibration of the asphalt distributor and the specialized asphalt spray applicator must be according to ASTM D2995.

632-4.5.3.2 Excess Rejuvenation Product Removal.

The Contractor must provide manufactured sand, as the RPR approved, at no additional costs and spread in sufficient quantity to effectively blot up any excess rejuvenation product remaining on the treated pavement surface after 24 hours, at no additional costs.

632-4.5.3.3 Ponding and Puddling of Rejuvenation Product.

Broom the pavement surface with a broom drag, if low spots and depressions in the pavement surface cause ponding or puddling of the rejuvenation product, the pavement surface. Continue brooming until the pavement surface is free of any pools of excess material. Ponding and/or puddling must not cause excess pavement softening and/or additional distress. The RPR must inspect and approve areas after brooming.

632-4.5.3.4 Excess Runoff of Rejuvenation Product.

Reduce the application rate, and notify the RPR, if the surface grade of the pavement surface causes excessive runoff of the rejuvenation product. Additional rejuvenation product, if necessary, may be applied after the first application of material has penetrated the pavement to achieve the required properties of the treated binder.

632-4.5.3.5 Insufficient Rejuvenation Product.

When the RPR determines that the actual application rate of the rejuvenation product is greater than 5% below the approved application rate, make subsequent applications of materials to bring the actual application rate up to the approved rate. Additional rejuvenation product must penetrate the pavement surface within 24 hours after application. The RPR may require multiple applications requiring additional pavement sampling and rejuvenation testing to ensure compliance with paragraph 632-2.1.

632-4.6 Cure Time Remedial Option – Application of Sand.

632-4.6.1 The Contractor must apply sand to the surface of the treated asphalt pavement if the rejuvenation product does not meet the cure time requirement and/or the frictional characteristics (skid resistance). Paragraph 632-6.5 defines an unacceptable level of frictional characteristics (skid resistance).

632-4.6.2 The manufactured sand must be dry, hard, durable, free from clay, salt, and foreign matter, be well graded (100% passing #8 (2.36 mm) sieve, and less than 10% passing #200 (75 µm) sieve). Uniformly apply the sand must at a rate of 3.0 lb/yd^2 ±0.5 lb/yd^2, rolled (as the Contractor recommended and the RPR accepted) into the treated surface, and any surplus removed with a power broom, or as the RPR directed. The Contractor is responsible for all materials, equipment, and costs associated with the application of sand.

632-4.6.3 Remove all manufactured sand or approved substitute used during the treatment from the airport as soon as practical after treatment of a pavement and prior to opening any airfield runway, taxiway, etc. Accomplish this by a combination of hand and mechanical sweeping. Clean all turnouts of any sand to the RPR’s satisfaction. The Contractor is responsible for all materials, equipment, and costs associated with the application, removal, and disposal of the sand.

632-4.6.4 If, after sand is swept and in the RPR’s opinion, a hazardous condition exists on the pavement, the Contractor must apply additional sand and sweep same immediately following reapplication. No additional compensation is allowed for reapplication and removal of sand.

632-5 QUALITY CONTROL (QC)

632-5.1 QC Application Rate.

The Contractor must verify the application rate of rejuvenator at least two times daily in the presence of the RPR. Provide daily documentation of QC testing to the RPR.

632-5.2 Warranty.

The Contractor must provide a manufacturer’s/applicator warranty that the treated pavement will retain the lower binder properties of paragraph 632-2.1, for a period of two years from the date of treatment. For compliance with the warranty, the Owner may obtain cores and perform tests according to Rejuvenation Acceptance. The Contractor must further warranty that from the date of rejuvenation application, the material will not flake, peel, chip, spall, or otherwise contribute to or accelerate the aging of the pavement. The Contractor must reapply the rejuvenation product, as necessary, or provide remedial actions at no cost to the Owner, and/or refund all payments at the Owner’s discretion. The RPR must designate and record an area of no less than 10 square yards (8.36 m^2) of untreated, and 10 square yards (8.36 m^2) of treated pavement, as the control strips for warranty testing. In the event a pay reduction, or no payment, is enforced, the warranty is rescinded.

632-6 REJUVENATION ACCEPTANCE

632-6.1 Product Sampling.

The RPR takes samples of the rejuvenation product proposed for use upon delivery of each shipment according to ASTM D140, and stored according to the SDS, Section VII for a period of at least six months after payment according to paragraph 6328.1. The RPR performs testing, as necessary, to verify the provided SDS information.

632-6.2 Rejuvenation QA Testing Responsibility.

QA testing organizations performing these acceptance tests must be accredited according to ASTM D3666. The QA laboratory accreditation must be current and listed on the accrediting authority’s website.

632-6.3 Rejuvenation QA Testing.

Submit all acceptance testing necessary to determine conformance with this specification to the RPR verifying that the rejuvenation product achieves the minimum decrease in the asphalt binder properties as measured from binder in the top ⅜ ±$^{1}/_{32}$ inch (9 mm ±1 mm) of the samples.

632-6.3.1 Extract the asphalt binder from the top ⅜ ±$^{1}/_{32}$ (9 mm ±1 mm) of the cores/slabs precisely cut from the field specimens. Binder extraction must be by ASTM D2172, Method A (centrifuge) with toluene, and recovered according to ASTM D1856 (Abson Method) or ASTM D5404 (Roto-Vap Method).

1. 632-6.3.1.1 Measure viscosity of the asphalt material according to ASTM D2171. Compute the percent decrease in the binder properties as follows.

   100 (absolute viscosity, P, of untreated sample) – (absolute viscosity, P, of treated sample)/ (absolute viscosity, P, of untreated samples)

2. 632-6.3.1.2 Measure the complex modulus, G*, kPa, according to AASHTO T315 C, at 140°F (60°C) 10 rad/sec or other recorded frequency. Compute the percent decrease in the binder properties as follows.

   100 (complex modulus, G*, kPa of untreated sample) – (complex modulus, G*, kPa, of treated sample)/ (complex modulus, G*, kPa, of untreated samples)

3. 632-6.3.1.3 Calculate and report the complex viscosity, η*, at 140°F (60°C) from the complex modulus, G* and angular frequency, ώ (radians/sec).

632-6.3.2 Report test results for absolute viscosity, complex modulus (and viscosity), and phase angle. Consider the maximum percent reduction calculated for absolute viscosity or complex modulus must be in Basis for Payment.

632-6.3.3 In the event of binders recovered from aged pavements, and/or pavements using polymer modified binders (before treatment) exhibiting absolute viscosities ≥ 200,000 P (data becomes suspect, viscosity exceeds test capabilities),determine the viscosity reduction compliance requirement based on the complex modulus, G*, kPa.

632-6.4 Friction Tests.

`[ Not used. |Accomplish friction tests according to AC 150/5320-12,` *`Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces`*`, on all runway and rapid exit taxiways that received a seal coat. The Contractor must coordinate testing with the RPR and provide the RPR the opportunity to be present during testing.`

`Each test includes performing friction tests at 40 mph and 60 mph, (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline.`

`Do not permit aircraft on the runway or rapid exit taxiway until the testing validates that surface friction is at or above the maintenance planning friction levels in AC 150/5320-12, Table 3-2, when tested at speeds of 40 and 60 mph, (65 and 95 km/h) wet, with approved CFME. Areas are not acceptable for payment until they surface friction is at or above the maintenance planning friction levels. The Contractor must provide the RPR a written report of friction test results.]`

632-7 METHOD OF MEASUREMENT

632-7.1 Asphalt Rejuvenation.

The quantity of rejuvenation product to be paid for is the number of square yards (square meters) performed according to the plans and specifications and the RPR accepted. The Contractor must furnish the RPR with the certified weigh bills when receiving materials for the rejuvenation product used under this contract. The

Contractor must not remove material from the tank car or storage tank until the RPR verifies initial amounts and temperature measurements.

632-8 BASIS OF PAYMENT

632-8.1 Payment for Rejuvenation Product.

Payment for accepted rejuvenation product is made at the contract unit price per square yard (square meter) for asphalt rejuvenation adjusted according to paragraph 632-8.1.1.

632-8.1.1 Basis of Adjusted Payment.

Calculate the payment for accepted rejuvenation product according to Table 632-8.1.

Table 632-8.1: Rejuvenation Pay Reduction

Binder Rejuvenation at Acceptance % Reduction in Absolute Viscosity or Complex Modulus		**% Payment**
Pavement More Than Three Years in Age	**Pavement Less Than Three Years in Age**	
≥ 40	≥ 25	100
30.0 - 39.9	20.0 - 24.9	75
Less than 30.0	Less than 20.0	No payment

632-8.1.2 Final Payment.

Final payment is not made until rejuvenation success is confirmed by acceptance testing. Final payment is full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

632-8.2 Friction Tests.

[Not required.]

[Friction testing is paid per lump sum.

Payment is made under:

Item P-632-8.1 Asphalt Rejuvenation – per square yard (square meter)

Item P-632-8.2 Friction Tests – Per lump sum]

632-9 REFERENCES

632-9.1 This list of publications forms 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 D140	*Standard Practice for Sampling Bituminous Materials*
ASTM D1856	*Standard Test Method for Recovery of Asphalt from Solution by Abson Method*
ASTM D2171	*Standard Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer*
ASTM D2172	*Standard Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures*
ASTM D2995	*Standard Practice for Estimating Application Rate of Bituminous Distributors*
ASTM D3549	*Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens*
ASTM D3666	*Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials*
ASTM D5340	*Standard Test Method for Airport Pavement Condition Index Surveys*
ASTM D5404	*Standard Practice for Recovery of Asphalt from Solution Using the Rotary Evaporator*

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T315	*Standard Method of Test for Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)*

Advisory Circulars (ACs)

AC 150/5320-12	*Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*

Code of Federal Regulations (CFR)

29 CFR Part 1910.1200	*Hazard Communication*
40 CFR	*Protection of the Environment*

END OF ITEM P-632

Item P-635 Polymer Concrete Micro-Overlay (PCMO)

****

The performance of a seal coat product is contingent on the pavement condition at the time of application. The pavement condition survey provides a measure of the pavement condition by analyzing the type, amount, and severity of the distresses, and by determining the pavement condition index (PCI) according to Advisory Circular (AC) 150/5380-7, *Airport Pavement Management Program (PMP),* and ASTM D5340. A typical asphalt pavement candidate is one with a structural condition index (SCI) deduct value of less than 10 and a PCI equal to or greater than 60.

PCMO may be used:

On pavements serving aircraft under 60,000 lbs. (kg).

When used on any pavement where aircraft operate, it must include friction testing before opening pavement to aircraft traffic.

Note: The PCMO will not stop shrinkage and other large thermal cracks from reflecting back through the new surface treatment.

****

635-1 DESCRIPTION

635-1.1 This item consists of an application of a polymer concrete micro-overlay (PCMO), consisting of polymer, cement, additives (pozzolans, plasticizers, air entraining agents, etc.) with mineral or synthetic aggregate, applied as a slurry on an asphalt or concrete surface providing a durable, fuel-resistant surface where pavements are subject to fuel spills. A PCMO assists in pavement preservation through reducing the rate of pavement oxidation. The application of the surface treatment must be according to these specifications and conform to the dimensions shown on the plans or as the Resident Project Representative (RPR) directed.

635-2 MATERIALS

635-2.1 Cement.

Cement must conform to the requirements of **[** `ASTM C150, Types I, II,III or V` | `ASTM C595 Types IS, IP, IL, or IT` | `ASTM C1157 Types GU, HS, MS, MH, or LH` **]**.

635-2.2 Water.

Water from a drinking water source is suitable for mixing. Water from other sources will meet the requirements of ASTM C1602. The temperature of the water added during mixing must be at least 40°F (4°C).

635-2.3 Aggregate.

The aggregate consists of sound, durable crushed igneous type stone (crushed basalt, granite, trap rock, etc.), clean washed masonry sand, or clean washed manufactured silica sand, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from coatings of clay, organic matter, and other deleterious materials. The aggregate must have a minimum Mohs hardness of 6. The aggregate must meet the gradation in Table 635-2.3 when tested according to ASTM C136. The Contractor must provide a certification showing particle size analysis and properties of the material delivered for the project's use.

Table 635-2.3: Aggregate Gradation Requirements

Sieve Designation (Square Openings)	Percentage by Weight Passing	Contractors Final Gradation	Job Control Tolerance[1]
No. 8 (4.72 mm)	95-100	*	±2%
No. 16 (2.36 mm)	70-100	*	±2%
No. 30 (1.18 mm)	40-75	*	±2%
No. 50 (0.85 mm)	10-35	*	±2%
No. 100 (0.60 mm)	2-15	*	±1%
No. 200 (0.40mm)	0-5	*	±1%

635-3 COMPOSITION AND APPLICATION

635-3.1 Job Mix Formula.

The contractor submits the proposed proportions of polymer, additives, cement, aggregate and water for the PCMO mix design. The mix design includes aggregate gradations, aggregate quality test results, mill certificate for cement, Certificate of Analysis (COA) of any additives and results of fuel resistant test. Any changes in sources of any of the materials requires a new trial batch.

635-3.2 Equipment.

635-3.2.1 Mixer.

For batch mixing, the mix tank must have a mechanically powered full sweep mixer with sufficient power to move and homogeneously mix the entire contents of the mix tank. For continuous mixing, the machine must be able to accurately deliver a predetermined proportion of cement aggregate dry blend, water, and polymer emulsion. The mixer must be able to thoroughly blend all materials and discharging to the distribution spreader box without segregation.

635-3.2.2 Spreading Equipment.

The Contractor provides all equipment necessary to apply the mix at a precise thickness. Place the material such that the overlap between passes is feathered to eliminate ridges. No buildup between passes is permitted. Provide other tools or equipment such as power brooms, power blowers, air compressors, hand brooms, hand squeegees, etc., as required.

635-3.2.3 Calibration.

The Contractor furnishes all equipment, materials, and labor necessary to calibrate the equipment. Calibrate the equipment to ensure it produces and applies a mix conforming to the JMF. Provide commercial equipment with a method of calibration by the manufacturer. Make all calibrations with the approved job materials prior to applying the control strip.

635-3.3 Control Strip.

Prior to full production, the Contractor must prepare a minimum of two control strips, at varying application rates to demonstrate the material, equipment, construction process and to determine the application rate and number of coats. Strips must be a minimum of 200 feet long by a minimum of 12 feet wide on representative sections of pavement, as recommended by the RPR. If operational conditions preclude placement of a control strip on the pavement to be treated, it may be applied on a pavement with similar surface texture.

****

For surface treatments on runway and rapid exit taxiway surfaces. Include before and after testing for skid resistance.

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[Before beginning the control strip, determine the skid resistance of the existing pavement at the location where the control strip will be placed with continuous friction measuring equipment (CFME). Place control strips and after the surface treatment has cured perform another skid resistance tests at approximately the same location as the test done on the existing pavement. Do not permit aircraft on the runway or taxiway control strips until the Contractor validates that its surface friction meets or exceeds the Maintenance Planning levels provided in AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-resistant Airport Pavement Surfaces*, when tested `at speeds of 40 and 60 mph (65 and 95km/h), wet, with approved CFME.` **]**

If the control strip should prove to be unsatisfactory, make the necessary adjustments to the mix composition, application rate, placement operations, and equipment, and place additional control strips. Do not begin full production until the RPR accepts the control strip. The surface preparation, personnel, materials, equipment, method of operation and rate of application used on the acceptable control strip must be used during production.

635-4 CONSTRUCTION METHODS

635-4.1 Weather Limitations.

Do not apply the material when the impending weather conditions will not permit proper drying or when the atmospheric or pavement temperature is below 45°F (7°C), unless the RPR directs otherwise.

635-4.2 Preparation of Pavement Surfaces.

Clean the pavement surface immediately prior to placing the surface treatment so it is free of dust, dirt, grease, vegetation, oil, or any type of objectionable surface film. Remove oil or grease by scrubbing with a detergent, then wash thoroughly with clean water. Any additional surface preparation, such as crack repair, must be according to Item P-101.

635-4.3 Application.

If multiple coats are specified, allow each coat to dry and cure initially before applying any subsequent coats.

635-4.4 Curing.

Cure for a minimum of 24 hours after application before opening to traffic.

635-5 QUALITY CONTROL

635-5.1 Batch Weights.

The Contractor must maintain daily records of quantity of polymer, cement, aggregate, additives, and water used. The Contractor records and calibration tests must document that the material application is in the same proportions and rate as approved with the control strip. Provide records to the RPR daily.

635-5.2 Aggregate Gradations.

The Contractor performs gradation sieve analysis **[** `daily` **]** according to ASTM C117 and ASTM C136 and provide the RPR with daily records.

635-5.3 Weather Conditions.

The Contractor must keep records of air temperature, pavement temperature, wind velocity and humidity and provide the RPR with daily records.

635-6 MATERIAL ACCEPTANCE

635-6.1 Friction Tests.

[Not used. |Accomplish friction tests according to AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, on all runway and rapid exit taxiways that received a seal coat. The Contractor must coordinate testing with the RPR and provide the RPR the opportunity to be present during testing.

Each test includes performing friction tests at 40 mph and 60 mph, (65 or 95 km/h) both wet, 15 feet (4.5 m) to each side of pavement centerline.

Do not permit aircraft on the runway or rapid exit taxiway until the testing validates that surface friction is at or above the maintenance planning friction levels in AC 150/5320-12, Table 3-2, when tested at speeds of 40 and 60 mph, (65 and 95 km/h) wet, with approved CFME. Areas are not acceptable for payment until they surface friction is at or above the maintenance planning friction levels. The Contractor must provide the RPR a written report of friction test results.]

635-6.2 Bond.

The contractor will perform [2] tests of bond per ASTM C1583 for each day's production. Remove, replace and retest areas that do not pass bond test.

635-7 METHOD OF MEASUREMENT

635-7.1 Measurement.

The quantity of Polymer Concrete Micro-Overlay (PCMO) is the number of [square yards (square meters)] of PCMO applied and accepted by the RPR.

635-8 BASIS OF PAYMENT

635-8.1 Payment.

Payment is made at the contract unit price per **[** `square yard` **]** (square meter) for the PCMO. This price is full compensation for furnishing all materials and all labor, equipment tools, and incidentals necessary to complete the installation, including mix design and data sheets and testing stipulated in these specifications.

Payments are made under:

Item P-635-8.1	Polymer Concrete Micro Overlay (PCMO) – per square yard **[** `square meter` **]**.
[`Item P-635-8.2`	`Runway and High-Speed Exit Taxiway Friction Testing – per lump sum` **|** `Not required` **]**.

635-9 REFERENCES

635-9.1 This list of publications forms 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 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 C150	*Standard Specification for Portland Cement*
ASTM C595	*Standard Specification for Blended Hydraulic Cements*
ASTM C1157	*Standard Performance Specification for Hydraulic Cement*
ASTM C1602	*Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*
ASTM D5340	*Standard Test Method for Airport Pavement Condition Index Surveys*

Advisory Circulars (AC)

AC 150/5320-12	*Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*

END OF ITEM P-635

Part 10 – Drainage

Item D-701 Pipe for Storm Drains and Culverts

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- **Design pipes and/or structures located under pavements and within runway or taxiway design safety areas to accommodate the single wheel load of the largest aircraft that can utilize the airport, the largest maintenance equipment load, or the earth load, whichever is greater.**
- **Use noncombustible and inert underground piping and components in drainage systems for terminal and aircraft fueling ramp drainage according to National Fire Protection Association (NFPA) 415.**
- **Typically, drainage pipes are designed for highway loadings; however, a modified design is necessary when aircraft loadings are greater than live loads or Load and Resistance Factor Design (LRFD) loads. Note: at shallow depths, the HS-20 loading controls, and at deeper depths the LRFD loads, generally control HS-20 loads (32K axle, two sets of dual wheels 16K) or LRFD (two -25K axles, spaced 4', with four sets of dual wheels, two sets per axle, each set of dual wheels 12.5K). Design drainage pipes for aircraft loadings if the airport has aircraft greater than 30K.**
- **Rigid pipes are designed to withstand loads with low reliance on structural support from the surrounding soil. Flexible pipes rely upon the surrounding soil to help share the load acting on the pipe and can deflect up to 5% without structural distress. Follow proper backfilling techniques with both rigid and flexible pipe. Adequate soil support along the sides of flexible pipe is necessary to develop the required lateral passive support of flexible pipes. Proper backfill materials and placement methods are critical when selecting flexible pipe. Insufficient lateral support of flexible pipes can lead to pipe failure. The trench excavation and location of the pipe, relative to the top of the trench, impacts how loads are transferred to the surrounding soil. Project plans must include details of pipe installation.**
- **It is acceptable to specify storm drains and drainage structures meeting state Department of Transportation (DOT) specifications for materials. Bedding, embedment, and overfull are critical to long-term performance of the piping system. Include all referenced state specifications in the project specification. Using state DOT specifications does not preclude the need to check the adequacy of the type and strength of the pipe material being used. It is imperative to**

design drainage for the most demanding loading, the critical area may be located outside the pavement under shoulders or safety areas.

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701-1 DESCRIPTION

701-1.1 This item consists of the construction of pipe culverts and storm drains according to these specifications and in reasonably close conformity with the lines and grades shown on the plans. Pipe performance requires attention be paid to the preparation of the foundation, placement of appropriate bedding, embedment compaction in haunch area, embedment compaction up to spring line and embedment compaction to at least 12 inches above the pipe. Compact embedment material from the pipe to in situ trench wall. Construct trenches to widths shown on plans, generally pipe width plus a minimum of 12 inches. Avoid creation of wide trenches. When trench shields or supports are required, ensure that when compacting the embedment. that embedment material is in contact with the trench wall, not the trench shield.

701-2 MATERIALS

701-2.1 Materials must 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 must be noncombustible and inert to fuel, according to NFPA 415. Design pipes and/or structures located under pavements and within runway or taxiway safety areas to accommodate the single wheel load of the largest aircraft that can utilize the airport, the largest maintenance equipment load, or the earth load, whichever is greater. Rigid pipes (e.g., concrete, cast iron, and vitrified clay) carry applied loads with minimal support from surrounding soil and backfill. Flexible pipes (e.g., corrugated steel, corrugated aluminum, ductile iron, plastic, welded seam, steel, and fiberglass) rely upon the surrounding soil and backfill to support applied loads. Proper backfill materials and techniques are critical to the pipe performance.

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The Engineer indicates the required class, schedule, standard dimension ratio (SDR), gauge, and/or strength of pipe desired.

The Engineer selects the pipe used for the project and deletes inappropriate requirements from paragraph 701-2.2 and from the list of material requirements.

The Engineer must include industry standard references (for example, ASTM and/or American Association of State Highway and Transportation Officials (AASHTO) for installation, if necessary.

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701-2.2 Pipe.

The pipe must be of the type called for on the plans or in the proposal and according to the following appropriate requirements. Submit manufacture’s data on type of pipe and installation requirements to RPR.

American Association of State Highway and Transportation Officials (AASHTO)

[American Association of State Highway and Transportation Officials (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*
AASHTO R73	*Standard Practice for Evaluation of Precast Concrete Drainage Productions*

ASTM International

ASTM A760	*Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains*
ASTM A761	*Standard Specification for Corrugated Structural Steel 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 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 C1433`	*`Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers`*
`ASTM C1479`	*`Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations`*
`ASTM C1577`	*`Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD`*
`ASTM C1786`	*`Standard Specification for Segmental Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD`*
`ASTM C1840`	*`Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe`*
`ASTM D3034`	*`Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings`* **]**
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 F667	*Standard Specification for 3 through 24 inch 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 and 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 F2764	*Standard Specification for 6 to 60 inch (150 to 1500 mm) Corrugated Double and Triple Wall Pipe Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications*
ASTM F2881	*Standard Specification for 12 to 60 inch (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications*

701-2.3 Concrete.

[Concrete for pipe cradles must have a minimum compressive strength of 2000 psi (13.8 MPa) at 28 days and conform to the requirements of ASTM C94. |Not used.]

701-2.4 Rubber Gaskets.

[Rubber gaskets for rigid pipe must conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe must conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe must conform to the requirements of ASTM D1056, for the "RE" closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe must conform to the requirements of ASTM F477. |Not used.]

701-2.5 Joint Mortar.

[Pipe joint mortar consists of one part Portland Cement and two parts sand. Portland Cement must conform to the requirements of ASTM C150, Type I. The sand must conform to the requirements of ASTM C144. |Not used.]

701-2.6 Joint Fillers.

[Poured filler for joints must conform to the requirements of ASTM D6690. |Not used.]

701-2.7 Plastic Gaskets.

[Plastic gaskets must conform to the requirements of ASTM C990. |Not used.]

701-2.8. Controlled Low-strength Material (CLSM).

`[ CLSM must conform to the requirements of Item P-153. When CLSM is used, all joints must have gaskets. |Not used. ]`

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The locations where CLSM is permitted must show on the plans. This paragraph must agree with paragraph 701-3.5.

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701-2.9 Precast Box Culverts.

Manufactured according to and conforming to ASTM C1433.

701-2.10 Precast Concrete Pipe.

Furnish precast concrete structures by a plant meeting National Precast Concrete Association Plant Certification Program or another Resident Project Representative (RPR)-approved third party certification program.

701-3 CONSTRUCTION METHODS

701-3.1 Excavation.

The width of the pipe trench must be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but not be less than the external diameter of the pipe, plus 12 inches (300 mm) on each side. The trench walls must be approximately vertical.

The Contractor must comply with all current federal, state, local rules, and regulations governing the safety of men and materials during excavation, installation, and backfilling operations. Specifically, the Contractor must observe and strictly adhere to all Occupational Safety and Health Administration (OSHA) requirements relating to excavations, trenching, and shoring. The trench width must be sufficient to permit satisfactorily jointing of the pipe and thorough, bedding material compaction under the pipe, and backfill material around the pipe, but not be greater than the widths shown on the plans.

When encountering rock, hardpan, or other unyielding material, the Contractor must remove it from below the foundation grade for a depth of at least 8 inches (200 mm) or ½ 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. Fill the excavation below grade 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, remove and replace the unstable soil with approved granular material for the full trench width. The RPR determines the depth of removal necessary. Compact the granular material to provide adequate support for the pipe. Do not make the excavation for pipes placed in embankment fill until the embankment is 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 provides a foundation of uniform density to support the pipe throughout its entire length.

701-3.2.1 Rigid Pipe.

Construct the pipe bedding uniformly for the full length of the pipe barrel. Use a maximum aggregate size of 1 inch when the bedding thickness is less than 6 inches, and 1½ inches when the bedding thickness is greater than 6 inches. Loosely place uncompacted bedding material under the middle third of the pipe prior to placement of the pipe.

701-3.2.2 Flexible Corrugated Pipe.

For flexible corrugated pipe, roughly shape the pipe bed to fit the pipe, and include bedding blanket of sand or fine granular material, as follows.

Table 701-3.2: Flexible Corrugated Pipe Bedding

Minimum Bedding Depth	
Depth of Corrugation Inch	**Inch**
½	1
1	2
2	3
2½	3½

701-3.2.3 Other Pipe Materials.

For PVC, polyethylene, polypropylene, or fiberglass pipe, use coarse sand or gravel bedding material with a maximum particle size of ¾ inches (19 mm). For pipes under paved areas, no more than 12% of the material may pass the No. 200 (0.075 mm) sieve. For all other areas, no more than 50% of the material may pass the No. 200 (0.075 mm) sieve. Use a minimum of 6 inches (150 mm) of bedding below the bottom of the pipe and extend up around the pipe not less than 50% of the pipe’s vertical outside diameter.

701-3.3 Laying Pipe.

Begin laying pipe at the lowest point of the trench and proceed upgrade. The lower segment of the pipe contact the bedding throughout its full length. Place bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes facing upgrade. Place paved or partially lined pipe so that the longitudinal center line of the paved segment coincides with the flow line. Place elliptical and elliptically-reinforced concrete pipes 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.

701-3.4.1 Concrete Pipe.

Concrete pipe may be bell and spigot, or tongue and groove. Fully seat pipe sections at joints with the inner surfaces flush and even. **[** Seal concrete pipe joints with rubber gaskets meeting ASTM C443 when leak resistant joints are required. |Seal concrete pipe joints with butyl mastic meeting ASTM C990 or mortar when soil tight joints are required. Thoroughly wet joints before applying mortar or grout. **]**

701-3.4.2 Corrugated Metal Pipe.

Join metal pipe by form-fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M196 for aluminum pipe.

701-3.4.3 PVC, Polyethylene, or Polypropylene Pipe.

Joints for PVC, Polyethylene, or Polypropylene pipe must conform to the requirements of ASTM D3212 when leak resistant joints are required. Joints for PVC and Polyethylene pipe must conform to the requirements of AASHTO M304 when soil tight joints are required. Fittings for polyethylene pipe must conform to the requirements of AASHTO M252 or ASTM M294.

701-3.4.4 Fiberglass Pipe.

Joints and fittings must be as detailed on the plans and according to the manufacturer's recommendations. **[** Joints must meet the requirements of ASTM D4161 for flexible elastomeric seals. |Enter manufacturers joint installation requirements. **]**

701-3.5 Embedment and Overfill.

Embedment is the material that supports the sides of the pipe. Embedment extends from the bottom of the pipe trench to a level **[** 12 **]** inches above the top of the pipe. Overfill is the material placed above the embedment material to backfill the trench excavated to place the pipe.

701-3.5-1 Embedment Material Requirements.

701-3.5-1.1 Concrete Pipe.

Embedment material and compaction requirements must be according to the applicable Type of Standard Installation (Types 1, 2, 3, or 4), per ASTM C1479. If using a concrete cradle or controlled low strength material (CLSM) embedment material, it must conform to the plan details.

701-3.5-1.2 Plastic and Fiberglass Pipe.

Embedment material must meet the requirements of ASTM D3282, A-1, A-2-4, A-2-5, or A-3. Embedment material must be free of organic material, stones larger than 1½ inches in the greatest dimension, or frozen lumps. Embedment material must extend to 12 inches above the top of the pipe.

701-3.5-1.3 Corrugated Metal Pipe.

Embedment material must be granular, as specified in the contract document and specifications, and be free of organic material, rock fragments larger than 1½ inches in the greatest dimension, and frozen lumps as a minimum. Backfill materials must meet the requirements of ASTM D3282, A-1, A-2, or A-3. Embedment material must extend to 12 inches above the top of the pipe.

701-3.5-2 Placement of Embedment Material.

Place and compact the embedment material under the haunches of the pipe without displacing the pipe. Compact the embedment material evenly on each side of the pipe in layers not exceeding 6 inches (150 mm) and until one foot (30 cm) above the top of the pipe. There should not be more than one lift thickness difference in elevation of embedment material on one side of the pipe from the other. Compact embedment material to **[** `90%` **|** `95%` **]** of maximum dry density per **[** `ASTM D698` **|** `ASTM D1557` **]**. Concrete cradles and flowable fills, such as CLSM or controlled density fill (CDF), may be used for embedment, provided restraints, weighing, or placement technique adequate flotation resistance is achieved. It is the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations.

701-3.6 Overfill.

Inspect pipes before any overfill is in place. The Contractor must remove and relay or replace any pipes found to be out of alignment, unduly settled, or damaged at the Contractor's expense. Place and compact overfill material in layers to at least 95% standard proctor per **[** `ASTM D698` **|** `ASTM D1557` **]**. The soil must not contain any debris, organic matter, frozen material, or stones with a diameter greater than half the thickness of the compacted layers being placed.

701-3.7 Control Installation.

The contractor must demonstrate, and the RPR approve, the method to be used to excavate the trench, the type and placement of bedding, the laying and jointing of pipe and the initial and final backfill of the pipe.

701-4 QUALITY ACCEPTANCE

701-4.1 Inspection Requirements.

The RPR must perform an initial post installation inspection no sooner than 30 days after installation completion 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. The camera must 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 documenting the pipe's condition. The video image must be clear, focused, and relatively free from roll, static, or other image distortion that prevents the reviewer from evaluating the condition of the pipe.]

[For pipe sizes larger than 48 inches, a walk-through visual inspection is required.]

Incorporate specific inspection requirements for the various types of pipes beneath the general inspection requirements.

[Reinforced concrete pipe must be inspected, evaluated, and reported on according to ASTM C1840, "*Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe*." Any issues reported must include still photo and video documentation. Provide the zoom ratio for all still or video images that document any issues of concern by the inspection firm.]

[Inspect flexible pipes for rips, tears, joint separations, soil migration, cracks, localized buckling, settlement, alignment, and deflection. Determine whether the allowable deflection is exceeded by use of a laser profiler or mandrel for internal pipe diameters of 48 inches or less, or direct measurement for internal pipe diameters greater than 48 inches. Laser profile equipment must utilize low barrel distortion video equipment. Deflection of installed pipe must not exceed the limits provided in Table 701-4.1, as a percentage of the average inside diameter of the pipe.

Table 701-4.1 Maximum Allowable Flexible Pipe Deflection

Type of Pipe	Maximum Allowable Deflection (%)
Corrugated Metal Pipe	5
Concrete Lined CMP	3
Thermoplastic Pipe	5
Fiberglass	5

If deflection readings more than the allowable deflection are obtained, remove the pipe with excessive deflection and replace with new pipe. Repair or replace any pipe with cracks exhibiting displacement across the crack, bulges, creases, tears, spalls, or delamination. The report for flexible pipe must include the deflection results and final post installation inspection report. The inspection report must include a copy of all video taken, pipe location identification, equipment used for inspection, inspector's name, deviation from design line and grade, and inspector's notes.]

701-5 METHOD OF MEASUREMENT

701-5.1 Measure the length of pipe in linear feet (m) of pipe in place, completed, and accepted. Measure it along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. Measure the [identify each class, types, and size of pipe] separately. Include all fittings in the footage as typical pipe sections in the pipe being measured.

701-5.2. [Measure precast box culverts by individual unit and size. |Not used.]

701-5.3 [The volume of concrete for pipe cradles is the number of cubic yards (cubic meters) of concrete completed in place and accepted. |Not used.]

701-5.4 [The volume of rock, hardpan, or other unyielding material is the number of cubic yards (cubic meters) excavated. No payment is made for the cushion material placed for the bed of the pipe. |Not used.]

701-6 BASIS OF PAYMENT

These prices are 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.

701-6.1 Payment is made at the contract unit price per linear foot (meter) for **[** `identify each class and size of pipe.` **]**.

701-6.2 Payment is made at the contract unit price per unit for **[** `identify each class and size of precast box culvert.` **]**. **[** `Not used.` **]**

701-6.3 **[** `Payment is made at the contract unit price per cubic yard (cubic meter) of concrete for pipe cradles.` **|**`Not used.` **]**

701-6.4 **[** `Payment is made at the contract unit price per cubic yard (cubic meter) for rock, hardpan, or other unyielding material excavation.` **|**`Not used.` **]**

Payment is made under:

Item 701-5.1	**[__]** inch **[__]** per linear foot (meter)
Item 701-5.2	**[** `Precast box culvert per unit.` **|**`Not used.` **]**
Item 701-5.3	**[** `Concrete for pipe cradles - per cubic yard (cubic meter).` **|**`Not used.` **]**
Item 701-5.4	**[** `Rock, hardpan, or other unyielding material excavation - per cubic yard (cubic meter).` **|**`Not used.` **]**

****

The Engineer indicates the size and type of storm drains and culverts as shown on the plans.

****

701-7 REFERENCES

701-7.1 This list of publications forms 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 R73	*Evaluation of Precast Drainage Products*

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 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 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 C1479	*Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations*
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-inch 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 F2764	*Standard Specification for 6 to 60 inch (152 to 1500 mm) Polypropylene (PP) Triple Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications*
ASTM F2881	*Standard Specification for 12 to 60 inch (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 OF ITEM D-701

Item D-702 Slotted Drains

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- **Pipes and/or structures located under pavements and within runway or taxiway safety areas must be designed to accommodate the single wheel load of the largest aircraft that can utilize the airport, the largest maintenance equipment load, or the earth load, whichever is greater.**
- **Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage must be noncombustible and inert to fuel according to National Fire Protection Association (NFPA) 415.**
- **Typically, drainage pipes are designed for highway loadings, however, a modified design will be necessary when aircraft loadings are greater than American Association of State Highway Transportation Officials (AASHTO) HS20 live loads or,Load and Resistance Factor Design (LRFD) loads Note: at shallow depths the HS20 loading controls and at deeper depths the LRFD loads generally control. HS 20 loads (32K axle, 2 sets of dual wheels 16K) or LRFD (2 -25K axles, spaced 4’, with four sets of dual wheels, two sets per axle, each set of dual wheels 12.5K). If airport has aircraft greater than 30K design drainage pipes for aircraft loadings.**
- **It is acceptable to specify storm drains and drainage structures meeting state DOT specifications for materials. Bedding, embedment and overfull are critical to long-term performance of the piping system. Include all referenced state specifications in the project specification. Using state DOT specifications does not preclude the need to check the adequacy of the type and strength of pipe material to be used. It is imperative to design drainage for the most demanding loading. Note: the critical area may be located outside the pavement under shoulders or safety areas.**

****

702-1 DESCRIPTION

702-1.1 This item consists of the construction of steel slotted drains or cast-iron slotted vane drains according to these specifications, and in reasonably close conformity with the lines and grades shown on the plans. Typical details must show on the plans.

702-2 MATERIALS

702-2.1 General.

All slotted drains must meet the requirements shown on the plans and specified below. All slotted drains must meet specified hydraulic design requirements and support the loadings specified. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage must be noncombustible and inert to fuel according to National Fire Protection Association (NFPA) 415. Design pipes and/or structures located under pavements and within runway or taxiway safety areas to accommodate the single wheel load of the largest aircraft that can utilize the airport, the largest maintenance equipment load, or the earth load, whichever is greater. Submit manufacture's data on type of pipe and installation requirements to RPR.

702-2.2 Pipe.

702-2.2.1 Steel Slotted Drain.

[Pipe must be metallic coated (galvanized or aluminized type 2) corrugated steel type I meeting the requirements of ASTM A760. Pipe diameter and gauge must be as shown on the plans. The corrugated steel pipe will have a minimum of two rerolled annular ends. |Not used.]

702-2.2.2 Cast Iron Slotted Vane Drain.

[Polyvinyl Chloride (PVC) pipe must meet the requirements of ASTM D3034. Pipe diameter must be as shown on the plans. The pipe must have an open slot to accept the cast iron slotted vane drain castings. |Not used.]

702-2.3 Grates and Castings.

702-2.3.1 Steel Slotted Drain.

[Use Grates manufactured from ASTM A36 Grade 36 steel. Spacers and bearing bars (sides) must be $^{3}/_{16}$ inch (5 mm) material. Weld the spacers to each bearing bar with four 1¼ inch long by $^{3}/_{16}$-inch wide (32 mm long by 5 mm wide) fillet welds on each side of the bearing bar at spacings not exceeding 6 inches (150 mm). The grates must be 6 inches (150 mm) high, or as shown on the plans, and have a maximum 1¾ inch (45 mm) opening in the top.

Use grates galvanized according to ASTM A123 except with a 2 ounce/square feet (0.61 kg/square meter) galvanized coating.

Fillet weld the grates welded to the corrugated steel pipe with a minimum weld 1 inch (25 mm) long on each side of the grate at every other corrugation. Thoroughly clean and paint weld areas and heat affected zones where the slot is welded to the corrugated pipe with a zinc-rich paint, according to repair of damaged coatings in ASTM A760.

Each 20-foot (6.1-m) length of drain delivered to the job site must be within the following tolerances: vertical bow ±⅜ inch (9 mm), horizontal bow ±⅝ inch (16 mm), twist ±½ inch (12 mm).]

[Not used.]

702-2.3.2 Cast Iron Slotted Vane Drain.

[Castings must meet the requirements of ASTM A48, Class 35B gray iron. Furnish castings without coatings.

Design castings to fit on open slots in 15-inch (38 cm) PVC pipe. Casting sections must not exceed 3 feet (1 m) in length. Use casting sections with a built-in vane configuration with bar spacings not exceeding 6 inches (150 mm). The opening at the surface must not exceed 3¾ inch (95 mm), and the vane constructed on a radius so that the opening is less than 1½ inch (38 mm) at a depth of 1½ inch (38 mm) from the surface. Casting sections must lock integrally into the concrete with top and bottom flanges and shear tabs. Castings must accept bolts for fastening sections together and accept wire for fitting to pipe.]

[Not used.]

****

Standard details can be found in AASHTO/The Associated General Contractors of America (AGC)/American Road and Transportation Builder’s Association (ARTBA) publication “A Guide to Standardized

Highway Drainage Products." All products used must meet the most demanding loading of aircraft or maintenance equipment.

****

702-2.4 Concrete.

Concrete will have a minimum compressive strength of 3,000 psi (20.7 MPa) at 28-days when tested according to ASTM C39. Use concrete conforming to the requirements of **[** `Item P-610` **]**.

702-3 CONSTRUCTION METHODS

702-3.1 Excavation.

The width of the trench must be sufficient to permit satisfactory installation and jointing of the slotted drain and placing of a concrete backfill material under and around the drain, but not be less than the external pipe diameter plus 6 inches (150 mm) on each side. The trench depth must be a minimum of 2 inches (50 mm) below the invert for steel slotted drain and 6 inches (150 mm) below the invert for a cast iron slotted vane drain.

702-3.2 Installation.

Lay slotted drains in sections joined firmly together as shown on the plans. Hold the top of all drains firmly in place to the proper grade, to preclude movement during the backfilling operation.

702-3.3 Joining.

[`Firmly join slotted steel drain joints by modified hugger type bands, or as indicated, to secure the pipe and prevent infiltration of the backfill. When the slotted steel drain is banded together, the adjacent grates must have a maximum gap of 3-inch (75 mm.` **|**`Bolt cast iron drain castings together.` **]**

702-3.4 Backfilling.

Inspect slotted drains before any backfill is placed. Repair or replacement of damaged drains is at the Contractor's expense. Backfill the trench holding the slotted drain assembly with concrete that flows under and around the drain and the trench wall. Cover the opening in the top of grates and castings to prevent material from entering the drain during the backfilling and surfacing operations.

702-4 METHOD OF MEASUREMENT

702-4.1 The length of **[** `each type of slotted drain` **]** is measured in linear feet (meters) of slotted drain in place, completed, and approved. It is measured along the centerline of the drain from end or inside face of structure to the end or inside face of structure, whichever is applicable. Each **[** `class, type, and size` **]** is measured separately. Include all fittings in the footage as measuring typical pipe sections.

702-5 BASIS OF PAYMENT

702-5.1 Payment is made at the contract unit price per linear foot (meter) for each **[** `identify each kind of slotted drain type and size` **]** designated. These prices are full compensation for all materials, all preparation, excavation, backfill, and installation of the slotted drain; and all labor, equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item 702-5.1	**[__]** inch (**[__]** mm) diameter **[** `gauge` **]** pipe per linear foot (meter)

****

The Engineer includes a pay item for each size and gauge pipe specified for each drain type.

****

702-6 REFERENCES

702-6.1 This list of publications forms 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 A36	*Standard Specification for Carbon Structural Steel*
ASTM A48	*Standard Specification for Gray Iron Castings*
ASTM A123	*Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*
ASTM A760	*Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains*

ASTM C39	*Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*
ASTM D3034	*Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings*

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO-AGC-ARTBA Task Force 13	
	Report A Guide to Standardized Highway Drainage Products

END OF ITEM D-702

Item D-705 Pipe Underdrains

705-1 DESCRIPTION

705-1.1 This item consists of the construction of pipe drains according to these specifications and in reasonably close conformity with the lines and grades shown on the plans.

705-2 MATERIALS

705-2.1 General.

Materials must meet the requirements shown on the plans and specified below.

****

The Engineer must indicate the required class, schedule, standard dimension ratio (SDR), gauge, and/or strength of pipe desired.

****

705-2.2 Pipe.

The pipe must be of the type called for on the plans or in the proposal and be according to the following requirements, as appropriate.

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

****

The Engineer selects the pipe used for the project and deletes inappropriate requirements from paragraph 705-2.2 and from the list of material requirements.

****

Submit manufactures data on type of pipe and any recommended installation requirements to the RPR.

705-2.3 Joint Mortar.

Pipe joint mortar must consist of one part by volume of Portland Cement and two parts sand. The Portland Cement must conform to the requirements of ASTM C150, Type I. The sand must conform to the requirements of ASTM C144.

705-2.4 Elastomeric Seals.

Elastomeric seals must conform to the requirements of ASTM F477.

705-2.5 Porous Backfill.

Porous backfill must be free of clay, humus, or other objectionable matter, and conform to the gradation in Table 705-2.5a when tested according to ASTM C136.

Table 705-2.5a: Gradation of Porous Backfill

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
	Porous Material No. *
1½ inch (37.5 mm)	*
1 inch (25.0 mm)	*
⅜ inch (9.5 mm)	*
No. 4 (4.75 mm)	*
No. 8 (2.36 mm)	*
No. 16 (1.18 mm)	*
No. 50 (300 µm)	*
No. 100 (150 µm)	*

****

The Engineer selects the gradation from Table 705-2.5b and inserts in Table 705-25.

Table 705-2.5b: Gradation of Porous Backfill

Sieve Designation (square openings)	Percentage by Weight Passing Sieves	
	Porous Material No. 1	**Porous Material No. 2**
1½ inch (37.5 mm)		100
1 inch (25.0 mm)		90 - 100
⅜ inch (9.5 mm)	100	25 - 60
No. 4 (4.75 mm)	95 – 100	5 - 40
No. 8 (2.36 mm)		0 - 20
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, use gradation No. 1 for the finer material and gradation No. 2 for the coarser material.

705-2.6 Granular Material.

Granular material used for backfilling must conform to the requirements of ASTM D2321 for Class IA, IB, or II materials.

705-2.7 Filter Fabric.

The filter fabric must conform to the requirements of AASHTO M288 Class 2 or equivalent.

Table 705-2.7: 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

****

The Engineer specifies Class 2 unless sufficient survivability information is available for a reduction in minimum property requirements. Base permittivity and apparent opening size requirements on type of situ soil.

****

705-2.8 Controlled Low-strength Material (CLSM).

[CLSM is not used. **|**CLSM must conform to the requirements of Item P-153. All joints must have elastomeric seals. **]**

****

The locations where CLSM is permitted must show on the plans.

****

705-3 CONSTRUCTION METHODS

705-3.1 Equipment.

All equipment required for the construction of pipe underdrains must be on the project, in good working condition, and RPR approved before construction is permitted to start.

705-3.2 Excavation.

The width of the pipe trench must be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls must be approximately vertical. Where rock, hardpan, or other unyielding material is encountered, remove to below the foundation grade for a depth of at least 4 inches (100 mm). Backfill the excavation below grade with selected fine compressible material, such as silty clay or loam, and lightly compact layers not over 6 inches (150 mm) 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, remove a minimum of 12 inches, and replace the unstable soil with approved granular material for the full trench width. The RPR determines if additional depth of removal is necessary. Compact the granular material to provide uniform support for the pipe.

The Contractor must dispose of excavated material not required or acceptable for backfill as the RPR directs. If the excavation is carried below the required depth; backfill the trench with material the RPR approved and compact to the density of the surrounding material. Construct the pipe bedding uniformly over the full length of the pipe barrel, as required on the plans. The maximum aggregate size is 1 inch when the bedding thickness is less than 6 inches, and 1½ inches when the bedding thickness is greater than 6 inches. Prior to placing pipe, loosely place uncompacted bedding material under the middle third of the pipe.

The Contractor must brace, sheath, or shore the trench, as necessary for safety and conformance to federal, state, and local laws. Unless otherwise provided, the Contractor removes the bracing, sheathing, or shoring after the backfill reaches at least 12 inches (300 mm) over the top of the pipe. Pull the sheathing or shoring as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of placing and removal of bracing, sheathing, or shoring, is included in the unit price bid per foot (meter) for the pipe.

705-3.3 Laying and Installing Pipe.

705-3.3.1 Concrete Pipe.

Start laying the pipe in the finished trench at the lowest point and proceed upgrade. When bell and spigot pipe are used, lay the bells upgrade. When tongue and groove pipe is used, lay the groove end upgrade. Place holes in the perforated pipe, down, unless shown otherwise on the plans. Set the pipe firmly and accurately to line and grade with a smooth and uniform invert. Do not lay pipe on frozen ground. Take up and relay pipe not true in alignment, or showing any settlement, at no additional expense. It is prohibited to make adjustments in grade by exerting force on the barrel of the pipe with excavating equipment, or by lifting and dropping the pipe, or by lifting the pipe and packing bedding material under it. Remove and reinstall sections of pipe installed not to grade.

705-3.3.2 Metal Pipe.

Lay the metal pipe with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Thoroughly coat any metal in the pipe or bands not protected by galvanizing with a suitable asphaltum paint. During installation, handle the asphalt-protected pipe without damaging the asphalt coating. Refill any breaks in the bitumen or treatment of the pipe with the type and kind of bitumen used in coating the pipe originally.

705-3.3.3 PVC, Fiberglass or Polyethylene Pipe.

Install PVC or polyethylene pipe according to the requirements of ASTM D2321. Perforations must meet the requirements of AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. Lay the pipe accurately to line and grade. Fiberglass per ASTM D3839 *Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe*.

705-3.3.4 All Types of Pipe.

Plug or cap, as the RPR approved, the upgrade end of pipelines, not terminating in a structure. Spread a **[** `4-inch (100 mm)` **]** bed of granular backfill material in the bottom of the trench throughout the entire length under all perforated pipe underdrains. Construct pipe outlets for the underdrains as required or shown on the plans. Lay the pipe with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. Make all connections to other drainage pipes or structures as required and in a satisfactory manner. Protect and construct the outlets as shown on the plans if connections are not made to other pipes or structures,

705-3.3.5 Filter Fabric.

Install the filter fabric according to the manufacturer’s recommendations, or according to the AASHTO M288 Appendix, unless otherwise shown on the plans.

705-3.4 Mortar.

Use mortar of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Discard mortar not used within 45 minutes after water has been added. Retempering of mortar is not permitted.

705-3.5 Joints in Concrete Pipe.

When open or partly open joints are required or specified, construct as indicated on the plans. Lay the pipe with the ends fitted together as designed. If bell and spigot pipe is used, place mortar along the inside bottom quarter of the bell to center the following section of pipe. Surround the open or partly open joints with granular material meeting requirements of porous backfill No. 2 in Table 705-2.7 or as indicated on the plans. Place backfill so its thickness is not less than 3 inches (75 mm) or more than 6 inches (150 mm), unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, use commercial concrete sand or granular material meeting requirements of porous backfill No. 1 to surround porous backfill No. 2 (Table 705-2.7), as shown on the plans or as the RPR directed. 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 the RPR directed.

705-3.6 Embedment and Backfill

705-3.6.1 Earth.

After pipe installation, backfill all trenches and excavations unless additional protection of the pipe is directed. Use select material from excavation or borrow for embedment material. Place and compact the select material 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. It must not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material the RPR objects. Moisten or dry the material, as required to aid compaction. Placement of the embedment material must not cause displacement of the pipe. Thoroughly compact under the haunches and along the sides to the top of the pipe.

Place the embedment material in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe. Place backfill material over the pipe in lifts not exceeding 8 inches (200 mm). Add successive layers and thoroughly compact by hand or pneumatic tampers until the trench is completely backfilled to the planned elevation. Avoid damaging the top or sides of the pipe when placing and compacting embedment and backfill. In embankments and other unpaved areas, compact the backfill to **[** `90%` **|** `95%` **]** per **[** `ASTM D698` **|** `ASTM D1557` **]**. Compact the subgrade and any backfill under paved areas to **[** `90%` **|** `95%` **]** per **[** `ASTM D698` **|** `ASTM D1557` **]**.

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Refer to AC 150/5320-6 and Item P-152 for direction on compaction requirements. Typically, cohesive backfill compacted to 90% of either ASTM D698/D1557 and non-cohesive material to 95% of either ASTM D698/D1557.

For aircraft ≤ 60K use ASTM D698 and for > 60K use ASTM D1557. For underdrains located under shoulders, compact as if under a pavement.

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705-3.6.2 Granular Backfill.

Install granular backfill in the trench and about the pipe as shown on the plans. The granular backfill must not contain an excessive foreign matter, or soil excavated or from sides of the trench. When two sizes of backfill are required, use a template to properly place and separate the two sizes of backfill. Place the backfill in loose layers not exceeding 6 inches (150 mm) in depth. Compact the granular backfill by hand and with pneumatic tampers to the requirements as given for embankment. Avoid damaging top or side of the pipe when backfilling. Extend the granular backfill to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, place granular backfill material along the full length of the pipe as shown on the plans. If the original material excavated from the trench is pervious and suitable, it may be used in lieu of porous backfill No. 1, if the RPR approved. If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, place the backfill material immediately after laying the pipe. The depth of the granular backfill must be not less than 12 inches (300 mm), measured from the top of the underdrain. Maintain a minimum depth of 12 inches (300 mm) of backfill over the underdrains. Remove porous backfill containing objectionable material and replace with suitable material. The cost of removing and replacing any unsuitable material is at the Contractor’s expense. If a granular subbase course is used extending several feet beyond the edge of paving to the outside edge of the underdrain trench, place the granular backfill material over the underdrains up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase. Remove and replace any unsuitable material that remains over the underdrain trench.

705-3.6.3 Controlled Low-strength Material (CLSM).

`[ CLSM is not used. |CLSM must conform to the requirements of Item P-153. ]`

705-3.7 Flexible Pipe Ring Deflection.

`[ Not used. |The Contractor must inspect the flexible pipe during and after installation to ensure the internal diameter of the pipe barrel has not been reduced by more than 5 percent. For guidance on properly sizing mandrels, refer to ASTM D3034 and ASTM F679 appendices. ]`

705-3.8 Connections.

When the plans call for connections to existing or proposed pipe or structures, connections must be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

705-3.9 Site Cleaning and Restoration.

After the backfill is completed, the Contractor must dispose of all surplus material, soil, and rubbish from the site. Deposit surplus soil in embankments, shoulders, or as the RPR directs. Except for paved areas of the airport, the Contractor must restore all disturbed areas to their original condition.

705-3.10 Control Installation.

Prior to installation of underdrains the contractor must demonstrate, and the RPR approve, the method to be used to excavate the trench, the type and placement [filter fabric], bedding, the laying and jointing of pipe and the initial and final backfill of the pipe.

705-4 METHOD OF MEASUREMENT

705-4.1 The length of pipe is 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. Measure the several classes, types, and sizes separately. Include all fittings in the footage as typical pipe sections in the pipeline being measured.

705-4.2 [The quantity of porous backfill is the number of cubic yards (cubic meters) of porous backfill No. 1 and No. 2, complete in place and accepted, and determined from the dimensions given on the plans by typical trench sections indicating the placement of porous backfill or dimensions as the RPR directs. |Not used.]

705-4.3 [The quantity of filter fabric is the number of square yards (square meters) of filter fabric in place, completed, and approved; and is determined from the dimensions given on the plans by typical trench sections indicating the placement of filter fabric or dimensions as the RPR directs. |Not used.]

705-4.4 [The quantity of pipe underdrains is made at the contract unit price per linear foot (meter) complete, including porous backfill and filter fabric. |Not used.]

705-5 BASIS OF PAYMENT

705-5.1 Payment is made at the contract unit price per linear foot (meter) for pipe underdrains of the type, class, and size designated.

705-5.2 Porous Backfill.

[705-5.2.1 Porous backfill No. 1 is made at the contract unit price [per cubic yard (cubic meter) | per ton (metric ton)].]

[705-5.2.2 Porous Backfill No. 2 is made at the contract unit price [per cubic yard (cubic meter) | per ton (metric ton)].]

705-5.3. Filter Fabric.

Filter fabric is made at the contract unit price per square yard (square meter) for filter fabric.

705-5.4 Pipe Underdrains, Complete.

[Pipe underdrains, complete (including porous backfill and filter fabric) is made at the contract unit price [per linear foot (meter) complete (including porous backfill and filter fabric.]]

These prices are 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.

Payment is made under:

Item D-705-5.1	[__] inch pipe (mm pipe) [__] per linear foot (meter)
[Item D-705-5.2a	Porous Backfill No. 1-[per cubic yard (cubic meter)	per ton (metric ton)]]
[Item D-705-5.2b	Porous Backfill No. 2-[per cubic yard (cubic meter)	per ton (metric ton)]]
Item D-705-5.3	Filter Fabric - per square yard (square meter)
[Item D-705-5.4	[__] inch pipe (mm pipe) [__] per linear foot (meter) complete, including porous backfill and filter fabric]

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The Engineer specifies the size and type of pipe, filter fabric, and backfill material for each pipe size and type specified in the plans.

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705-6 REFERENCES

705-6.1 This list of publications forms 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 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

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Design structures located under pavements and within runway or taxiway design safety areas to accommodate the single wheel load of the largest aircraft that can utilize the airport, the largest maintenance equipment load, or the earth load, whichever is greater.

- **Use noncombustible and inert underground piping and components in drainage systems for terminal and aircraft fueling ramp drainage according to National Fire Protection Association (NFPA) 415.**
- **Typically, drainage structures are designed for highway loadings; however, a modified design is necessary when aircraft loadings are greater than live loads or Load and Resistance Factor Design (LRFD) loads. Note: at shallow depths, the HS-20 loading controls, and at deeper depths the LRFD loads, generally control HS-20 loads (32K axle, two sets of dual wheels 16K) or LRFD (two -25K axles, spaced 4 feet, with four sets of dual wheels, two sets per axle, each set of dual wheels 12.5K). Design drainage pipes for aircraft loadings if the airport has aircraft greater than 30K.**
- **Rigid pipes are designed to withstand loads with low reliance on structural support from the surrounding soil. Flexible pipes rely upon the surrounding soil to help share the load acting on the pipe and can deflect up to 5% without structural distress. Follow proper backfilling techniques with both rigid and flexible pipe. Adequate soil support along the sides of flexible pipe is necessary to develop the required lateral passive support of flexible pipes. Proper backfill materials and placement methods are critical when selecting flexible pipe. Insufficient lateral support of flexible pipes can lead to pipe failure. The trench excavation and location of the pipe, relative to the top of the trench, impacts how loads are transferred to the surrounding soil. Project plans must include details of pipe installation.**
- **It is acceptable to specify storm drains and drainage structures meeting state Department of Transportation (DOT) specifications for materials. Bedding, embedment, and overfull are critical to long-term performance of the piping system. Include all referenced state specifications in the project specification.**

Using state DOT specifications does not preclude the need to check the adequacy of the type and strength of the pipe material being used. It is imperative to design drainage for the most demanding loading, the critical area may be located outside the pavement under shoulders or safety areas.

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751-1 DESCRIPTION

751-1.1 This item consists of construction of manholes, catch basins, inlets, and inspection holes, according to these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or as the Resident Project Representative (RPR) required.

751-2 MATERIALS

751-2.1 General.

Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage must be noncombustible and inert to fuel according to National Fire Protection Association (NFPA) 415. Design pipes and/or structures located under pavements and within runway or taxiway safety areas to accommodate the single wheel load of the largest aircraft that can utilize the airport, the largest maintenance equipment load, or the earth load, whichever is greater.

751-2.2 Brick.

The brick must conform to the requirements of ASTM C32, Grade MS.

751-2.3 Mortar.

Mortar must consist of one part Portland Cement and two parts sand. The cement must conform to the requirements of ASTM C150, Type I. The sand must conform to the requirements of ASTM C144.

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Use Item P-610, Item P-501, or concrete meeting state Department of Transportation (DOT) specifications for structures may be used provided that aggregates meet reactivity requirements of Item P-610 or Item P-501.

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751-2.4 Concrete.

Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames must conform to the requirements of **[** `Item P-610` **]**.

751-2.5 Precast Concrete Pipe Manhole Rings.

Precast concrete pipe manhole rings must conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections must have an inside diameter of not less than 36 inches (90 cm) or more than 48 inches (120 cm). There must be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets must conform to the requirements of ASTM C443.

751-2.6 Corrugated Metal.

Corrugated metal must conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

751-2.7 Frames, Covers, and Grates.

The castings must conform to one of the following requirements:

1. ASTM A48, Class 35B: Gray iron castings
2. ASTM A47, Malleable iron castings
3. ASTM A27, Steel castings
4. ASTM A283, Grade D: Structural steel for grates and frames
5. ASTM A536, Grade 65-45-12: Ductile iron castings
6. ASTM A897, Austempered ductile iron castings

All castings or structural steel units must conform to the dimensions shown on the plans and be designed to support the loadings, aircraft gear configuration and/or direct loading, specified. Provide each frame and cover or grate with fastening members to prevent it from being dislodged by traffic, but allows easy removal for access to the structure. Thoroughly clean all castings. After fabrication, galvanize structural steel units to meet the requirements of ASTM A123.

751-2.8 Steps.

The steps or ladder bars must be gray, malleable cast iron, or galvanized steel. The steps must be the size, length, and shape shown on the plans. Give ungalvanized steps a coat of asphalt paint, when directed.

751-2.9 Precast Inlet Structures.

Manufactured according to and conforming to ASTM C913.

751-3 CONSTRUCTION METHODS

751-3.1 Unclassified Excavation.

751-3.1.1 The Contractor must excavate for structures and footings to the lines and grades or elevations, shown on the plans, or as the RPR staked. The excavation must 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, are considered as approximately only; and the RPR may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

751-3.1.2 Remove boulders, logs, or any other objectionable material encountered in excavation. Clean all rock or other hard foundation material of all loose material and cut to a firm surface either level, stepped, or serrated, as the RPR directed. Clean out and grout all seams or crevices. Remove all loose and disintegrated rock and thin strata. Where concrete will rest on a surface other than rock, do not disturb the bottom of the excavation and excavation to final grade not made until immediately before the concrete or reinforcing is placed.

751-3.1.3 The Contractor does 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 is included in the unit price bid for the structure.

751-3.1.4 The Contractor removes all bracing, sheathing, or shoring involved in the construction of this item after the completion of the structure. Removal must not disturb or damage finished masonry. The cost of removal is included in the unit price bid for the structure.

751-3.1.5 After excavation is completed for each structure, the Contractor notifies the RPR. Do not place any concrete or place reinforcing steel until the RPR has approved the depth of the excavation and the character of the foundation material.

751-3.2 Brick Structures.

751-3.2.1 Foundations.

Place a prepared foundation for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base consists of reinforced concrete mixed, prepared, and placed according to the requirements of Item P-610.

751-3.2.2 Laying Brick.

Clean and thoroughly wet all brick before laying so they will not absorb any appreciable amount of additional water at the time they are laid. Lay all brick in freshly made mortar. Discard mortar not used within 45 minutes after adding water. Retempering of mortar is not permitted. Spread an ample layer of mortar on the beds. Make a shallow furrow in it that can be readily closed by the laying of the brick. Fill all bed and head joint solid with mortar. Fully butter with mortar the end joints of stretchers and side or cross joints of headers and a shove joint made to squeeze out mortar at the top of the joint.

Remove, reclean, and re-lay any bricks loosened after the mortar has taken its set. Do not use any broken or chipped brick in the face, and do not use any spalls or bats except where necessary to shape around irregular openings or edges; in which case, place full bricks at ends or corners where possible, and use the bats in the course interior. In making closures, do not use any piece of brick shorter than the width of a whole brick; and wherever practicable, use and lay whole brick as headers.

751-3.2.3 Joints.

Fill all joints with mortar at every course. Lay up exterior faces in advance of backing. Before backing is laid up, plaster or parge exterior faces with a coat of mortar not less than ⅜ inch (9 mm) thick. Prior to parging, cut all joints on the back of face courses flush. Unless otherwise noted, joints will not be less than ¼ inch wide (6 mm) or more than ½ inch (12 mm) wide. Maintain the selected joint width uniform throughout the work.

751-3.2.4 Pointing.

Neatly strike face-joints using the weather-struck joint. Properly finish all joints as bricky laying progresses. When nails or line pins are used, immediately plug holes with mortar and point when the nail or pin is removed.

751-3.2.5 Cleaning.

Upon completion of the work, thoroughly clean all exterior surfaces by scrubbing and washing with water. If necessary to produce satisfactory results, clean with a 5% solution of muriatic acid and then rinse off with liberal quantities of water.

751-3.2.6 Curing and Cold Weather Protection.

Protect the brick masonry and keep moist for at least 48 hours after brick laying. Do not work or point brick masonry work or pointing 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.

Build concrete structures to be cast-in-place within the project boundaries on prepared foundations, conforming to the dimensions and shape indicated on the plans. The construction must conform to the requirements specified in Item P-610. Place any reinforcement required as indicated on the plans. The RPR must approve before concrete is placed. Construct and shape all invert channels accurately to be smooth, uniform, and cause minimum resistance to flowing water. Slope the interior bottom to the outlet.

751-3.4 Precast Concrete Structures.

A plant meeting the National Precast Concrete Association Plant Certification Program, or another RPR approved third party certification program, must make the precast concrete structures. Precast concrete structures must conform to ASTM C478. Construct and prepare precast concrete structures on previously placed slab foundations conforming to the dimensions and locations shown on the plans. Furnish all precast concrete sections necessary to build a completed structure. The different sections must fit together readily. Full bed in cement mortar, joints between precast concrete risers and tops, and must: (1) be smoothed to a uniform surface on both the interior and exterior of the structure, or (2) utilize a rubber gasket per ASTM C443. Suitably form and dimension the upper precast concrete section to receive the metal frame and cover or grate, or another cap, as required. Make provisions for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines must be smooth, uniform, and cause minimum resistance to flow. Align and place the metal or metal encapsulated steps that are embedded or built into the side walls according to ASTM C478. Securely fasten into position when a metal ladder replaces the steps.

751-3.5 Corrugated Metal Structures.

Prefabricate corrugated metal structures. Furnish all standard or special fittings to provide pipe connections or branches with the correct dimensions and be of sufficient length to accommodate connecting bands. Weld the fittings must in place to the metal structures. Design the top of the metal structure 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. Furnish steps or ladders as shown on the plans. Construct corrugated metal structures on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, place the structures on a reinforced concrete base.

751-3.6 Inlet and Outlet Pipes.

Extend inlet and outlet pipes through the structure walls, a sufficient distance beyond the outside surface, to allow for connections. Cut off pipes flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, place mortar around these pipes to form a tight, neat connection.

751-3.7 Placement and Treatment of Castings, Frames, and Fittings.

Place all castings, frames, and fittings in the positions indicated on the plans or as the RPR directed and set true to line and elevation. Place all anchors or bolts before placing the concrete or mortar if frames or fittings are being set in concrete or cement mortar. Do not disturb the unit until the mortar or concrete sets.

When frames or fittings are placed on previously constructed masonry, bring the bearing surface of the masonry true to line and grade, and present an even bearing surface so the entire face or back of the unit meets the masonry. Set the unit must in mortar beds and anchor to the masonry as indicated on the plans or as the RPR directed. All units must set firm and secure. After the frames or fittings have been set in final position, allow the concrete or mortar to harden for seven days before placing and fastening down the grates.

751-3.8 Step Installation.

Install the steps as indicated on the plans or the RPR directed. When setting the steps in concrete, place and secure the steps in position before placing the concrete. When installing steps in brick masonry, place as the masonry is being built. Do not disturb or use the steps until the concrete or mortar hardened for at least seven days. After seven days, clean and paint the steps, unless they are galvanized.

When precast concrete structures require steps, they must meet the requirements of ASTM C478. Cast the steps 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. Weld steps with corrugated metal structures into aligned position at a vertical spacing of 12 inches (300 mm).

Install prefabricated ladders instead of steps. For brick or concrete structures, hold the ladder in place by grouting the supports in drilled holes. For metal structures, secure the ladder by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as the RPR directed.

751-3.9 Backfilling.

751-3.9.1 After a structure is complete, backfill the area around it 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. Deposit each layer evenly around the structure to approximately the same elevation. The top of the fill must meet the elevation shown on the plans or as the RPR directed.

751-3.9.2 Do not place backfill against any structure until the RPR approves. For concrete structures, the RPR’s approval is not given until the concrete has been in place seven days, or until tests establish the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

751-3.9.3 Do not measure backfill or direct payment. Performance of this work is considered an obligation of the Contractor covered under the contract unit price for the structure involved.

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When structures are located within the runway safety area, the Precision Object Free Area (POFA), runway protection zones (RPZ), etc., the elevation of the structures must be set to meet the grading requirements of these areas. Structures must not exceed three inches (75 mm) above the elevation the surrounding areas.

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751-3.10 Site Cleaning and Restoration.

After backfill is completed, the Contractor must dispose of all surplus material, dirt, and rubbish from the site. Deposit surplus dirt in embankments, shoulders, or as the RPR approved. The Contractor restores all disturbed areas to their original condition. The Contractor removes all tools and equipment, leaving the entire site free, clear, and in good condition.

751-4 METHOD OF MEASUREMENT

751-4.1 Manholes, catch basins, inlets, and inspection holes must be measured by the unit.

751-5 BASIS OF PAYMENT

751-5.1 The accepted quantities of manholes, catch basins, inlets, and inspection holes are paid for at the contract unit price per each in place when completed. This price is 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 is made under:

Item D-751-5.1	Manholes - per each
Item D-751-5.2	Catch Basins - per each
Item D-751-5.3	Inlets - per each
Item D-751-5.4	Inspection Holes - per each

751-6 REFERENCES

751-6.1 This list of publications forms 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 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

Item D-752 Concrete Culverts, Headwalls, and Miscellaneous Drainage Structures

752-1 DESCRIPTION

752-1.1 This item consists of **[** `plain` **|** `reinforced` **]** concrete culverts, headwalls, and miscellaneous drainage structures constructed according to these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or as the Resident Project Representative (RPR) required.

752-2 MATERIALS

752-2.1 Concrete.

[`Plain` **|** `Reinforced` **]** concrete must meet the requirements of **[** `Item P-610` **]**.

****

Use Item P-610, Item P-501, or concrete meeting state Department of Transportation (DOT) specifications for structures provided aggregates meet reactivity requirements of Item P-610 or P-501.

****

752-3 CONSTRUCTION METHODS

752-3.1 Unclassified Excavation.

752-3.1.1 Excavate trenches and foundation pits for structures or structure footings to the lines and grades and elevations shown on the plans. Excavate sufficient size to permit the placing of the full width and length of the structure or structure footings shown. Consider the elevations of the bottoms of footings, as shown on the plans, as approximate, only. The RPR may approve, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

752-3.1.2 Remove boulders, logs, or any other objectionable material encountered in excavation. Clean all rock or other hard foundation material of all loose material and cut to a firm surface either, level, stepped, or serrated, as the RPR directed. Clean out and grout all seams or crevices. Remove all loose and disintegrated rock, and thin strata.When concrete rests on a surface other than rock, do not make the bottom of the excavation to final grade until immediately before the concrete or reinforcing steel is placed.

752-3.1.3 The Contractor must perform all bracing, sheathing, or shoring necessary to protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring is included in the unit price bid for excavation.

752-3.1.4 The Contractor removes all bracing, sheathing, or shoring after the completion of the structure. Removal must not disturb or damage the finished concrete. The cost of removal is included in the unit price bid for excavation.

752-3.1.5 After each excavation is completed, the Contractor notifies the RPR. Do not place any concrete or reinforcing steel until the RPR approves the depth of the excavation and the character of the foundation material.

752-3.2 Backfilling.

752-3.2.1 After completing a structure, accomplish backfill with approved material by applying the fill in horizontal layers not to exceed inches (200 mm) in loose depth, and compacted. The field density of the compacted material must be at least 90% of the maximum density for cohesive soils and 95% of the maximum density for noncohesive soils. Determine the maximum density according to ASTM D698. Determine the field density according to [ASTM D6938 using procedure A, the direct transmission method, and ASTM D6938 to determine the moisture content of the material. The machine must be calibrated in accordance with [ASTM D6938.] ASTM D7830 | ASTM D8167] for in-place density and [ASTM D4959, | ASTM D8153, | ASTM D4643, | ASTM D4944] for moisture].

752-3.2.2 Do not place any backfilling against any structure until the RPR approves. For concrete, the RPR will not approve until the concrete has been in place seven days, or until tests establish the concrete attained sufficient strength to withstand any pressure created by the backfill or the placement methods.

752-3.2.3 Deposit fill placed around concrete culverts on each side at the same time and to approximately the same elevation. Step or serrate all slopes bounding or within the areas to be backfilled to prevent wedge action against the structure.

752-3.2.4 Backfill is not measured for direct payment. Performance of this work is considered as a subsidiary obligation of the Contractor, covered under the contract unit price for “unclassified excavation for structures.”

752-3.3 Weep Holes.

Construct weep holes as shown on the plans.

752-3.4 Site Cleaning and Restoration.

After the backfill is completed, the Contractor disposes of all surplus material, dirt, and rubbish from the site. Deposit surplus dirt in embankment, shoulders, or as the RPR approved. The Contractor restores all disturbed areas to their original condition. The Contractor removes all tools and equipment, leaving the entire site free, clear, and in good condition.

752-4 METHOD OF MEASUREMENT

752-4.1 The quantity of unclassified excavation for structures is the number of cubic yards (cubic meters), measured in original position, of material excavated according to the plans, or the RPR approved; but in no case is any yardage included in the measurement for payment which is outside of a volume bounded by vertical planes 18 inches (0.5 m) outside of and parallel to the neat lines of the footings.

752-4.2 Concrete is measured by the number of cubic yards (cubic meters) of concrete, complete in place and accepted. In computing the yardage of concrete for payment, use the dimensions shown on the plans or as the RPR approved. No measurements or other allowances are made for forms, false work, cofferdams, pumping, bracing, expansion joints, or finishing of the concrete. Deductions are not made in yardage for the volumes of reinforcing steel or embedded items.

752-4.3 The quantity of reinforcing steel is the calculated theoretical number of lbs (km) placed, as shown on the plans, complete in place and accepted. The unit weight used for deformed bars is the weight of plain square or round bars of equal nominal size.

752-5 BASIS OF PAYMENT

752-5.1 Payment is made at the contract unit price per cubic yard (cubic meter) for unclassified excavation for structures.

752-5.2 Payment is made at the contract unit price per cubic yard (cubic meter) for concrete for the structures.

752-5.3 Payment is made at the contract unit price per pound (km) for reinforcing steel.

These prices are full compensation for furnishing all materials and for all preparation, excavation, and placing the materials, and for all labor, equipment, tools, and incidentals necessary to complete the structure.

Payment is made under:

Item D-752-5.1	Unclassified Excavation for Structures - per cubic yard (cubic meter)
Item D-752-5.2	Structural Concrete - per cubic yard (cubic meter)
Item D-752-5.3	Reinforcing Steel - per pound (km)

752-6 REFERENCES

This list of publications forms 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 D698	*Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3))*

END OF ITEM D-752

Item D-754 Concrete Gutters, Ditches, and Flumes

754-1 DESCRIPTION

754-1.1 This item consists of Portland Cement concrete gutters, ditches, and flumes constructed according to these specifications at the specified locations according to the dimensions, lines, and grades as shown on the plans.

754-2 MATERIALS

754-2.1 Concrete.

Plain and reinforced concrete must meet the requirements of **[** `Item P-610` **]**.

****

Use Item P-610, Item P-501, or concrete meeting state Department of Transportation (DOT) specifications for structures may be used provided that aggregates meet reactivity requirements of Item P-610 or P-501.

****

754-2.2 Joints.

Joint filler materials and premolded joint material must conform to Item P-605.

754-3 CONSTRUCTION METHODS

754-3.1 Preparing Subgrade.

Make excavation to the required width and depth and compact the subgrade upon which the item is being built to a firm uniform grade. Remove and replace all soft and unsuitable material with suitable approved material. When required, place layer of approved granular material, compacted to the thickness indicated on the plans, to form a subbase. The Resident Project Representative (RPR) must check and accept the underlying course before placing and spreading operations start.

754-3.2 Placing.

The forms and mixing, placing, finishing, and curing of concrete must conform to the requirements of Item P-610 and the following requirements. Tamp the concrete until it is consolidated, and mortar covers the top surface. Float smooth the surface of the concrete and round the edges to the radii shown on the plans. Before concrete is given the final finishing, test the surface with a 12-foot (3.7-m) straightedge, and eliminate any irregularities of more than ¼ inch (6 mm) in 12-foot (3.7-m). Place the concrete with dummy-grooved joints not exceeding 25 feet (7.5 m) apart, without any sections less than 4 feet (1.2 m) long.

Construct the type of expansion joints called for in the plans to replace dummy groove joints at a spacing of approximately 100 feet (30 m). When the gutter is placed next to concrete pavement, locate expansion joints in the gutter opposite expansion joints in the pavement. When a gutter abuts a pavement or other structure, place an expansion joint between the gutter and the other structure. Do not remove forms within 24 hours after the placing the concrete. Repair minor defects with mortar containing one part cement and two parts fine aggregate. Conduct depositing, compacting, and finishing the item to build a satisfactory structure. The Contractor removes and replaces any section of concrete found to be porous, or is otherwise defective, without additional compensation.

754-3.3 Backfilling.

After the concrete has set sufficiently, refill the spaces adjacent to the structure to the required elevation with material specified on the plans, and compacted by mechanical equipment to at least 90% of the maximum density, as determined by ASTM D698. Determine the in-place density according to ASTM D1556.

754-3.4 Site Cleaning and Restoration.

After backfill is completed, the Contractor disposes of all surplus material, dirt, and rubbish from the site. Deposit surplus dirt in embankments, shoulders, or as the RPR ordered. The Contractor restores all disturbed areas to their original condition. The Contractor removes all tools and equipment, leaving the entire site free, clear and in good condition. Performance of the work described in this section is considered as a subsidiary obligation of the Contractor, covered under the contract unit price for the structure.

754-4 METHOD OF MEASUREMENT

754-4.1 Concrete is measured by the cubic yard (cubic meter) according to the dimensions shown on the plans or the RPR ordered. Deductions are not made for the volume occupied by reinforcing steel, anchors, conduits, weep holes, or piling.

754-4.2 Reinforcing steel is measured by the pound (kg), based on the theoretical number of lbs (kg) complete in place as shown on the plans or placed, as the RPR ordered.

754-5 BASIS OF PAYMENT

754-5.1 The accepted quantities of structural concrete are paid for at the contract unit price per cubic yard (cubic meter) complete in place.

754-5.2 The accepted quantities of reinforcing steel are paid for at the contract price per pound (kg) complete in place. No allowance is made for clips, wire, or other material used for fastening reinforcement in place.

Payment is made under:

Item D-754-5.1	Structural Concrete - per cubic yard (cubic meter)
Item D-754-5.2	Reinforcing Steel - per pound (kg)

754-6 REFERENCES

This list of publications forms 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 D698	*Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/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*

END OF ITEM D-754

Part 11 – Fencing

Item F-860 Fencing

860-1 DESCRIPTION

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- **See the Airport Improvement Program (AIP) Handbook FAA Order 5300.38 for guidance on eligibility of federal funds for all types of fencing.**
- **Prior to specifying fencing material on a federally funded project, the type and nature of fencing depends upon the fence's intended purpose. Project plans must indicate the location, type of fencing, type, and spacing of posts, and location of gates and braces.**
  - **Perimeter fencing is typically used to designate the boundary of property. Typically, this is woven wire or barbed wire type fencing.**
  - **Wildlife fencing is used to impede the entry of wildlife onto an airport is as outlined in a Wildlife Hazard Assessment Plan.**
    - **See F-863 Wildlife Deterrent Fence Skirt**
    - **See F-864 Wildlife Exclusion Fence**
  - **Security fencing is intended to slow the access of pedestrians and vehicles onto an airport, as outlined in a 1542 Security Plan The location, type, and size must be as outlined in the 1542 Security Plan. The type and size of security fencing depends upon where on the airport the fencing is installed.**
  - **Location, type, and details of fencing near or adjacent to Navigational Aids (NAVAIDS) must be coordinated with FAA Airport District Office (ADO) or Region during design. Fencing may need to be non-ferrous or location and/or alignment may need to be adjusted to ensure the fence does not interfere with NAVAIDs.**
- **This specification covers field fencing or barbed wire fencing installed with either wood or steel posts to designate the perimeter or property boundary.**
- **See specification F-862 for chain link fencing**

All steel and manufactured goods provided for this item must meet the Buy American provisions contained in this contract.

****

860-1.1 This item covers the requirements for furnishing materials and constructing new wire fences and gates with **[** wood **|** steel **]** posts according to the details included herein and as shown on the plans. The class of fence to be erected is **[** Class A: woven wire fencing topped by two strands of barbed wire **|** Class B: four strands of barbed wire **]**, as indicated on the plans.

860-2 MATERIALS

860-2.1 Wire.

860-2.1.1 Woven Wire (Zinc-coated).

[Not used. **|** The woven wire fence must be 7-bar, 26-inch (66 cm) field fence with top and bottom wires No. 10 gauge, and filler and stay wires No. 12½ gauge. Stay wires must be spaced 6 inches (150 mm) apart. All wires must be smooth galvanized steel wire, conforming to ASTM A116. Twice-dip all wires and space as shown on the plans. **]**

860-2.1.2 Barbed Wire (Zinc-coated).

[Not used. **|** Zinc-coated barbed wire must be 2-strand twisted No. 12-½ gauge galvanized steel wire with 4-point barbs of No. 14 gauge galvanized steel wire. All wire must conform to ASTM A121, Type A. The barbs must be spaced approximately 5 inches (125 mm) apart. **]**

860-2.1.3 Barbed Wire (Copper-covered).

[Not used. **|** Copper-covered steel barbed wire must conform to ASTM A121,Type A. **]**

860-2.1.4 Barbed Wire (Aluminum-coated).

[Not used. **|** Aluminum-coated steel-barbed wire must be 2-strand twisted No. 12½ gauge. The 4-point barbs of No. 14 gauge aluminum-coated steel wire must be spaced approximately 5 inches (125 mm) apart. The steel wire must have a tensile strength of between 60,000 and 80,000 lbs per square inch (413 400 and 551 200 kPa), and the aluminum coating must have a minimum weight of 0.30 ounces per square foot (0.07 kg/m2) of wire surface on the No. 12½ gauge line wires and 0.25 ounces per square foot (0.06 kg/m2) of wire surface on the No. 14 gauge barbs. **]**

860-2.1.5 Bracing Wire (Zinc-coated).

Use No. 9 smooth galvanized soft wire for bracing.

860-2.2 Gates and Hardware.

Use galvanized steel tubing for gates conforming to Federal Specification RR-F-19, size shown on the plans. Furnish heavily galvanized hinges and latches for gates installed on wood posts.

860-2.2.1 Steel Fence Posts, Gates, Rails, Braces, and Accessories.

[Not used. **|**These items, when specified, must conform to the requirements of AASHTO M281 and AASHTO M181. **]**

860-2.2.2 Wood Posts. **[** Not used. **]**

860-2.2.2.1 **[** Species.

Use one of the following species of wood for all posts unless the plans note otherwise.

Table 861-2.2: Wood Species

Group I	Group II
Cedar	Douglas-fir
Chestnut	Gum, Red
Cypress, Southern	Larch, Western
Locust, Black	Pine, Southern Yellow
Osage-orange	Pine, Lodgepole
Redwood	Tamarack
Yew, Pacific	Ash
Honey locust	Maple, Sugar
Oak, White	Oak, Red
Mulberry	Spruce
Live Oak	

Posts of Group I may be used untreated, provided at least 75% of the wood is heartwood. Give posts of less than 75% heartwood of Group I, a preservative treatment for the part of the post that has contact with the ground line. Give the full length of posts of Group II a preservative treatment.

860-2.2.2.2 Quality.

Only use peeled, sound, straight grained, and free from decay, cracks, and splits, posts. Shakes must not be more than ¼-inch (6 mm) wide and 3 feet (1 m) long. Checks (lengthwise separations of the wood in a generally radial direction) are permitted, provided they are not harmful.

860-2.2.2.3 Dimensions.

All posts must be the length shown on the plans. Posts must have the minimum top diameters shown on the plans. Sawn and split posts are acceptable instead of round posts if the required diameter round posts could be turned from the sawn or split posts.

860-2.2.2.4 Manufacture.

Completely remove the outer bark from all posts including depressions. Remove all inner bark from all post surfaces to be treated, except inner bark may remain in depressions.

860-2.2.2.5 Treatment.

Condition posts by air seasoning, steaming, or heating in oil in a manner that prevents injurious checking, splitting, or warping before treating. Thoroughly season all timber and dry (22% maximum moisture content) before applying preservative treatment. The treatment, care, and preservative must be with waterborne preservatives according to American Wood Preservers Association (AWPA) Standard U1, Use Category 4 (UC4).]

860-2.3 Wood Braces.

[Not used. |Cleats, gate stops, and braces must be of the size shown on the plans. They must be of the same species and quality specified for the posts or RPR approved, and free from knots larger than one-third the width of the piece. Make gate stops of posts of suitable length. Braces may be made of posts of suitable length or of sawn lumber. Treat all cleats, gate stops, and any braces in `contact with the ground and for a distance of at least 6 inches (150 mm) above the ground by the hot and cold bath process, specified herein for posts. Use No. 9 smooth galvanized wire for bracing.` **]**

860-2.4 Staples.

[`Not used.` **|**`The staples must be No. 9 galvanized steel wire, 1 inch (25 mm) long for hardwood posts and 1½ inch (38 mm) long for use in softwood posts.` **]**

860-2.5 Concrete.

Concrete must be of a commercial grade with a minimum 28-day compressive strength of 3000 psi (2670 kPa).

860-3 CONSTRUCTION METHODS

860-3.1 General.

Construct the fence according to the details on the plans and as specified here using new materials. **[** `The RPR establishes and marks the property line or fence line for the work.` **|**`The Contractor lays out the fence line based on the plans.` **]** Span openings below the fence with barbed wire in all locations where it is not practical to conform the fence to the general contour of the ground surface because of natural or manufactured features such as drainage ditches. Permanently tie the new fence to the terminals of existing fences whenever the RPR requires. The finished fence must be plumb, taut, true to line and ground contour, and complete in every detail. Stake down the woven wire fence at several points between posts when necessary to keep fence to ground contour, or when the RPR directs. When replacing existing fencing, the length of unfenced section at any time must not exceed **[** `300 feet (90 m)` **]**. At the close of the working day, tie the newly constructed fence to the unremoved existing fence.

****

Select whether the RPR or Contractor will lay out the fence and/or property lines.

****

860-3.2 Clearing Fence Line.

The fence line must be clear of obstructions and surface irregularities on each side of the fence line. Grade the fence line so the fence conforms to the general ground contour. This clearing consists of the removal of all stumps, brush, rocks, trees, or other obstructions that interfere with proper construction of the fence. Grub or excavate stumps within the cleared area of the fence line. Place the bottom of the fence a uniform distance above ground as specified in the plans. Remove the existing fence as shown on the plans or as the RPR directed, unless removal is a separate item in the bid schedule. Fill all holes remaining after post and stump removal with suitable soil, gravel, or other material and s compact with tampers. The work includes the handling and disposal of all material cleared, of excess excavation and the removal of spoiled material regardless of the type, character, composition, or condition of such material encountered.

860-3.3 Setting Posts.

Space all posts as shown on the plans. No extra compensation for rock excavation.

860-3.3.1 Wood Posts.

[Not used. |Set wood posts with large ends down, plumb, and in a straight line on the side the wire is to be fastened. Posts must not be cut off to eliminate rock or other excavation. Where rock is encountered, remove it to provide full-depth and full-size holes. Cut off the bottom of all posts, square. The diameter of the holes must be at least 6 inches (150 mm) larger than the diameter of the posts. When cleats are used on posts, the holes must be dug large enough to accommodate the cleat. After placing and lining the posts, backfill holes with suitable material and compact with tampers. Set and brace the posts adjacent to end, corner, anchor, and gate posts with braces and wire, as shown on the plans. No extra compensation is made for rock excavation.]

860-3.3.2 Steel Posts.

[Not used. |Set corner, brace, anchor, end, and gate posts in concrete as shown on the plans. Trowel finish the top of the concrete to be slightly above the ground surface sloped to drain. Posts must be full height and must not be cut off to eliminate rock or other excavation. All line posts may be either driven or set in dug holes to a depth of 3 feet (1 m). Set posts to true alignment. Replace, tamp, and level dirt removed for placing posts, anchor bars, flanges, etc. Damaged posts must be replaced at the Contractor’s expense. No extra compensation is made for rock excavation.]

860-3.4 Wood Post Anchoring.

[Not used. |Anchor corner, end, gate, and adjacent intermediate posts by gaining and spiking cleats to the sides of the posts, as indicated on the plans. Cleats are not required on other intermediate posts or on anchor posts.]

860-3.5 Wood Post Bracing.

[Not used. |Brace end, corner, anchor, and gate posts by using a post of sufficient length or a piece of sawn lumber of the proper size, together with a wire cable. Gain and securely place the wooden brace spiked into the end, corner, anchor, or gate posts and into the next intermediate posts about 6 inches (150 mm) from the top of the respective posts. Loop a cable made of a double strand of galvanized soft wire around the end, corner, anchor, or gate post near the ground and around the next intermediate post about 12 inches (300 mm) from the top. Twist until tight after the cable has been stapled in this position. Use staples not less than 1-½ inch (38 mm) long to hold the cable. Leave the tool used for twisting the cable in place to permit later adjustment of bracing. Set anchor posts at approximately 500 feet (150 m) intervals braced to adjacent posts. Brace posts before the wire fencing is placed.]

860-3.6 Installing Wire.

Place wires on the side of the posts away from the airport or as directed. Place the fence on the posts at the height indicated on the plans. Carefully stretch and hang the woven wire without sag and with true alignment. Take care not to stretch the wire so tightly that it will break in cold weather or pull up corner and brace posts Install longitudinal wires parallel and draw uniformly taut. The vertical stay wires of the woven wire fencing must be straight and vertical. Wrap the woven wire around end, corner, and gate posts, and tie the ends of all horizontal wires with snug, tight twists staple or fasten to prevent slippage or movement.

860-3.6.1 Steel Posts.

[Not used. |Fasten all horizontal wires securely to each post by fasteners or clips designed for use with the posts furnished. Secure the wire must to prevent slipping up and down the post. Stretch barbed wire strands and secure each strand to each post to prevent slipping out of line or becoming loose.]

860-3.6.2 Wood Posts.

[Not used. |Staple each longitudinal wire to each intermediate post with one steel wire staple; use two or more staples at the corner and anchor posts. Staple the top strand of barbed wire of all fences with two staples in each post. Set all staples diagonally with the grain of the wood and drive up tight. After erecting the fence, saw off the tops of the wood posts be sawn off with a 1-to-3 pitch after the fence.] The bottom wire of the wire fencing must clear the ground by not more than 4 inches (100 mm) or less than 1 inch (25 mm) at any place.

860-3.7 Splicing Wire.

Wire splices in longitudinal wires are permitted if made with an approved galvanized bolt-clamp splice or a wire splice made as follows. Carry the end of the wires 3 inches (75 mm) past the splice tool and wrap around the other wire away from the tool for at least six turns in opposite directions. After the splice tool is removed, close the space occupied by it by pulling the ends together. Cut the unused ends of the wires close to make a neat, workmanlike job. Only splice woven wire at posts.

860-3.8 Installing Gates.

Erect gates at locations shown on the plans. Hang gates fittings, as shown on the plans. Clamp, screw or bolt fittings on the gate posts to prevent slipping. Erect gates to swing in the direction indicated and provide with gate stops as shown on the plans.

860-3.9 Existing Fence Connections.

Set and brace a corner or anchor post wherever the new fence joins an existing fence. If the connection is made at other than the corner of the new fence, the last span of the old fence must contain a brace span.

860-3.10 Electrical Grounds.

[Not used. |Construct electrical grounds [where a power line passes over the fence |at 500 feet (150 m) intervals]. [The ground must be installed directly below the point of crossing.] Accomplish the ground with a copper clad rod 8 feet (2.4 m) long and a minimum of ⅝ inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. Clamp a No. 6 solid copper conductor to the rod and fence in such a manner that each element of the fence is grounded. Installation of ground rods does not constitute a pay item and is considered incidental to fence construction. The Contractor must comply with FAA-STD-019, *Lightning and Surge Protection, Grounding, Bonding and Shielding*

Requirements for Facilities and Electronic Equipment, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities. **]**

****

The Engineer indicates the location of all electrical grounds on the plans. Grounding may not be necessary with the use of composite posts.

****

860-3.11 Control Installation.

Fence installation must not begin until the RPR has approved the Contractors materials, processes and equipment to be used to establish the fence line, clear the fence line, install brace and set posts, and install fence wire.

860-3.12 Cleaning Up.

The Contractor must remove from the vicinity of the completed work all tools, buildings, equipment, etc., used during construction. Seed all disturbed areas per T-901.

860-4 METHOD OF MEASUREMENT

860-4.1 Measure fences in place from outside to outside of end posts or corner posts and be the length of fence actually constructed, excluding the space occupied by gates.

860-4.2 Measure gates units for each gate installed and accepted.

860-5 BASIS OF PAYMENT

860-5.1 Payment is made at the contract unit price per linear foot of wire fence. This price is full compensation for furnishing all materials and for preparation, erection, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

860-5.2 Payment is made at the contract unit price per each vehicle or pedestrian gate. This price is full compensation for furnishing all materials and for all preparation, erection, and installation of these materials and for all labor, equipment, tools, and necessary incidentals to complete the item.

Payment is made under:

Item F-860-5.1a	Fence, Class A - per linear foot (meter)
Item F-860-5.1b	Fence, Class B - per linear foot (meter)
Item F-860-5.2a	Vehicle Gates - per each

Item F-860-5.2b Pedestrian Gates - per each

860-6 REFERENCES

860-6.1 This list of publications forms a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AASHTO

AASHTO M181	*Chain Link Fence*
AASHTO M281	*Steel Fence Posts and Assembles, Hot -Wrought*

ASTM International

ASTM A116	*Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric*
ASTM A121	*Standard Specification for Metallic-Coated Carbon Steel Barbed Wire*

American Wood Preservers Association (AWPA)

AWPA U1	*Use Category System: User Specification for Treated Wood*

FAA Standards (FAA STD)

FAA-STD-019	*Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*

END OF ITEM F-860

Item F-862 Chain-Link Fence

****

- **See the Airport Improvement Program (AIP) Handbook FAA Order 5300.38 for guidance on eligibility of federal funds for all types of fencing.**
- **Prior to specifying fencing material on a federally funded project, the type and nature of fencing depends upon the fence's purpose. The project plans must indicate the location, type of fencing, type and spacing of posts, location of gates and braces.**
    - **Perimeter fencing is typically used to designate the boundary of property. Typically, this is woven wire or barbed wire type fencing, but portions may be chain link.**
    - **Wildlife fencing is to impede the entry of wildlife onto an airport is as outlined in a Wildlife Hazard Assessment Plan.**
        - **See F-863 Wildlife Deterrent Fence Skirt**
        - **See F-864 Wildlife Exclusion Fence**
    - **Security fencing is intended to slow the access of pedestrians and vehicles onto an airport as outlined in a 1542 Security Plan. The location, type and size must be as outlined in the 1542 Security plan. The type and size of security fencing depends upon where on the airport the fencing is installed.**
    - **Coordinate the location, type, and details of fencing near or adjacent to navigational aids (NAVAIDS) with FAA Airport District Office (ADO) or Region during design. Fencing may need to be non-ferrous or location and or alignment may need to be adjusted to ensure the fence does not interfere with NAVAIDs.**
- **This specification covers chain link.**
- **See specification F-861 Fencing for field fencing or barbed wire fencing installed with either wood or steel posts to designate the perimeter or property boundary.**
- **See the Chain Link Fence Manufacturers Institute for additional guidance on fence materials' specifications.**

All steel and manufactured goods provided for this item must meet the Buy American Provisions contained in this contract.

****

862-1 DESCRIPTION

862-1.1 This item consists of furnishing and erecting a chain-link fence according to these specifications and the project plans.

862-2 MATERIALS

862-2.1 Chain Link Fabric.

Steel chain link fabric **[** `2-inch` **]** mesh, **[** `9` **]** gauge, **[** `60-inch` **]** high type **[** `I` **|**`II` **|**`III` **|**`IV` **]** with **[** `standard` **|**`K&K` **|**`K&T` **]** selvage, per American Association of State Highway and Transportation (ASHTO) M181.

****

1. Type I - Zinc Coated Steel Fabric hot dipped galvanized before or after weaving

  a. Class 1, 1.2 oz/ft2

  b. Class 2, 2.0 oz/ft2

2. Type II Aluminum coated steel fabric (Aluminized)

3. Type III Zinc 5% Aluminum-Mischmetal Alloy Coated Steel Fabric

  a. Class 1, 0.6 oz/ft2

  b. Class 2, 1.0 oz/ft2

4. Type IV Polymer coated steel fabric

  a. Class 1 extruded

  b. Class 2a extruded and adhered

  c. Class 2b fused and adhered

  d. color [`dark green` |`olive green` |`brown` |`black`]

5. Selvage

  a. Standard fabric selvage for 2-inch mesh under 72-inch height is knuckle finish top and bottom

  b. Standard fabric selvage for 2-inch mesh over 72-inch height is knuckle finish top and twist bottom.

****

862-2.2 Classification.

Chain link fabric, posts, rails, ties, bands bars, rods and other fittings must be composed of **[** `Type and if applicable grade or class` **]** material.

Metallic coated steel posts, rails or gate frames must be **[** `Grade 1` **|** `Grade 2` **]**, line posts **[** `insert outside diameter and weight` **]**, end, corner and pull posts **[** `insert outside diameter and weight` **]**. The fabric is **[** `2-inch` **]** mesh, **[** `9 gauge` **]** wire, **[** `36` **|** `48` **|** `60` **|** **___** **]** high with standard salvage. Fence must be according to AASHTO M181, *Chain Link Fence*, and AASHTO M281, *Steel Fence Posts and Assemblies*.

See AASHTO M181 for guidance on specification of chain link fence materials.

The specifier must indicate the type of material and if applicable the grade and class of material.

Additionally, the specifier must indicate the size of mesh, size of wire, height of wire type of selvage if nonstandard. In addition, the specifier must indicate the type and class of tension wire, the type, grade, size, shape and spacing of posts, rails, rods, and other fittings. Specify the fence color for polymer-coated fabric.

[`Type I – Zinc coated steel` **[** `Class C` **|** `Class D` **]** `with tension wire` **[** `Class 1` **|** `Class 2` **|** `Class 3` **]]**

[`Type II Aluminum Coated Steel` **]**

[`Type III Aluminum Alloy` **]**

Type IV Polyvinyl Chloride (PVC) and other organic coated steel (Need to specify class and color. Class 1 extruded, Class 2a extruded and adhered and Class 2b fused and adhered. The standard selvage for mesh under 72 inches is K&K, knuckle on top and bottom, and for over 72 inches is K&T, knuckle on top and twist on bottom.

862-2.3 AASHTO M 181 Chain-Link Fence.

See ASTMF1043 for sizing of fence posts. Base spacing of fence upon the wind load the fence is designed to resist, fabric height, and steel strength used for posts (standard 30,000 psi or high 50,000 psi). See Chain Link Fence Manufactures Institute Guide WLG 2445 for wind load guide for selection of line post and line post spacing.

862-2.4 Barbed Wire.

Barbed wire must be 2-strand 12½ gauge **[** `zinc-coated` **|** `aluminum-coated` **]** wire with 4-point barbs and conform to the requirements of ASTM A121.

****

Zinc-coated barbed wire must conform to the requirements of ASTM A121, Class 3, Chain Link Fence Grade.

Aluminum-coated barbed wire must conform to the requirements of ASTM A121, Class II.

****

862-2.5 Gates.

Gate frames must consist of [galvanized steel pipe |polymer-coated steel pipe |aluminum alloy pipe |composite posts] and conform to the specifications for [AASHTO M181 |ASTM F1083 |ASTM B429]. The fabric must be of the same type of material as used in the fence.

862-2.6 Wire Ties and Tension Wires.

Wire ties for use in conjunction with a given type of fabric must be of the same material and coating weight identified with the fabric type. Tension wire must be [7-gauge marcelled steel] wire with the same coating as the fabric type.

862-2.7 Miscellaneous Fittings and Hardware.

Miscellaneous steel fittings and hardware for use must be treated with [zinc-coated |aluminum-coated |zinc-5% aluminum-mischmetal alloy-coated] and steel fabric be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficiently strong to provide a balanced design when used in conjunction with fabric posts, and wires of the quality specified herein. [Protect all steel fittings and hardware with a zinc coating applied in conformance with ASTM A153. |Use wrought or cast aluminum for all miscellaneous aluminum fittings for use with aluminum alloy fabric] Barbed wire support arms must withstand a load of 250 lbs (113 kg) applied vertically to the outermost end of the arm.

862-2.8 Concrete.

Concrete must have a minimum 28-day compressive strength of 3000 psi (2670 kPa).

862-2.9 Marking.

Each roll of fabric must carry a tag showing the kind of base metal (steel, aluminum, or aluminum alloy number), kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Identify posts, wire, and other fittings as to manufacturer, kind of base metal (steel, aluminum, or aluminum alloy number), and kind of coating.

862-3 CONSTRUCTION METHODS

862-3.1 General.

Construct the fence according to the details on the plans and as specified here using new materials. Perform all work in a workmanlike manner to the Resident Project Representative's (RPR's) satisfaction. [The RPR establishes and marks the property line or fence line for the work. |The Contractor lays out the fence line based on the plans.] The Contractor must span the opening below the fence with barbed wire at all locations where it is not practical to conform the fence to the general contour of the ground surface because of natural or manufactured features such as drainage ditches. Tie the new fence to the terminals of existing fences as shown on the plans. The Contractor must stake down the woven wire fence at several points between posts as shown on the plans.

[When project includes the removal of existing fence, the Contractor must arrange the work so that construction of any new fence immediately follows the removal of existing fences. The length of unfenced section at any time must not exceed [300 feet (90 m)]. The work must progress in this manner and at the close of the working day the newly constructed fence is tied to the existing fence.]

****

Select whether the RPR or Contractor lays out the fence and/or property lines. Also select if project includes removal of existing fence.

****

862-3.2 Clearing Fence Line.

Clearing will consist of the removal of all stumps, brush, rocks, trees, or other obstructions that will interfere with proper construction of the fence. Grub or excavate stumps within the cleared area of the fence. Place the bottom of the fence a uniform distance above ground, as specified in the plans. When shown on the plans or as the RPR directed, the Contractor removes existing fences which interfere with the new fence location as a part of the construction work unless such removal is listed as a separate item in the bid schedule. Refill all holes remaining after post and stump removal with suitable soil, gravel, or other suitable material and compacted with tampers. The cost of removing and disposing of the material is not a pay item and is considered incidental to fence construction.

862-3.3 Installing Posts.

Set all posts in concrete in holes the width, depth and spacing shown on the plans.

****

Do not space posts more than 10 feet (3 m) apart and set a minimum of 36 inches (90 cm) in concrete footings. If the frost depth is greater than 36 inches (90 cm), set the posts accordingly. The posts holes must be in proper alignment so there is a minimum of 3 inches (75 mm) of concrete on all sides of the posts. Design post size and spacing according to the height and wind load on the fence.

****

Consolidate the concrete around the posts by tamping or vibrating and finish smooth slightly higher than the ground and sloped to drain away from the posts. Set all posts plumb and to the required grade and alignment. Do not disturb posts or install materials on posts for **[** `7 days` **]** after placement. If rock is encountered at a depth less than the planned footing depth, drill a hole at least 2 inches (50 mm) larger than the greatest dimension of the posts to a depth of 12 inches (300 mm) into the rock. Fill the hole drilled in the rock with grout composed of one part Portland Cement and two parts mortar sand after the posts are set. Fill any space above the rock with concrete in the manner described above. In lieu of drilling, the rock may be excavated to the required footing depth. No extra compensation is made for rock excavation.

862-3.4 Installing Top Rails.

The top rail must be continuous and pass through the post tops. The coupling used to join the top rail lengths must allow for expansion.

862-3.5 Installing Braces.

Install horizontal brace rails, with diagonal truss rods and turnbuckles at all terminal posts.

862-3.6 Installing Fabric.

Firmly attach the wire fabric to the posts and brace as shown on the plans. Stretch all wire taut and install to the required elevations. The fence must generally follow the contour of the ground, with the bottom of the fence fabric no less than 1 inch (25 mm) or more than 4 inches (100 mm) from the ground surface. Perform grading where necessary to provide a neat appearance.

At locations of small natural swales or drainage ditches and where it is not practical to have the fence conform to the general contour of the ground surface, longer posts may be used, and multiple strands of barbed wire stretched to span the opening below the fence. The vertical clearance between strands of barbed wire must be 6 inches (150 mm) or less.

****

Openings below the fence may also be spanned with barbed wire fastened to stakes.

The Engineer must specify if tension wire is to be installed.

****

862-3.7 Electrical Grounds.

Construct electrical grounds **[** `where a power line passes over the fence` | `at 500 feet (150 m) intervals` **]**. Use a copper clad ground rod 8 feet (2.4 m) long and a minimum of ⅝ inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. Clamp a No. 6 solid copper conductor to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods is not a pay item and is considered incidental to fence construction. The Contractor must comply with FAA-STD-019, *Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for*

*Facilities and Electronic Equipmen*t, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities.

****

The Engineer indicates the location of all electrical grounds on the plans. Grounding may not be necessary with the use of composite posts.

****

862-3.8 Control Installation.

Fence installation must not begin until the RPR has approved the Contractor’s materials, processes, and equipment to be used to establish the fence line, clear the fence line, install brace and set posts, and install fence fabric.

862-3.9 Cleaning Up.

The Contractor will remove from the vicinity of the completed work all tools, buildings, equipment, etc., used during construction. Seed all disturbed areas per T-901.

862-4 METHOD OF MEASUREMENT

862-4.1 Measure chain-link fence for payment by the linear foot (meter). Measurement is along the top of the fence from center to center of end posts, excluding the length occupied by gate openings.

862-4.2 Measure gates as complete units.

862-5 BASIS OF PAYMENT

862-5.1 Payment for chain-link fence is made at the contract unit price per linear foot (meter).

862-5.2 Payment for vehicle or pedestrian gates is made at the contract unit price for each gate.

The price is full compensation for furnishing all materials, and for all preparation, erection, and installation of these materials, and for all labor equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item F-862-5.1	Chain-Link Fence - per linear foot (meter)
Item F-862-5.2a	Vehicle Gates - per each
Item F-862-5.2b	Pedestrian Gates - per each

862-6 REFERENCES

862-6.1 This list of publications forms a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AASHTO

AASHTO M181	*Chain Link Fence*
AASHTO M281	*Steel Fence Posts and Assembles, Hot -Wrought*

ASTM International

ASTM A121	*Standard Specification for Metallic-Coated Carbon Steel Barbed Wire*
ASTM A153	*Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*
ASTM A392	*Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric*
ASTM A491	*Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric*
ASTM A824	*Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence*
ASTM B117	*Standard Practice for Operating Salt Spray (Fog) Apparatus*
ASTM F668	*Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and other Organic Polymer Coated Steel Chain-Link Fence Fabric*
ASTM F1043	*Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework*
ASTM F1083	*Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures*
ASTM F1183	*Standard Specification for Aluminum Alloy Chain Link Fence Fabric*
ASTM F1345	*Standard Specification for Zinc 5% Aluminum-Mischmetal Alloy Coated Steel Chain-Link Fence Fabric*
ASTM G152	*Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*

ASTM G153	*Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*
ASTM G154	*Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials*
ASTM G155	*Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials*

Federal Specifications (FED SPEC)

FED SPEC RR-F-191/3	*Fencing, Wire and Post, Metal (Chain-Link Fence Posts, Top Rails and Braces)*
FED SPEC RR-F-191/4	*Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)*

FAA Standard

FAA-STD-019	*Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*

FAA Orders

5300.38	*AIP Handbook*

END OF ITEM F-862

Item F-863 Wildlife Deterrent Fence Skirt

****

- **See AIP Handbook FAA Order 5300.38 for guidance on eligibility of federal funds for all types of fencing.**
- **Prior to specifying fencing material on a federally funded project, the type and nature of fencing depends upon the fence's purpose. The project plans must indicate the location, type of fencing, type and spacing of posts, location of gates and braces.**
    - **Perimeter fencing is typically used to designate the boundary of property. Usually, this is woven wire or barbed wire type fencing, but portions may be chain link.**
    - **Wildlife fencing is to impede the entry of wildlife onto an airport is as outlined in a Wildlife Hazard Assessment Plan.**
        - **Item F-863 Wildlife Deterrent Fence Skirt.**
        - **Item F-864 Wildlife Exclusion Fence.**
    - **Security fencing is intended to slow the access of pedestrians and vehicles onto an airport as outlined in a 1542 Security Plan. The location, type and size must be as outlined in the 1542 Security plan. The type and size of security fencing depends upon where on the airport the fencing is installed.**
    - **Location, type, and details of fencing near or adjacent to NAVAIDS must be coordinated with the FAA during design, via a 7460 study. Fencing may need to be non-ferrous or location and or alignment may need to be adjusted to insure that fence does not interfere with NAVAIDs.**
    - **See F-862 Chain Link Fence.**
- **See specification F-861 Fencing or field fencing or barbed wire fencing installed with either wood or steel posts to designate the perimeter or property boundary.**
- **See Chain Link Fence Manufacturers Institute for additional guidance on specification of fence materials.**

All steel and manufactured goods provided for this item must meet the Buy American provisions contained in this contract.

****

863-1 DESCRIPTION

863-1.1 This item consists of furnishing and installing chain-link fence fabric underground along an existing chain link fence or wildlife fabric fence, constructing concrete pads at existing fence gates according to these specifications and the details shown on the drawings and in conformity with the lines and grades shown on the plans or the RPR established.

863-2 MATERIALS

863-2.1 Chain Link Fence Fabric.

The fabric must be woven with a 9-gauge galvanized steel wire in a 2-inch (50 mm) mesh and meet the requirements of ASTM A392, Class II. The fabric must be 5 feet (1.5 m) wide.

863-2.2 Barbed Wire.

Barbed wire must be 2-strand 12½ gauge zinc-coated wire with 4-point barbs and conform to the requirements of ASTM A121, Class 3.

863-2.3 Wire Ties and Tension Wires.

Use the same material as the fabric type for wire fabric ties, wire ties, and tension wire. Use 7-gauge coiled spring wire coated similarly to the respective wire fabric being used for tension wire. Wire fabric ties must be hog rings of galvanized steel wire not less than 9-gauge.

863-2.4 Miscellaneous Fittings and Hardware.

Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric must be of commercial grade steel or better quality, wrought or cast as appropriate to the fitting or hardware, and sufficiently strong to provide a balanced design when used with fabric, posts, and wires of the specified quality. Protect all steel fittings and hardware with a zinc coating applied in conformance with ASTM A153.

863-2.5 Concrete Pads at Gates.

Use concrete of a commercial grade with a minimum 28-day compressive strength of 3,000 psi (2670 kPa).

863-2.6 Marking.

Each roll of fabric must carry a tag showing the kind of base metal, kind of coating, the gauge of the wire, the length of fencing in the roll, and the name of the manufacturer. Posts, wire, and other fittings must be identified as to manufacturer, kind of base metal, and kind of coating.

863-2.7 Weed Control Material.

Apply a commercially available weed control material at the manufacturer’s recommended rate.

863-3 CONSTRUCTION METHODS

863-3.1 General.

Construct the fence according to the details on the plans and as specified here using new materials. Perform all work in a workmanlike manner to the RPR's satisfaction. **[** The RPR establishes and marks the property line or fence line for the work. **|**The Contractor will layout the fence line based on the plans. **]** At the close of the working day tie the newly constructed fence to the existing fence.

****

Select whether the RPR or Contractor lays out the fence and/or property lines.

****

863-3.2 Clearing Fence Line.

Remove all brush, stumps, logs, and other debris which could interfere with the construction of the fence on either side of the fence centerline before starting fencing operations. Material removed and disposed of clearing the fence line is considered incidental to fence construction.

863-3.3 Installing Fabric.

Excavate ground to the depth required for proper installation of the fabric. Obtain the RPR's approval of depth of excavation before placing the wire fabric. Place the fabric and lap splice it to existing fence fabric and tie with wire ties at 2-foot (0.6-m) spacing. Cut wire fabric around fence post footing to allow proper placement. Backfill with native soil to original grade and compact. Gate concrete pads must be installed at each gate or as shown on the plans.

863-3.4 Weed Control Application.

Apply weed control material over the wildlife fence skirt and over an area 5 feet (1.5 m) wide, measured from the fence centerline. Apply weed control material as recommended by the manufacturer's instructions and in compliance with state and local regulations.

863-3.5 Electrical Grounds.

Construct electrical grounds **[** where a power line passes over the fence **|**at 500 feet (150 m) intervals **|**directly below the point of power line crossing **].** The ground must be a copper clad rod 8 feet (2.4 m) long and a minimum of ⅝ inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. Clamp a No. 6 solid copper conductor to the rod and to the fence so each fence element is grounded. Installation of ground rods is considered incidental to fence construction. The Contractor must comply with FAA-STD-019, *Lightning and Surge Protection,* *Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities.

****

The Engineer must indicate the location of all electrical grounds on the plans. Grounding may not be necessary with the use of composite posts. The Engineer must indicate when a fence is adjacent to FAA NAVAIDS that require FAA-STD-019 is applicable. The RPR cannot allow the Contractor to make this decision.

****

863-3.6 Control Installation.

Fence installation must not begin until the RPR has approved the Contractor's materials, processes, and equipment to be used to establish the fence line, clear the fence line, and install fence fabric.

863-3.7 Cleaning Up.

The Contractor must remove from the worksite all tools, buildings, equipment, etc., used during construction. Seed all disturbed areas per Item T-901.

863-4 METHOD OF MEASUREMENT

863-4.1 Chain Link Fence Fabric.

Measure chain-link fence fabric for payment by the linear foot to the nearest foot. Measure along the fence from center to center of end or corner posts, excluding the length occupied by gate openings.

863-4.2 Concrete Pads at Gates.

Measure concrete pads at gates by the unit.

863-4.3 Borrow Fill Material.

The Contractor furnishes borrow material for fill. This is measured by the cubic yard in place.

863-4.4 Weed Control Application.

Measure by the linear foot.

863-5 BASIS OF PAYMENT

863-5.1 Chain Link Fence Fabric.

Payment for chain-link fence fabric is made at the contract unit price per linear foot. This price is full compensation for furnishing materials, all labor (including preparation, excavation, backfill, fill, and installation), equipment, tools, and incidentals necessary to complete this item. Include utility locates in this pay item.

863-5.2 Concrete Pads at Gates.

Payment for concrete pads at gates is made at the contract unit price for each pad. This price is compensation for furnishing materials, all labor (including preparation, excavation, backfill, placement of concrete, reinforcing steel, and forms), equipment, tools, and incidentals necessary to complete this item.

863-5.3 Borrow Fill Material.

Payment for the loading, transporting, and placing of borrow material is made at the contract unit price per cubic yard. This price is full compensation for furnishing all labor (including placement, compaction, and grading), equipment, tools, and incidentals necessary to complete this item.

863-5.4 Weed Control Application.

Payment for weed control application is made at the contract unit price per linear foot of fence. This price is full compensation for furnishing materials, all labor, equipment, tools, and incidentals necessary to complete this item.

Payment is made under:

Item F-863-5.1	Chain link Fence Fabric per linear foot
Item F-863-5.2	Concrete Pads at Gates, each
Item F-863-5.3	Borrow Fill Material per cubic yard (m^3)
Item F-863-4.4	Weed control application per linear foot

863-6 REFERENCES

863-6.1 This list of publications forms 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 A121	*Standard Specification for Metallic-Coated Carbon Steel Barbed Wire*
ASTM A153	*Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM A392	*Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric*

Federal Specifications (FED SPEC)

FED SPEC RR-F-191/4	*Fencing, Wire and Post, Metal (Chain-Link Fence Accessories)*

FAA Standard

FAA-STD-019	*Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*

FAA Orders

5300/38	*AIP Handbook*

END OF ITEM F-863

Item F-864 Wildlife Exclusion Fence

****

- **Edit this specification as necessary to match the approved Wildlife Hazard Assessment Plan. See Airport Improvement Program (AIP) Handbook FAA Order 5300.38 for guidance on the eligibility of federal funds for fencing.**
- **Prior to specifying fencing material on a federally funded project, the type and nature of fencing depends upon what the fence is needed for. The project plans must indicate the location, type of fencing, type and spacing of posts, location of gates and braces.**
    - **Perimeter fencing is typically used to designate the boundary of property. Typically, this is woven wire or barbed wire type fencing, but portions may be chain link.**
    - **Wildlife fencing is to impede the entry of wildlife onto an airport, as outlined in the Wildlife Hazard Assessment Plan.**
        - **See F-863 Wildlife Deterrent Fence Skirt**
        - **See F-864 Wildlife Exclusion Fence**
    - **Security fencing is intended to slow the access of pedestrians and vehicles onto an airport as outlined in a 1542 Security Plan. The location, type, and size must be as outlined in the 1542 Security plan. The type and size of security fencing depends on where on the airport the fencing is installed.**
    - **Coordinate the location, type, and details of fencing near or adjacent to Navigation Aids (NAVAIDS) with the FAA's Airport District Office (ADO) or Region during design. Fencing may need to be nonferrous, or location and/or alignment may need to be adjusted to ensure the fence does not interfere with NAVAIDs.**
    - **See F-862 Chain Link Fence**
- **This specification covers F-864 Wildlife Exclusion Fence**
- **See specification F-860 Fencing for field fencing or barbed wire fencing installed with either wood or steel posts to designate the perimeter or property boundary.**
- **See the Chain Link Fence Manufacturers Institute for additional guidance on specification of fence materials.**

All steel and manufactured goods provided for this item must meet the Buy American provisions contained in this contract.

http://www.faa.gov/airports/engineering/

****

864-1 DESCRIPTION

864-1.1 This item covers the requirements for furnishing materials and constructing new wire wildlife exclusion fences and gates with wood posts; furnishing and installing chain-link fence fabric underground along the wire fence line; and constructing concrete pads at fence gates according to the details included here and as shown on the plans. The wildlife fence is **[** `woven wire` **|** `chain-link` **]** fencing topped by three strands of barbed wire, as indicated on the plans and in the bid proposal.

864-2 MATERIALS

864-2.1 Wire.

864-2.1.1 Woven Wire (Zinc-coated).

[`The woven wire fence is 23-bar, 120-inch (3 m) field fence with top and bottom wires No. 12½ gauge, and filler and stay wires No. 12½ gauge. Stay wires is spaced 6 inches (150 mm) apart. All wires must be smooth galvanized steel wire, conforming to ASTM A116. Twice-dip all wires and space as shown on the plans.` **|** `Woven wire is not required.` **]**

864-2.1.2 Chain-Link Fence Fabric.

[[`The fabric must be woven with a 9-gauge` **[** `galvanized steel wire` **|** `polyvinyl chloride (PVC)-coated steel` **|** `aluminum alloy` **|** `zinc-5% aluminum mischmetal wire in a 2-inch (50 mm) mesh and must meet the requirements of` **[____]**. **]]**

[`The fabric must be woven from a` **[____]** `gauge aluminum-coated steel wire in a 2-inch (50-mm) mesh and conform to the requirements of ASTM A491.` **]** **|** `Chain-link fence fabric is not required.` **]**

****

- **Galvanized steel fabric must conform to the requirements of ASTM A392, Class 2.**
- **Polyvinyl chloride-coated steel must conform to the requirements of ASTM F668, Class 2b.**
- **Aluminum alloy fabric must conform to the requirements of ASTM F1183.**
- **Zinc-5% aluminum mischmetal alloy coated steel must conform to the requirements of ASTM F1345, Class 2.**
- **The Engineer specifies 9 or 10-gauge aluminum-coated steel wire.**
- **Metallic-coated fabric must have a clear acrylic coating applied to the selvage area after weaving.**

****

864-2.1.3 Chain Link Skirt Fabric.

`[ The fabric must be woven with a 9-gauge galvanized steel wire in a 2-inch (50-mm) mesh and meet the requirements of ASTM A392, Class II. The fabric must be 5 feet (1.5 m) wide. | Not required. ]`

****

The Engineer must determine locations for installation of fence skirt fabric based on the wildlife Hazard Assessment Plan.

****

864-2.1.4 Barbed Wire (Zinc-coated).

Zinc-coated barbed wire must be 2-strand, twisted, No. 12½ gauge galvanized steel wire with 4-point barbs of No. 14 gauge galvanized steel wire. All wire must conform to ASTM A121, Type A. Space the barbs approximately 5 inches (125 mm) apart.

864-2.1.5 Wire Ties and Tension Wires.

Use wire fabric ties, wire ties, and tension wire for a given type of fabric of the same material as the fabric type. The tension wire must be 7-gauge coiled spring wire coated similarly to the respective wire fabric being used. The fabric must be attached to the tension wire as shown on the plans, but not greater than every four feet. Wire fabric ties must be hog rings of galvanized steel wire not less than 9-gauge. All material must conform to Federal Specification RR-F-191/4.

864-2.1.6 Bracing Wire (Zinc-coated).

Only use No. 9 smooth galvanized soft wire used for cable for bracing.

864-2.2 Gates and Hardware.

Construct gates of galvanized steel tubing conforming to AASHTO M181 and the size shown on the plans. Furnish heavily galvanized hinges and latches for wood posts with each gate. Use a bolt or lag screw hinge, and furnish either a wing or butterfly latch. The fabric is the same as required for the fence, F-804-2.0.

864-2.3 Miscellaneous Fittings and Hardware.

Miscellaneous steel fittings and hardware for use with zinc-coated steel fabric must be of commercial grade steel, or better quality, wrought, or cast as appropriate to the fitting or hardware, and sufficiently strong to provide a balanced design when used with fabric, posts, and wires of the specified quality. Protect all steel fittings and hardware with a zinc coating applied in conformance with ASTM A153.

864-2.4 Wood Posts. [Not used.]

[864-2.4.1 Species.

All posts must be one of the following species of wood unless the plans note otherwise.

Table 864-2.4: Wood Species

Group I	Group II
Cedar	Douglas-fir
Chestnut	Gum, Red
Cypress, Southern	Larch, Western
Locust, Black	Pine, Southern Yellow
Osage-orange	Pine, Lodgepole
Redwood	Tamarack
Yew, Pacific	Ash
Honey locust	Maple, Sugar
Oak, White	Oak, Red
Mulberry	Spruce
Live Oak	

Posts of Group I may be used untreated, provided at least 75% of the wood is heartwood. Give posts of less than 75% heartwood of Group I a preservative treatment for the part of the post that contacts the ground line. Give a preservative treatment, the full length of posts of Group II.

864-2.4.2 Quality.

Posts must be peeled, sound, straight grained, and free from decay, cracks, and splits. Shakes must not be more than ¼-inch (6 mm) wide and 3 feet (1 m) long. Checks (lengthwise separations of the wood in a generally radial direction) are permitted, provided they are not harmful.

864-2.4.3 Dimensions.

All posts must be the length shown on the plans. Posts must have the minimum top diameters shown on the plans. Sawn and split posts are acceptable instead of round posts, if the required diameter round posts can be turned from the saw or split posts.

864-2.4.4 Manufacture.

Completely remove outer bark from all posts including depressions. Remove inner bark from all post surfaces to be treated, except inner bark may remain in depressions.

864-2.4.5 Treatment.

Condition posts by air seasoning, steaming, or heating in oil in a manner that prevents injurious checking, splitting, or warping before treating. Thoroughly season all timber and dry (22% maximum moisture content) before applying preservative treatment. Use waterborne preservatives the according to American Wood Preservers Association (AWPA) Standard U1. Use Category 4 (UC4) for treatment, care, and preservation.]

864-2.5 Wood Braces.

[Not used. |Cleats, gate stops, and braces must be of the size shown on the plans. They must be of the same species and quality specified for the posts or the RPR approved, and be free from knots larger than one-third the width of the piece. Make gate stops of suitable length posts. Braces may be made of posts of suitable length or of sawn lumber. Treat all cleats, gate stops, and any braces in contact with the ground and for a distance of at least 6 inches (150 mm) above the ground by the hot and cold bath process, specified herein for posts. Use No. 9 smooth galvanized wire for bracing.]

[864-2.6 Steel Posts, Rails, and Braces.

864-2.6.1 Line posts, rails, and braces must conform to the requirements of ASTM F1043 or ASTM F1083 as follows:

- Galvanized tubular steel pipe must conform to the requirements of Group IA, (Schedule 40), coatings conforming to Type A, or Group IC (High Strength Pipe), external coating Type B, and internal coating Type B or D.
- Galvanize roll formed steel shapes (C-Sections) must conform to the requirements of Group IIA, according to the requirements of ASTM F1043, Type A.
- Galvanize hot-rolled shapes (H Beams) must meet the requirements of Group III, according to the requirements of ASTM F1043, Type A.
- Aluminum Pipe must conform to the requirements of Group IB.
- Aluminum Shapes must conform to the requirements of Group IIB.
- Vinyl or polyester coated steel must conform to the requirements of ASTM F1043, Paragraph 7.3, Optional Supplemental Color Coating.
- Composite posts must conform to the strength requirements of ASTM F1043 or ASTM F1083. The strength loss of composite posts must not exceed 10% when subjected to 3,600 hours of exposure to light and water according to ASTM G152, ASTM G153, ASTM G154, and ASTM G155.
- Posts, rails, and braces furnished for use in conjunction with aluminum alloy fabric must be aluminum alloy or composite.

864-2.6.2 Posts, rails, and braces, except for galvanized steel must conform to ASTM F1043 or ASTM F1083, Group 1A, Type A, or aluminum alloy, must demonstrate the ability to withstand testing in salt spray according to ASTM B117 as follows:

- External: 1,000 hours with a maximum of 5% red rust.

- Internal: 650 hours with a maximum of 5% red rust.

The dimensions of the posts, rails, and braces must be according to Tables I through VI of Federal Specification RR-F-191/3.]

****

The Engineer must select the appropriate fence materials based on the wildlife hazard assessment for the airport.

****

864-2.6 Staples.

[Not used. |The staples must be No. 9 galvanized steel wire, 1 inch (25 mm) long for hardwood posts and 1-½ inch (38 mm) long for use in softwood posts.]

864-2.7 Concrete Pads at Gates.

Concrete must be commercial grade with a minimum 28-day compressive strength of 3000 psi (2670 kPa).

864-2.8 Weed Control Material.

Apply a commercially available weed control material at the manufacturer's recommended rate.

864-3 CONSTRUCTION METHODS

864-3.1 General.

Construct the fence according to the details on the plans and as specified here using new materials. [The RPR establishes and marks the property line or fence line for the work. |The Contractor lays out the fence line based on the plans.] Span openings below the fence with barbed wire in all locations where it is not practical to conform the fence to the general contour of the ground surface because of natural or manufactured features, such as drainage ditches. Permanently tie the new fence to the terminals of existing fences whenever the RPR requires. The finished fence must be plumb, taut, true to line and ground contour, and complete in every detail. Stake down the woven wire fence at several points between posts when necessary to keep fence to ground contour, or when the RPR directs. When replacing existing fencing, the length of unfenced section at any time must not exceed [300 feet (90 m)]. Tie the newly constructed fence to the unremoved existing fence. at the close of the working day.

864-3.2 Clearing Fence Line.

The fence line must be clear of obstructions, and surface irregularities on each side of the fence line. Grade the fence line so the fence conforms to the general contour of the ground. This clearing consists of the removal of all stumps, brush, rocks, trees, or other obstructions that will interfere with proper construction of the fence. Grub or excavate stumps within the cleared area of the fence line. Place the bottom of the fence a uniform distance above ground, as specified in the plans. Remove the existing fence, as shown on the plans or as the RPR directed, unless removal is listed as a separate item in the bid schedule. Fill all holes remaining after post and stump removal with suitable soil, gravel, or other material and compact with tampers.

864-3.3 Setting Posts.

864-3.3.1 Wood Posts.

[Not used. |Set wood posts with large ends down, plumb, and in a straight line on the side on which the wire is to be fastened. Posts must not be cut off to eliminate rock or other excavation. Remove rock when encountered, to provide full-depth and full-size holes. Cut off square the bottom of all posts. The diameter of the holes must be at least 6 inches (150 mm) larger than the diameter of the posts. When cleats are used on posts, the holes must be dug large enough to accommodate the cleat. After placing and lining posts, backfill holes with suitable material and compact with tampers. Set and brace the posts adjacent to end, corner, anchor, and gate posts with braces and wire, as shown on the plans. No extra compensation is made for rock excavation.]

864-3.3.2 Steel Posts.

[Not used. |Set corner, brace, anchor, end, and gate posts in concrete as shown on the plans. Trowel finish the top of the concrete to be slightly above the ground surface sloped to drain. Posts must be full height and must not be cut off to eliminate rock or other excavation. All line posts may be either driven or set in dug holes to a depth of 3 feet (1 m). Set posts to true alignment. Replace, tamp, and level dirt removed for placing posts, anchor bars, flanges, etc. Replace damaged posts the Contractor’s expense. No extra compensation is made for rock excavation.]

864-3.4 Anchoring and Bracing.

Anchor and brace corner, end, gate, and adjacent intermediate posts, as shown on the plans. Set anchor posts at approximately 500 feet (150 m) intervals and brace to the adjacent posts. Brace posts must before placing the wire fencing.

864-3.5 Installing Wire.

Place wires on the side of the posts away from the airport or as directed. Place the fence on the posts at the height indicated on the plans. Carefully stretch and hang the woven wire without sag and with true alignment. Take care not to stretch the wire so tightly it will break in cold weather or pull up corner and brace posts Install longitudinal wires parallel and draw uniformly taut. The vertical stay wires of the woven wire fencing must be straight and vertical. Wrap the woven wire around end, corner, and gate posts, and tie the ends of all horizontal wires with snug, tight twists staple or fasten to prevent slippage or movement.

864-3.5.1 Steel Posts.

`[Not used. |Fasten all horizontal wires fastened securely to each post by fasteners or clips designed for use with the posts furnished. Secure the wire to prevent slipping up and down the post. Stretch each barbed wire strand and secure each strand to each post to prevent slipping out of line or becoming loose.]`

864-3.5.2 Wood Posts.

`[Not used. |Staple each longitudinal wire to each intermediate post with one steel wire staple; use two or more staples at the corner and anchor posts. Staple the top strand of barbed wire of all fences with two staples in each post. Set all staples diagonally with the grain of the wood and drive up, tight. Saw off the tops of the wood posts sawn off with a 1-to-3 pitch after erecting the fence.]` The bottom wire of the wire fencing must clear the ground by not more than 4 inches (100 mm) or less than 1 inch (25 mm) at any place.

864-3.6 Splicing Wire.

Wire splices in longitudinal wires are permitted if made with an approved galvanized bolt-clamp splice or a wire splice made as follows. Carry the end of the wires 3 inches (75 mm) past the splice tool and wrap around the other wire away from the tool for at least six turns in opposite directions. After the splice tool is removed, close the space occupied by it by pulling the ends together. Cut the unused ends of the wires close to make a neat, workmanlike job. Only splice woven wire at posts.

864-3.7 Installing Chain-link Skirt Fabric.

[Excavate trench to the depth required for proper installation of the chain-link fabric. Obtain the RPR’s approval of depth of excavation before placing the wire fabric. Place the fabric and lap splice it to existing fence fabric and tie with wire ties at 2-foot (0.6-m) spacing. Cut wire fabric around fence post footing to allow proper placement. Backfill with native soil to original grade. |Chain-link skirt fabric is not required.]

****

Review the approved Wildlife Hazard Assessment Plan for locations where chain-link skirt fabric is recommended.

****

864-3.8 Installing Gates.

Erect gates at locations shown on the plans. Hang gates fittings, as shown on the plans. Clamp, screw or bolt fittings on the gate posts to prevent slipping. Erect gates to swing in the direction indicated and provide with gate stops as shown on the plans.

864-3.9 Existing Fence Connections.

Set and brace a corner or anchor post wherever the new fence joins an existing fence. If the connection is made at other than the corner of the new fence, the last span of the old fence must contain a brace span.

864-3.10 Electrical Grounds.

[Not used. |Construct electrical grounds [where a power line passes over the fence |at 500 feet (150 m) intervals]. [Install the ground directly below the point of crossing.]Accomplish the ground with a copper clad rod 8 feet (2.4 m) long and a minimum of ⅝ inches (16 mm) in diameter driven vertically until the top is 6 inches (150 mm) below the ground surface. Clamp a No. 6 solid copper conductor to the rod and to the fence in such a manner that each element of the fence is grounded. Installation of ground rods does not constitute a pay item and is considered incidental to fence construction. The Contractor must comply with FAA-STD-019, Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment, paragraph 4.2.3.8, Lightning Protection for Fences and Gates, when fencing is adjacent to FAA facilities.]

****

The Engineer indicates the location of all electrical grounds on the plans. Grounding may not be necessary with the use of composite posts.

****

864-3.11 Weed Control Application.

Apply weed control material over the chain link wildlife fence skirt. and an area 5 feet (1.5 m) wide, measured from the fence centerline. Apply weed control material as recommended by the manufacturer’s instructions and in compliance with state and local regulations.

864-3.12 Cleaning Up.

The Contractor removes from the completed work vicinity all tools, buildings, equipment, etc., used during construction. Seed all disturbed areas per T-901.

864-3.13 Control Installation.

Fence installation must not begin until the RPR has approved the Contractor’s materials, processes, and equipment to be used to establish the fence line, clear the fence line, install brace and set posts, and install fence fabric.

****

Standard detail: Examples and example drawings are available at the following website: www.faa.gov/airports/engineering/pavement_design

****

864-4 METHOD OF MEASUREMENT

864-4.1 Fence.

Measure the fence in place from outside to outside of end posts or corner posts, except deduct the space occupied by the gates.

864-4.2 Chain Link Fence Skirt Fabric.

[Measure chain-link fence fabric for payment by the linear foot (m) to the nearest foot (meter). Measurement is along the fence from center to center of end or corner posts, excluding the length occupied by gate openings. **|** Not required. **]**

864-4.3 Vehicle Gates and Pedestrian Gates.

Measure vehicle gates and pedestrian gates in units for each gate installed and accepted.

864-4.4 Concrete Gate Pad.

[Measure concrete gate pads measured by the unit. | Not required.]

864-4.5 Weed Control Application.

Measure weed control application by the linear foot.

864-5 BASIS OF PAYMENT

864-5.1 Fence.

Payment is made at the contract unit price per linear foot (meter) for wire [chain-link] fence. This price is full compensation for furnishing all materials and for preparation, erection, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

864-5.2 Chain Link Fence Skirt Fabric.

[Payment for chain-link fence skirt fabric is made at the contract unit price per linear foot. This price is full compensation for furnishing materials, all labor (including preparation, excavation, backfill, fill, and installation), equipment, tools, and incidentals necessary to complete this item. Utility locates are included in this pay item. |Not required.]

864-5.3 Vehicle Gates and Pedestrian Gates.

Payment is made at the contract unit price per each for driveway or for walkway gates. This price is full compensation for furnishing all materials and for all preparation, erection, and installation of these materials and for all labor, equipment, tools, and necessary incidentals to complete the item.

864-5.4 Concrete Gate Pad.

[Payment for concrete pads at gates is made at the contract unit price for each pad. This price is full compensation for furnishing materials, all labor (including preparation, excavation, backfill, placement of concrete, reinforcing steel, and forms), equipment, tools, and incidentals necessary to complete this item. | Not required.]

864-5.5 Weed Control Application.

Payment for weed control application is made at the contract unit price per linear foot. This price is full compensation for furnishing materials, all labor, equipment, tools, and incidentals necessary to complete this item.

Payment is made under:

Item F-864-5.1	Fence per linear foot (m)
Item F-864-5.2	Chain link Fence Skirt Fabric per linear feet (m)
Item F-864-5.3a	Vehicle gate, each
Item F-864-5.3b	Pedestrian gate, each
Item F-864-5.4	Concrete Gate Pad, each
Item F-864-5.5	Weed Control, per linear foot

864-6 REFERENCES

864-6.1 This list of publications forms 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 A116	*Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric*
ASTM A121	*Standard Specification for Metallic-Coated Carbon Steel Barbed Wire*
ASTM A153	*Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*
ASTM A392	*Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric*
ASTM A491	*Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric*
ASTM F668	*Standard Specification for Polyvinyl Chloride (PVC), Polyolefin and other Organic Polymer Coated Steel Chain-Link Fence Fabric*
ASTM F1043	*Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework*
ASTM F1083	*Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures*
ASTM F1183	*Standard Specification for Aluminum Alloy Chain Link Fence Fabric*
ASTM F1345	*Standard Specification for Zinc 5% Aluminum-Mischmetal Alloy Coated Steel Chain-Link Fence Fabric*

ASTM G152	*Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*
ASTM G153	*Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials*
ASTM G154	*Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials*
ASTM G155	*Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials*

American Wood Preservers Association (AWPA)

AWPA U1	*Use Category System: User Specification for Treated Wood*

American Association of State Highway Transportation Officials (AASHTO)

AASHTO	*M 181 Chain-Link Fence*

FAA Standard

FAA-STD-019	*Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment*

FAA Order

5300.38	*AIP Handbook*

END OF ITEM F-864

Part 12 – Turfing

Item T-901 Seeding

****

The Engineer may specify that seeding be constructed according to state specifications. Include all referenced state specifications in project specifications.

A modification to standards is not required when using state specifications for seeding. Consult the United States Department of Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS)/Wildlife Service staff to ensure seed recommended is not a hazardous wildlife attractant.

Wildlife Hazard Attractants and Mitigation: Through the appropriate selection of turf materials for the project(s), the Engineer must address the elimination and/or mitigation of materials that could attract hazardous wildlife on and/or around an airport. The Engineer should refer to the following documents and sites for guidance on wildlife hazards at Airports for all projects:

(1) Advisory Circular (AC) 150/5200-33, *Hazardous Wildlife Attractants on or Near Airports*, contains guidance on certain land uses having the potential to attract hazardous wildlife on or near airports. The AC is available at: https://www.faa.gov/airports/resources/advisory_circulars/.

(2) *Wildlife Hazard Management at Airports, A Manual for Airport Personnel*, is available at: https://www.faa.gov/sites/faa.gov/files/airports/environmental/policy_guidance/2005_FAA_Manual_complete.pdf.

(3) Additional information on wildlife issues can be found on the Federal Aviation Administration (FAA) Guidance on Wildlife website at: https://www.faa.gov/airports/airport_safety/wildlife/resources.

****

901-1 DESCRIPTION

901-1.1 This item consists of soil preparation, seeding **[__]** the areas shown on the plans or as the Resident Project Representative (RPR) directed according to these specifications.

****

The Engineer specifies fertilizing, liming, or both, as needed for a specific project.

****

901-2 MATERIALS

901-2.1 Seed.

The species and application rates of grass, legume, and cover-crop seed furnished must be those stipulated in this document. Seed must conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural. Furnish seed 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 furnishes the RPR duplicate, signed copies, of a vendor statement certifying a recognized laboratory for seed, tested each lot of seed, within six months of the delivery date. Include in the statement 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. Reject wet, moldy, or otherwise damaged seed. Apply seeds as follows.

Table 901-2.1: Seed Properties and Rate of Application

Seed	Minimum Seed Purity (Percent)	Minimum Germination (Percent)	Rate of Application lb/Acre (or lb/1,000 S.F.)
*	*	*	*
*	*	*	*

Perform seeding during the period between **[__]** and **[__]** inclusive, unless the RPR approved otherwise.

****

Consult the USDA-APHIS-Wildlife Service staff to ensure seed recommended is not a hazardous wildlife attractant.

Specify that seeding dates, species and seeding rates are compatible with local climate and soil conditions. Give due consideration to the longevity of plants, resistance to traffic and erosion, and attraction of birds or large animals. More than one seeding season may be specified, if appropriate.

Consult local offices of the USDA Natural Resources Conservation Service (NRCS) and/or the State University Agricultural Cooperative Extension Office (County Agent or equivalent) for assistance and recommendations. Also consult these agencies for liming and fertilizer recommendations.

****

901-2.2 Lime.

[Lime must be ground limestone containing not less than 85% of total carbonates, and ground to such fineness that 90% will pass through a No. 20 (850 µm) mesh sieve and 50% will pass through a No. 100 (150 µm) mesh sieve. Coarser material is acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions based on the two sieve requirements above. Dolomitic lime or a high magnesium lime must contain at least 10% of magnesium oxide. Apply lime at the rate of **[__]**. All liming materials must conform to the requirements of ASTM C602. |Not required. **]**

****

The Engineer specifies the application rate in lbs per acre.

****

901-2.3 Fertilizer.

[Use standard, commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. Apply the fertilizer at the rate and to the depth specified, while also meeting applicable state laws. Furnish the fertilizer in standard containers with the name, weight, and guaranteed analysis of contents, clearly marked. Mixing cyanamide compounds or hydrated lime in fertilizers is not permitted.

Supply the fertilizers in one of the following forms:

1. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
2. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
3. A granular or pellet form suitable for application by blower equipment.

`Fertilizers must` **[__]** `commercial fertilizer spread at the rate of` **[__]**. **]**

[`Not required.` **]**

****

The Engineer specifies the analysis and the application rate in lbs per acre.

Check with the local Agricultural Cooperative Extension Office for recommended fertilizer mixture for local conditions.

Delete paragraphs 901-2.2 and 901-2.3 if not applicable.

****

901-2.4 Soil for Repairs.

The soil for repairing fill and topsoiling areas must be at least of equal quality to that existing in areas adjacent to the repair areas. The soil must be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and RPR approved before being placed.

901-3 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 must 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 occurred after the completion of grading, and before beginning the application of fertilizer and ground limestone, the Contractor repairs such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded is 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, first cut or otherwise satisfactorily dispose of any grass and weeds, otherwise loosened to a depth not less than 5 inches (125 mm). Break clods and work the top 3 inches (75 mm) of soil must into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 Dry Application Method.

901-3.2.1 Liming.

[Apply lime separately and prior to the application of any fertilizer or seed and only on seedbeds previously prepared as described above. Then work the lime into the top 3 inches (75 mm) of soil after which the seedbed must again be properly graded and dressed to a smooth finish. |Not required.]

901-3.2.2 Fertilizing.

[Following advance preparations and cleanup, uniformly spread fertilizer at the rate that does not provide any less than the minimum quantity stated in paragraph 901-2.3.]

[Not required.]

****

Delete paragraphs 901-3.2.1 and 901-3.2.2 if not applicable.

****

901-3.2.3 Seeding.

Grass seed must be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. Rake the fertilizer and seed within the depth range stated in the special provisions. Inoculate seeds of legumes, either alone or in mixtures, before mixing or sowing, according to the instructions of the manufacturer of the inoculant. Sow a cover crop when seeding is required, at the other seasons shown, on the plans or in the special provisions by the same methods required for grass and legume seeding.

901-3.2.4 Rolling.

After properly covering the seed, immediately compact the seedbed by means of an approved lawn roller, weighing 40 to 65 lbs 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 lbs per foot (223 to 298 kg per meter) of width for sandy or light soils.

901-3.3 Wet Application Method.

901-3.3.1 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 must be as specified in the special provisions.

901-3.3.2 Spraying Equipment.

The spraying equipment must 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 must also be equipped with a mechanical power-driven agitator capable of always keeping all the solids in the mixture in complete suspension until used.

The unit must also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb/square inches (690 kPa). The pump must 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 must be able to provide clearance for ⅝ inch (16 mm) solids. The power unit for the pump and agitator must have controls mounted to be accessible to the nozzle operator. There must be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe must 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 must 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 must be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One nozzle must 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, connect all nozzles to the nozzle pipe by means of quick-release couplings. To reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length must be provided to which the nozzles may be connected.

901-3.3.3 Mixtures.

Lime, if required, must be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 lbs (100 kg) of lime must be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer must be mixed together in the relative proportions specified, but not more than a total of 220 lbs (100 kg) of these combined solids must be added to and mixed with each 100 gallons (380 liters) of water.

All water used must be obtained from fresh water sources and must be free from injurious chemicals and other toxic substances harmful to plant life. The Contractor identifies to the RPR all sources of water at least two 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 must not use any water from any source that the RPR disapproves following such tests.

All mixtures must be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures must be used within two hours from the time they were mixed or they must be wasted and disposed of at approved locations.

901-3.3.4 Spraying.

Lime, if required, must be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, work the lime into the top 3 inches (75 mm), after which the seedbed must again be properly graded and dressed to a smooth finish.

Only spray mixtures of seed and fertilizer upon previously prepared seedbeds on which the lime, if required, was already worked in. Apply the mixtures by means of a high-pressure spray that must always be directed upward so that the mixtures falls to the ground like rain in a uniform spray. Never direct nozzles or sprays toward the ground that it might produce erosion or runoff. Exercise care to ensure that the application is made uniformly at the prescribed rate and to guard against misses and overlapped areas. Use proper predetermined quantities of the mixture according to specifications to cover specified sections of known area.

Make checks on the rate and uniformity of application 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. On surfaces to be mulched as indicated by the plans or the RPR designated, 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 is required after the soil has dried.

901-3.4 Control Installation.

Prior to seeding the RPR must approve the Contractors material, equipment, and processes for installation of seeding.

901-3.5 Maintenance of Seeded Areas.

The Contractor must protect seeded areas against traffic or other use by warning signs or barricades, as the RPR approved. Surfaces gullied or otherwise damaged following seeding must be repaired by regrading and reseeding as directed. The Contractor must 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, the Contractor is required to establish a good stand of grass of uniform color and density to the RPR's satisfaction. A grass stand must be considered adequate when bare spots are one square foot (0.01 square meter) or less, randomly dispersed, and do not exceed 3% of the area seeded.

901-4 METHOD OF MEASUREMENT

901-4.1 The quantity of seeding paid for is the number of units **[** `1,000 square feet (square meters)` **|**`acre (square meter)` **]** measured on the ground surface, completed, and accepted.

901-5 BASIS OF PAYMENT

901-5.1 Payment is made at the contract unit price per **[** `1,000 square feet (square meters)` **|**`acre (square meter)` **]** or fraction of, which price and payment is 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 is made under:

Item 901-5.1	Seeding - per **[** `1,000 square feet (square meters)` **|**`acre (square meter)` **]**

901-6 REFERENCES

901-6.1 This list of publications forms 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 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

****

Wildlife Hazard Attractants and Mitigation: Through the appropriate selection of turf materials for the project(s), the Engineer must address the elimination and/or mitigation of materials that could attract hazardous wildlife on and/or around an airport. The Engineer should refer to the following documents and sites for guidance on wildlife hazards at Airports for all projects:

(1) Advisory Circular (AC) 150/5200-33, *Hazardous Wildlife Attractants on or Near Airports*, contains guidance on certain land uses that have the potential to attract hazardous wildlife on or near airports. The AC is available at: https://www.faa.gov/airports/resources/advisory_circulars/.

(2) Wildlife Hazard Management at Airports, A Manual for Airport Personnel, is available at: https://www.faa.gov/sites/faa.gov/files/airports/environmental/policy_guidance/2005_FAA_Manual_complete.pdf.

(3) Additional information on wildlife issues can be found on the Federal Aviation Administration's (FAA) Guidance on Wildlife website at: https://www.faa.gov/airports/airport_safety/wildlife/resources.

It is acceptable to specify that sodding be constructed according to state specifications. Include all referenced state specifications in the project specifications.

The United States Department of Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS)/Wildlife Service staff should be consulted to ensure sod recommended is not a hazardous wildlife attractant.

****

904-1 DESCRIPTION

904-1.1 This item consists of furnishing, hauling, and placing approved live sod on prepared areas according to this specification at the locations shown on the plans or as the RPR directed.

904-2 MATERIALS

904-2.1 Sod.

Contractor-furnished sod must have a good cover of living or growing grass. This interprets to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. Obtain all sod from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Cut or strip sod 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 must be composed of the species stated in the special provisions, and any vegetation more than 6 inches (150 mm) in height must 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, must be cut uniformly to a thickness not less than that stated in the special provisions.

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Base the specific species and varieties on the recommendations of the local Agriculture Cooperative Extension Office. Modify sod thickness as required for species specified. State certified is usually more stringently monitored than State approved.

Consult the USDA/Wildlife Service staff to ensure the recommended sod stock is not a hazardous wildlife attractant.

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904-2.2 Lime.

[Lime must be ground limestone containing not less than 85% of total carbonates, and must be ground to such fineness that 90% will pass through a No. 20 (850 µm) mesh sieve and 50% will pass through a No. 100 (150 µm) mesh sieve. Coarser material is acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions based on the two sieve requirements above. Dolomitic lime or a high magnesium lime must contain at least 10% of magnesium oxide. Apply lime at the rate of **[__]**. All liming materials must conform to the requirements of ASTM C602. |Not required.]

****

The Engineer specifies the application rate in lbs per acre.

****

904-2.3 Fertilizer.

[Use standard, commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. Apply the fertilizer at the rate and to the depth specified, while also meeting applicable state laws. Furnish the fertilizer in standard containers with name, weight, and guaranteed analysis of contents, clearly marked. Mixing cyanamide compounds or hydrated lime in fertilizers is not permitted.

The fertilizers may be supplied in one of the following forms:

1. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
2. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
3. A granular or pellet form suitable for application by blower equipment.

Fertilizers must be **[__]** commercial fertilizer and spread at the rate of **[__]**. **]**

[Not required. **]**

****

The Engineer specifies the analysis and the application rate in lbs per acre.

Check with the local Agricultural Cooperative Extension Office for recommended fertilizer mixture for local conditions.

Delete paragraphs 904-2.2 and 904-2.3 if not applicable.

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904-2.4 Water.

The water must 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 must be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil must be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and the RPR must approve before being placed.

904-3 CONSTRUCTION METHODS

904-3.1 General.

Areas to be solid, strip, or spot sodded must show on the plans. Areas requiring special ground surface preparation such as tilling, and those areas in a satisfactory condition that are to remain undisturbed, must 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 must be on hand, in good condition, and RPR approved before the various operations are started. The Contractor must demonstrate to the RPR before starting the various operations that the application of required materials are 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 must 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 must 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 must 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 must then be spread at a rate that will provide not less than the minimum quantity stated in the special provisions. These materials must 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 must be removed.

904-3.4 Obtaining and Delivering Sod.

After inspection and approval of the source of sod by the RPR, the sod must 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 must have a uniform thickness of not less than 2 inches (50 mm). Sod sections or strips must be cut in uniform widths, not less than 1 inch (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 must 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 must be stacked, kept moist, and protected from exposure to the air and sun and must be kept from freezing. Cut and move sod only when the soil moisture conditions are such that favorable results can be expected. Where the soil is too dry, only grant approval to cut sod after it has been watered sufficiently to moisten the soil to the depth the sod is to be cut.

904-3.5 Laying Sod.

Perform sodding only during the seasons when satisfactory results can be expected. Do not use frozen sod. Do not place sod upon frozen soil. Sod may be transplanted during periods of drought, with the RPR's approval, 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 must be moist and placed on a moist earth bed. Do not use pitch forks to handle sod. Dumping from vehicles is not permitted. Carefully place the sod 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. Immediately and firmly, press the sod into contact with the sod bed by tamping or rolling with approved equipment to provide a true and even surface. 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 workers, when replacing it, must work from ladders or treaded planks to prevent further displacement.

Use screened soil of good quality to fill all cracks between sods. The quantity of the fill soil must not smother the grass. Where the grades are such that the flow of water is from paved surfaces across sodded areas, set the surface of the soil in the sod after compaction approximately 1 inch (25 mm) below the pavement edge. Where the flow is over the sodded areas and onto the paved surfaces around manholes and inlets, after compaction the surface of the soil, place the sod flush with pavement edges. On slopes steeper than one vertical to 2½ horizontal and in V-shaped or flat-bottom ditches or gutters, peg the sod with wooden pegs not less than 12 inches (300 mm) in length and have a cross-sectional area of not less than ¾ square inch (18 square mm). Drive the pegs 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 kept moist until it is established, and its continued growth, ensured. In all cases, perform watering in a manner that avoids erosion from the application of excessive quantities and avoids damage to the finished surface.

904-3.7 Establishing Turf.

The Contractor must provide general care for the sodded areas as soon as the sod is laid and must continue until final inspection and acceptance of the work. Protect all sodded areas against traffic or other use by warning signs or barricades the RPR approved. The Contractor must mow the sodded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. Mow weeds or other undesirable vegetation, rake and remove the clippings 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 must be repaired to re-establish the grade and the condition of the soil, as the RPR directed, and must then be sodded as specified in paragraph 904-3.5.

904-4 METHOD OF MEASUREMENT

904-4.1 This item is be measured based on the area in square yards (square meters) of the surface covered with sod and accepted.

904-5 BASIS OF PAYMENT

904-5.1 This item is paid for based on the contract unit price per square yard (square meter) for sodding, which price is full compensation for all labor, equipment, material, staking, and incidentals necessary to satisfactorily complete the items as specified.

Payment is made under:

Item T-904-5.1	Sodding - per square yard (square meter)

904-6 REFERENCES

904-6.1 This list of publications forms 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 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-905 Topsoil

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Wildlife Hazard Attractants and Mitigation: Through the appropriate selection of turf materials for the project(s), the Engineer must address the elimination and/or mitigation of materials that could attract hazardous wildlife on and/or around an airport. The Engineer should refer to the following documents and sites for guidance on wildlife hazards at Airports for all projects:

(1) Advisory Circular (AC) 150/5200-33, *Hazardous Wildlife Attractants on or Near Airports*, contains guidance on certain land uses that have the potential to attract hazardous wildlife on or near airports. The AC is available at: https://www.faa.gov/airports/resources/advisory_circulars/.

(2) Wildlife Hazard Management at Airports, A Manual for Airport Personnel, is available at: https://www.faa.gov/sites/faa.gov/files/airports/environmental/policy_guidance/2005_FAA_Manual_complete.pdf.

(3) Additional information on wildlife issues can be found on the Federal Aviation Administration (FAA) Guidance on Wildlife website at: https://www.faa.gov/airports/airport_safety/wildlife/resources.

The Engineer may specify that topsoil be constructed according to state specifications. All referenced state specifications must be included in project specifications.

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905-1 DESCRIPTION

905-1.1 This item consists of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas according to this specification at the locations shown on the plans or as the Resident Project Representative (RPR) directed.

905-2 MATERIALS

905-2.1 Topsoil.

The topsoil must be the surface layer of soil without any admixture of refuse or any material toxic to plant growth. It must be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Cut and remove brush and other vegetation not incorporated with the soil during handling operations. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but thoroughly broken up and intermixed with the soil during handling operations. Remove heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means. The topsoil or soil mixture, unless otherwise specified or approved, must have a pH range of approximately 5.5 pH to 7.6 pH, when tested according to the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content must not be less than 3% or more than 20% as determined by the wet-combustion method (chromic acid reduction). No less than 20% and no more than 80% of the material may pass the 200 mesh (75 µm) sieve, as determined by the wash test according to ASTM C117. The Contract may amend natural topsoil with approved materials and methods to meet the above specifications.

905-2.2 Inspection and Tests.

Within ten days following acceptance of the bid, notify the RPR of the source of the topsoil the Contractor furnished. Inspect the topsoil to determine if the soil meets the requirements specified and to determine the depth to which stripping is permitted. At this time, the RPR may require the Contractor to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

905-3 CONSTRUCTION METHODS

905-3.1 General.

Show topsoil areas on the plans. If topsoil is available on the site, show the location of the stockpiles or areas to be stripped of topsoil and the stripping depths on the plans. Suitable equipment necessary for proper preparation and treatment of the ground surface, topsoil stripping, and for the handling and placing of all required materials must be on hand, in good condition, and RPR approved before the various operations start.

905-3.2 Preparing the Ground Surface.

Immediately prior to dumping and spreading the topsoil on any area, loosen the surface by discs or spike-tooth harrows, or by other means the RPR approved, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade soil. Clear the surface of the area to be topsoiled all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, too compact to respond to these operations will receive special scarification. Maintain grades on the area to be topsoiled, established by others as shown on the plans, in a true and even condition. Where grades have not been established, smooth-graded and the surface the areas left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

905-3.3 Obtaining Topsoil.

Prior to the stripping of topsoil from designated areas, remove any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, using methods the RPR approved. Remove heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means.

When suitable topsoil is available on the site, the Contractor removes this material from the designated areas and to the depth the RPR directed. Spread the topsoil on areas already tilled and smooth-graded or stockpiled in areas the RPR approved. Any topsoil stockpiled by the Contractor is rehandled and placed without additional compensation. The Contractor removes and places any topsoil stockpiled on the site by others, required for topsoil purposes. The Contractor grades, and if required, put into a condition acceptable for seeding the sites of all disturbed stockpiles and adjacent areas.

When suitable topsoil is secured off the airport site, the Contractor locates and obtains the supply, subject to the approval of the RPR. The Contractor notifies the RPR sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor removes the topsoil from approved areas, and to the depth as directed. Haul the topsoil to the work site and place for spreading or spread as required. Rehandle and place, without additional compensation, any topsoil hauled to the work site and stockpiled.

905-3.4 Placing Topsoil.

Evenly spread the topsoil on the prepared areas to a uniform depth of 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Do not spread when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Carry on spreading so that turfing operations can proceed with a minimum of soil preparation or tilling.

After spreading, break any large, stiff clods and hard lumps with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter). It is the Contractor’s responsibility to rake and dispose of roots, litter, or any foreign matter, after spreading is complete. The topsoil must be satisfactorily compacted by rolling with a cultipacker or by other means the RPR approved. Ensure the compacted topsoil surface conforms to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements due to hauling or handling of topsoil, must be promptly removed.

905-4 METHOD OF MEASUREMENT

905-4.1 Measure the topsoil obtained by the number of cubic yards (cubic meters) of topsoil measured in its original position and stripped or excavated. Measure topsoil stockpiled and removed for topsoil by the Contractor by the number of cubic yards (cubic meters) of topsoil measured in the stockpile. Measure topsoil by volume in cubic yards (cubic meters) computed by the method of end areas.

905-4.2 Measure topsoil obtained off the site by the number of cubic yards (cubic meters) of topsoil measured in its original position and stripped or excavated. Measure topsoil by volume in cubic yards (meters) computed by the method of end areas.

905-5 BASIS OF PAYMENT

905-5.1 Payment is made at the contract unit price per cubic yard (cubic meter) for topsoil (obtained on the site). This price is full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

905-5.2 Payment is made at the contract unit price per cubic yard (cubic meter) for topsoil (obtained off the site). This price is full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment is made under:

Item T-905-5.1	Topsoil (Obtained on Site or Removed from Stockpile - per cubic yard (cubic meter)
Item T-905-5.2	Topsoil (Furnished from Off the Site) - per cubic yard (cubic meter)

905-6 REFERENCES

901-6.1 This list of publications forms 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 C117	*Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing*

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-905

Item T-908 Mulching

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Wildlife Hazard Attractants and Mitigation: Through the appropriate selection of turf materials for the project(s), the Engineer must address the elimination and/or mitigation of materials that could attract hazardous wildlife on and/or around an airport. The Engineer should refer to the following documents and sites for guidance on wildlife hazards at Airports for all projects:

(1) Advisory Circular (AC) 150/5200-33, *Hazardous Wildlife Attractants on or Near Airports*, contains guidance on certain land uses that have the potential to attract hazardous wildlife on or near airports. The AC is available at: https://www.faa.gov/airports/resources/advisory_circulars/.

(2) Wildlife Hazard Management at Airports, A Manual for Airport Personnel, is available at: https://www.faa.gov/sites/faa.gov/files/airports/environmental/policy_guidance/2005_FAA_Manual_complete.pdf.

(3) Additional information on wildlife issues can be found on the Federal Aviation Administration's (FAA) Guidance on Wildlife website at: https://www.faa.gov/airports/airport_safety/wildlife/resources.

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It is acceptable to specify that mulching be constructed according to state specifications. All referenced state specifications must be included in project specifications. A modification to standards is not required.

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908-1 DESCRIPTION

908-1.1 This item consists of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or the Resident Project Representative (RPR) designated.

908-2 MATERIALS

908-2.1 Mulch Material.

Acceptable materials for mulch must be listed below, or any approved locally available material that is like those specified, is also acceptable. Mulch must be free from noxious weeds, mold, and other deleterious materials. Mulch materials, containing matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, is not acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or in such an advanced stage of decomposition as to smother or retard the planted grass, is not acceptable.

`[ 908-2.1.1 Hay.`

`Hay must be native hay in an air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay must be sterile, containing no fertile seed.`

`908-2.1.2 Straw.`

`Straw is the stalks from threshed plant residue of oats, wheat, barley, rye, or rice from which grain has been removed. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw must not contain any fertile seed.`

`908-2.1.3 Hay Mulch Containing Seed.`

`Hay mulch must be mature hay containing viable seed of native grasses or other desirable species stated in the special provisions or as the RPR approved. Cut and handle the hay to preserve the maximum quantity of viable seed. Place hay mulch that cannot be hauled and spread immediately after cutting in weather-resistant stacks or baled and stored in a dry location until used.`

`908-2.1.4 Manufactured Mulch.`

`Cellulose-fiber or wood-pulp mulch must be products commercially available for use in spray applications. ]`

908-2.2 Asphalt Binder.

Asphalt binder material must conform to the requirements of ASTM D977, Type SS-1 or RS-1.

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Check with the local Agriculture Conservation Extension Office to determine choice of mulch most suitable for the project area. Specify only one type of mulch and delete the other mulches.

The United States Department of Agriculture (USDA) / Animal and Plant Health Inspection Service (APHIS) / Wildlife Service staff should be consulted to ensure mulch type selected is not a hazardous wildlife attractant.

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908-2.3 Inspection.

Notify the RPR of sources and quantities of mulch materials available. The Contractor furnishes 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 RPR's approval. The RPR rejects any materials brought on the site not meeting these standards.

908-3 CONSTRUCTION METHODS

908-3.1 Mulching.

Before spreading mulch, remove all large clods, stumps, stones, brush, roots, and other foreign material from the area to be mulched. Apply mulch immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.

Furnish, haul, and evenly apply on the area shown on the plans or the RPR designated. Spread straw or hay over the surface to a uniform thickness at the rate of 2 to 3 tons per acre (1800 - 2700 kg per acre) to provide a loose depth of not less than 1½ inches (38 cm) or more than 3 inches (75 mm). Spread other organic material at the rate the RPR directed. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose is permitted to the extent that at least 95% of the mulch in place on the slope must be 6 inches (150 mm) or more in length. When mulches applied by the blowing method are cut, the loose depth in place must not be less than 1 inch (25 mm) or more than 2 inches (50 mm).

908-3.2 Securing Mulch.

The mulch must be held in place by light discing, a very thin covering of topsoil, pins, stakes, wire mesh, asphalt binder, or other adhesive material the RPR approved. It is not permissible to walk on the slopes after the binder application, where mulches have been secured by either of the asphalt binder methods. When an application of asphalt binder material is used to secure the mulch, the Contractor must take every precaution to guard against damaging or disfiguring structures or property on, or adjacent to, the areas worked and is held responsible for any such damage resulting from the operation. If the "peg and string" method is used, secure the mulch using stakes or wire pins driven into the ground on 5-foot (1.5-m) centers or less. String binder twine between adjacent stakes in straight lines and crisscross diagonally over the mulch, after which the stakes are firmly driven nearly flush to the ground to draw the twine down tight onto the mulch.

908-3.3 Care and Repair.

908-3.3.1 The Contractor cares for the mulched areas until final acceptance of the project. Care consists of providing protection against traffic or other use by placing warning signs, as the RPR approved and erecting any barricades shown on the plans before or immediately after mulching has been completed on the designated areas.

908-3.3.2 The Contractor is required to repair or replace any defective or damaged mulch until the project is finally accepted. When, in the RPR’s judgment, such defects or damages are the result of poor workmanship or failure to meet the requirements of this specifications, the cost of the necessary repairs or replacement is borne by the Contractor.

908-3.3.3 If the “asphalt spray” method is used, spray all mulched surfaces with asphalt binder material so the surface has a uniform appearance. Uniformly apply the binder to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 square meters), or as the RPR directed, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 square meters), depending on the mulch type and effectiveness of the binder securing it. Asphalt binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. Use an approved spray nozzle. The nozzle must operate at a distance no less than 4 feet (1.2 m) from the surface of the mulch and uniform distribution of the asphalt material is required. Use a pump or air compressor of adequate capacity to ensure uniform distribution of the asphalt material.

908-3.3.4 If the “asphalt mix” method is used, apply the mulch by blowing, and the asphalt binder material sprayed into the mulch as it leaves the blower. Uniformly apply the binder to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 square meters), or as the RPR directed, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 square meters) depending on the type of mulch and the effectiveness of the binder securing it.

908-4 METHOD OF MEASUREMENT

908-4.1 Measure mulching in square yards (square meters) based on the actual surface area acceptably mulched.

908-5 BASIS OF PAYMENT

908-5.1 Payment is made at the contract unit price per square yard (square meter) for mulching. The price is 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 is made under:

Item T-908-5.1	Mulching - per square yard (square meter)

908-6 REFERENCES

908-6.1 This list of publications forms 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 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

Part 13 – Lighting

Item L-101 Airport Rotating Beacons

101-1 DESCRIPTION

101-1.1 This item consists of **[** `removal of existing beacon;` **]** furnishing and installing new airport rotating beacons. The work includes mounting, leveling, wiring, painting, maintaining, and testing of the beacon. This item includes all materials and incidentals necessary for the installation of a beacon in serviceable condition (as a completed unit) to the RPRs satisfaction. This item must include a mounting platform, if specified in the plans.

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When removal of an existing beacon and associated equipment is required as a part of the project, the Engineer edits specifications as necessary to cover removal, disposal, and ownership. Include necessary details and information on the plan's specifications.

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101-2 EQUIPMENT AND MATERIALS

101-2.1 General.

101-2.1.1 FAA airport lighting equipment and materials manufactured per FAA Advisory Circulars (ACs) must be certified per AC 150/5345-53, *Airport Lighting Equipment Certification Program (ALECP)*, and listed in the ALECP Addendum, current edition.

101-2.1.2 All other equipment and materials covered by other referenced specifications is subject to acceptance through manufacturer's certification of compliance with the applicable specification when the RPR requests.

101-2.1.3 Manufacturer's certifications do not relieve the Contractor of the responsibility to provide materials that are per these specifications. Remove materials supplied and/or installed that do not comply with these specifications (when the RPR directs) and replace with materials that are per these specifications at the Contractor's cost.

101-2.1.4 Submit all materials and equipment used to construct this item to the RPR for approval prior to ordering the equipment. Provide submittals consisting of marked catalog sheets or shop drawings. Present submittal data 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 mark each copy to identify the products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components or electrical equipment and systems must identify the equipment to which they apply on each submittal sheet. Make markings bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that accrue directly or indirectly from late submissions or resubmissions of submittals.

101-2.1.5 The data submitted must be sufficient, in the RPR's opinion, to determine compliance with the Contract Documents plans and specifications. The Contractor's submittals must be **[** `neatly bound in a properly sized 3-ring binder` **|** `in an electronic pdf file format` **]**, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures not meeting the system design and the standards and codes, specified in this document.

101-2.1.6 All equipment and materials furnished and installed in this section must be guaranteed against defects in materials and workmanship for at least **[** `twelve months` **]** from the date of final acceptance by the Owner. Repair or replace the defective materials and/or equipment at the Owner's discretion, with no additional cost to the Owner.

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The Engineer specifies the form in which submittals are to be received and the number of copies. State the length of time for guarantee of materials and workmanship as stated in the contract between the Owner and Contractor and the contract special provisions.

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101-2.2 Beacon.

The beacon must be a Type **[__]** Class **[__]** beacon certified to the requirements of AC 150/5345-12, *Specification for Airport and Heliport Beacons*.

****

The Engineer selects the Type and Class of beacon required.

****

101-2.3 Beacon Installation.

Installation is as shown on the plans. Provide two light source sets as spares.

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The Engineer must include installation details on the plans. See AC 150/5340-30, *Design and Installation Details for Airport Visual Aids*, for airport beacon and AC 150/5390-2, *Heliport Design,* for heliport beacon installation details.

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101-2.4 Panel Boards and Breakers.

Panel boards and breakers must conform to the requirements of Federal Specification W-P-115, Panel, Power Distribution.

101-2.5 Weatherproof Cabinets.

The weatherproof cabinets must conform to National Electrical Manufacturers Association Standards (NEMA) and be constructed of steel not less than No. 16 United States Standard (USS) gauge.

101-2.6 Electrical Wire.

For ratings up to 600 volts, use moisture and heat resistant thermoplastic wire conforming to Commercial Item Description A-A-59544A Type THWN-2. The wires must be the type, size, number of conductors, and voltage shown in the plans or proposal.

101-2.7 Conduit.

Rigid steel conduit and fittings must be per Underwriters Laboratories (UL) Standards 6, 514B, and 1242.

101-2.8 Paint.

101-2.8.1 Priming paint for non-galvanized metal surfaces must be a high solids alkyd primer compatible with the manufacturer’s recommendations for the intermediate or topcoat.

101-2.8.2 Priming paint for galvanized metal surfaces must be a zinc-rich epoxy primer paint per MIL-DTL-24441/19C, Formula 159, Type III. Use MIL-24441 thinner per paint manufacturer’s recommendations.

101-2.8.3 Use orange paint for the body,and the finish coats on metal. Wood surfaces must consist of a ready-mixed non-fading paint meeting the requirements of Master Painters Institute (MPI) Reference #9 (gloss). The color must be per Federal Standard 595, International Orange number 12197 or aviation yellow, color number 13538.

101-2.8.4 White paint for body and finish coats on metal and wood surfaces must be ready-mixed paint per the Master Painters Institute, Reference #9, Exterior Alkyd, Gloss, volatile organic content (VOC) Range E2.

101-2.8.5 Priming paint for wood surfaces must be mixed on the job by thinning the above-specified orange or white paint with ½ pint (0.24 liter) of raw linseed oil to each gallon (liter).

101-3 CONSTRUCTION METHODS

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Include project specific installation information from AC 150/5345-30, as required.

****

101-3.1. Placing the Beacon.

The beacon must be mounted as shown in the plans.

101-3.2 Hoisting and Mounting.

Hoist the beacon to the mounting platform by using suitable slings and hoisting tackle. Before fastening the beacon to the mounting platform, check the mounting holes for correct spacing. The beacon base or mounting legs must not be strained or forced out of position to fit incorrect spacing of mounting holes. Raise the beacon base first, set in position, and bolt in place. Then raise the drum and assemble to the base.

101-3.3 Leveling.

After mounting the beacon, accurately level the beacon following the manufacturer’s instructions. Check the leveling in the RPR’s presence. Leveling must be to the RPR’s satisfaction.

101-3.4 Servicing.

Before placing the beacon in operation, the Contractor checks the manufacturer’s manual for proper servicing requirements. Follow the manufacturer’s servicing instructions for each size beacon.

101-3.5 Beam Adjustment.

After mounting and leveling the beacon, adjust the elevation of the beam. Make final beam adjustments at night so results can be readily observed. Adjust beams to the elevation as the RPR directed, or as shown in the plans. Check the manufacturer’s manual for proper servicing requirements, including any beam adjustments. See AC 150/5340-30 for additional information about airport beacon beam adjustment.

101-3.6 Beacon Mounting Platform.

Where the beacon is to be mounted at a location other than the beacon tower and where a special mounting platform is required, the construction of the mounting platform and any necessary lightning protection equipment must be per the details shown in the plans.

101-3.7 Wiring.

The Contractor furnishes all necessary labor and materials and makes complete above ground electrical connections per the wiring diagram furnished with the project plans. The electrical installation must conform to the requirements of the latest edition of National Fire Protection Association (NFPA)-70, National Electrical Code (NEC). If underground cable for the power feed from the transformer vault to the beacon site and duct for this cable installation is required, the cable, install ground rods and duct as shown on the plans. If shown on the plans, the Contractor connects the tell-tale relay mechanism in the beacon to energize the tower obstruction light circuit when failure of the beacon service (primary) lamp occurs. If lightning protection is specified in the plans, install it per Item L-103, Airport Beacon Towers, paragraph 103-2.3.

101-3.8 Panel and Cabinet.

If shown on the plans, the Contractor furnishes and installs at the top of the beacon tower or mounting platform a circuit-breaker panel consisting of four, 15-ampere breakers mounted in a weather-proof cabinet to provide separate protection for the circuits to the beacon lamps, motor, obstruction lights, and other equipment. Locate the cabinet on the side of the beacon platform as shown on the plans or as the RPR directed.

101-3.9 Conduit.

Install all exposed wiring not less than ¾ inch (19 mm) galvanized rigid steel conduit. Outdoor rated, liquid-tight, flexible metal conduit may be used for final connection at the beacon equipment. Do not install conduit on top of a beacon platform floor. Install all conduits to provide drainage. If mounted on a steel beacon tower, fasten the conduit to the tower members with Wraplock® straps (or equivalent), clamps, or approved fasteners, spaced approximately 5 feet (1.5 m) apart. Fasten the conduit to wooden structures with galvanized pipe straps and with galvanized wood screws not less than No. 8 or less than 1¼ inches (32 mm) long. There must be at least two fastenings for each 10 feet (3 m) length.

101-3.10 Booster Transformer.

`[ The installation is as indicated in the plans and described in the specifications. |Not used. ]`

****

Refer to AC 150/5340-30 for requirements. All requirements must be included in specifications.

Install a booster transformer, if required, to compensate for voltage drop to the beacon in a suitable weatherproof housing under or on the tower platform or at the base of the tower.

If the booster transformer is required for installation remote from the beacon, edit measurement and payment specifications as required.

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101-3.11 Photoelectric Control.

If shown in the plans or specified in the job specifications, the Contractor furnishes and installs an automatic control switch at the location indicated in the plans. The switch must be a photoelectric type. It must be a standard commercially available unit that energizes when the illumination on a vertical surface facing North decreases to 25 to 35 foot-candles (269 to 377 lux). The photoelectric switch should de-energize when the illumination rises to 50 to 60 foot-candles (538 to 646 lux). Install, connect, and adjust the photoelectronic switch per the manufacturer’s instructions.

101-3.12 Obstruction Lights.

Unless otherwise specified, the Contractor installs on the top of the beacon tower or mounting platform two L-810 obstruction lights on opposite corners. Mount these lights on conduit extensions to a height of not less than 4 inches (100 mm) above the top of the beacon.

101-3.13 Painting.

Clean all surfaces before painting. The surfaces must be dry and free from scale, grease, rust, dust, and dirt. Cover all knots in wood surfaces with shellac immediately before applying the priming coat of paint. Fill nail holes and permissible imperfections with putty. Thin the ready-mixed paint for the priming and body coats per the manufacturer’s recommendations. In the absence of such recommendations, the following applies:

1. Body coats (for both wood and steel surfaces) - add ½ pint (0.24 liter) of turpentine to each gallon (liter) of ready-mixed paint for body coats.
2. Finish coats (for both wood and steel surfaces) use the ready-mixed paint as it comes from the container for finish coats.

If construction of a wooden mounting platform is stipulated in the proposal as part of this item, give all wooden parts of the platform one priming coat of white or aviation-orange paint after fabrication prior to erection and one body and one finish coat of international-orange paint after erection. Give steel mounting platforms one priming coat of corrosion-inhibiting primer before erection and one body and one finish coat of international-orange paint after erection.

Give one body and one finish coat of international-orange (per Federal Standard 595, Number 12197), or white paint, all equipment installed under this contract and exposed to the weather, as required. This includes the beacon (except glass surfaces), beacon base, breaker cabinet, all conduit, and transformer cases. It does not include lightning protection system air terminals or obstruction light globes.

Apply the paint uniformly at the proper consistency. The finished paint must be free from sags, holidays, and smears. Give each coat of paint ample time to dry and harden before the next coat of paint is applied. Allow a minimum of three days for drying on wood surfaces and allow a minimum of four days for drying on metal surfaces. Do not paint in cold, damp, foggy, dusty, or frosty atmospheres, or when the air temperature is below 40°F (4°C), or started when the weather forecast indicates such conditions for the day.

101-3.14 Testing.

Test the beacon installation as a completed unit prior to acceptance. These tests must include operation of the lamp-changer and performing insulation resistance and voltage readings. The insulation resistance to ground of the beacon power supply circuit must not be any less than 100 megohms when measured ungrounded. The Contractor furnishes testing equipment. Tests must be conducted in the presence of and to the RPR's satisfaction.

101-4 METHOD OF MEASUREMENT

101-4.1 The quantity to be paid for is the number of beacons installed as completed units in place, accepted, and ready for operation.

101-5 BASIS OF PAYMENT

101-5.1 Payment is made at the contract unit price for each completed and accepted job. This price is full compensation for **[** `removal of existing beacon;` **]** 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 is made under:

Item L-101-5.1 **[** `List type, style, size` **]** Airport Rotating Beacon, in place - per unit

101-6 REFERENCES

101-6.1 This list of publications forms 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 150/5345-7	*Specification for L-824 Underground Cable for Airport Lighting Circuits*
AC 150/5345-12	*Specification for Airport and Heliport Beacons*
AC 150/5340-30	*Design and Installation Details for Airport Visual Aids*
AC 150/5345-53	*Airport Lighting Equipment Certification Program*
AC 150/5390-2	*Heliport Design*

Commercial Item Description

A-A-59544A	*Cable and Wire, Electrical (Power, Fixed Installation)*

Federal Specification (FED SPEC)

FED SPEC W-P-115	*Panel, Power Distribution*

Federal Standard (FED STD)

FED STD 595	*Colors Used in Government Procurement*

Master Painter Institute (MPI)

MPI Reference #9	*Alkyd, Exterior, Gloss (MPI Gloss Level 6)*

Mil Spec

MIL-DTL-24441C/19C	*Paint, Epoxy-Polyamide, Zinc Primer, Formula 159, Type III*

National Fire Protection Association (NFPA)

NFPA 70	*National Electric Code (NEC)*
NFPA 780	*Standard for the Installation of Lightning Protection Systems*

Underwriters Laboratories (UL)

UL Standard 6	*Electrical Rigid Metal Conduit – Steel*
UL Standard 514B	*Conduit, Tubing, and Cable Fittings*
UL Standard 1242	*Electrical Intermediate Metal Conduit - Steel*

END OF ITEM L-101

Item L-103 Airport Beacon Towers

103-1 DESCRIPTION

103-1.1 This item consists of **[** `removal of existing beacon tower;` **]** furnishing and installing an airport beacon tower of the type shown in the plans, per these specifications. This work includes the clearing of the site, erection of the tower, installation of lightning protection, painting, and all incidentals necessary to place it in operating condition as a completed unit to the Resident Project Representative's (RPR's) satisfaction. See Advisory Circular (AC) 150/5340-30 for additional installation information about airport beacon towers.

****

When removal of an existing beacon tower and associated equipment is required as a part of the project, the Engineer edits specifications as necessary to cover removal, disposal, and ownership. Include necessary details and information on the plan's specifications.

****

103-2 EQUIPMENT AND MATERIALS

103-2.1 General.

103-2.1.1 All equipment and materials covered by referenced specifications are subject to acceptance through manufacturer's certification of compliance with the applicable specification when the RPR request.

103-2.1.2 Manufacturer's certifications do not relieve the Contractor of the responsibility to provide materials per these specifications. Remove materials supplied and/or installed that do not comply with these specifications (when the RPR directed) and replace with materials, that are per specifications, at the Contractor's cost.

103-2.1.3 Submit all materials and equipment used to construct this item to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings must be provided. Present submittal data 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 to components of electrical equipment and systems must identify the equipment for which they apply on each submittal sheet. Make markings 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.

103-2.1.4 The data submitted must be sufficient, in the RPR's opinion, to determine compliance with the plans and specifications. The Contractor's submittals must be **[** `neatly bound in a properly sized 3-ring binder` **|** `in an electronic pdf file format` **]**, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures not meeting the system design and the standards and codes, specified in this document.

103-2.1.5 All equipment and materials furnished and installed under this section must be guaranteed against defects in materials and workmanship for at least **[** `twelve months` **]** from the date of final acceptance by the Owner. Repair or replace the defective materials and/or equipment at the Owner's discretion, with no additional cost to the Owner.

****

The Engineer should specify the form in which submittals are to be received and number of copies. The length of time for guarantee of materials and workmanship should be as stated in the contract between the Owner and Contractor and the contract special provisions.

****

103-2.2 Tower.

The beacon tower is **[ ]**.

****

Refer to AC 150/5340-30, *Design and Installation Details for Airport Visual Aids*, Chapter 6.

****

103-2.3 Lightning Protection.

Lightning protection must comply with the National Fire Protection Association (NFPA) 780, Standard for the Installation of Lightning Protection Systems. All materials must comply with NFPA 780 Class II minimum material requirements regardless of the tower height.

103-2.4 Paint.

103-2.4.1 Priming paint for galvanized steel towers must be zinc dust-zinc oxide primer paint per Military (MIL)-Specific Detail (DTL)-24441C/19B. Use MIL-24441 thinner per paint manufacturer's recommendations.

103-2.4.2 Priming paint for non-galvanized steel towers must be a high solids alkyd primer per the Master Painters Institute (MPI), Reference #9, Exterior Alkyd, Gloss.

103-2.4.3 Orange paint for the body and the finish coats on metal and wood surfaces must consist of a ready-mixed non-fading paint MPI Reference #9 (gloss). Use Federal Standards 595, International Orange Number 12197 for the orange body.

103-2.4.4 White paint for a steel tower must be ready-mixed paint per Master Painters Institute (MPI) Reference #8.

103-3 CONSTRUCTION METHODS

103-3.1 Clearing and Grading.

The beacon tower site where the tower is being erected must be cleared and leveled. Remove all trees and brush from the area within a distance of 25 feet (7.5 m) from the tower or as called for in the plans. Remove stumps to a depth of 18 inches (0.5 m) below finished grade and the excavation filled with earth and tamped. If a transformer vault or other structure is included as part of the installation, clear the area to a distance of 25 feet (7.5 m) from these structures. Level the ground near the tower to permit the operation of mowing machines. Extend the leveling at least two feet (60 cm) outside the tower legs. The Contractor disposes of all debris removed from the tower site to the RPR's satisfaction and per federal, state, or local regulations.

103-3.2 Excavation and Fill.

Excavation for the tower footings must be carried to a minimum of 4 inches (100 mm) below the footing depth. Backfill and compact the excess excavation below the footing with gravel or crushed stone. Install the footing plates and place and compact 18 inches of gravel or stone above the footing plates in layers of not over 6 inches. The remainder of the backfill may be of excavated earth placed in layers not to exceed 6 inches (150 mm). Thoroughly compact each layer by tamping.

With the RPR's approval, cut off the tower anchor posts at the required length and install the hold-down bolts as indicated in the plans under the following conditions: (a) where solid rock is encountered, and it prevents the carrying of the foundation legs to the required depth and (b) is of sufficient strength to use hold-down bolts. Anchor each tower leg to the rock by means of two 7/8-inch (22 mm) diameter by 3 feet (1 m) long expansion or split bolts and grout with neat Portland Cement into holes drilled into the natural rock. Except as required for rock foundations, do not cut off or shorten the footing members. If excavated material is of such consistency that it will not readily compact when backfilled, the RPR may order the excavation backfilled with concrete or other suitable material. Install the concrete footing for tubular beacon towers per the manufacturer's recommendations. Do not include portions of the footing in the topsoil layer in the footing height.

103-3.3 Erection.

Erect tower erection as shown on the plans and detailed on manufacturer's erection drawings. Erect all towers in sections from the ground up unless otherwise specified. For final assembly, install all bolts and fastenings. The structure must be plumb, true, square, and level. Take up nuts and locknuts to a firm bearing and bolts cut to proper length to protrude three full threads, if necessary. Insert ladder bolts with the head to the outer face of the tower. Install diagonal, leg, and handrail bolts with nuts on the outer face of the tower, unless otherwise specified. Straighten bent parts before erection without damage to the protective coating. Paint surfaces abraded or bared of protective coating with the proper priming paint per these specifications.

The Contractor installs the ladder on the side of the tower adjacent to the driveway or most accessible approach to the tower. Erect tubular beacon towers per the manufacturer's recommendations. Locate the safety cable on the side of the tower adjacent to the driveway or most accessible approach to the tower.

103-3.4 Lightning Protection.

The Contractor furnishes and installs a Class II lightning protection system according to NFPA 780. Install ground rods and underground cables according to the plans. Securely fasten down-conductor cables to the surface of the tower leg at 5 feet (1.5 m) intervals with suitable bronze fasteners having bronze or noncorrosive metal bolts. Sharp turns or bends in the down conductor are not permitted.

All connections of cable to cable, cable to air terminals, and cable to ground plates or rods must be made with solder-less connectors or noncorrosive metal the RPR approved. Securely attach the down-conductor cable to ground rods or plates at least 2 feet (60 cm) away from the tower foundations. Drive the ground rod until the top is at least 6 inches (150 mm) below grade. Attach the down-conductor to the ground plate or rod by means of an exothermic weld. Embed plates in an area of permanent moisture.

The resistance to ground of any part of the lightning protection system must not exceed 25 ohms. If a single rod grounding electrode has a resistance to earth of over 25 ohms, install one supplemental rod not less than 10 feet from the first rod. If the desired resistance to ground levels is not achieved, see Federal Aviation Administration-Standard (FAA-STD)-019 for guidance on the application of coke breeze.

103-3.5 Painting.

The Contractor furnishes all materials and labor for painting the beacon tower. The color scheme for the steel tower is as shown in the plans.

103-3.5.1 Parts to be Painted.

Do not treat or prime tower parts (except those parts to be exposed to earth) before erection. Give all tower parts placed below ground level or within 12 inches (300 mm) above ground level two coats of approved asphalt paint. Apply the proper consistency of paint uniformly. The finished paint must be free from sags, holidays, and smears. Sharply define division lines between colors. Give each coat of paint ample time to dry and harden before the next coat is applied. Allow a minimum of four days for drying on metal surfaces. Do not paint in cold, damp, foggy, or dusty atmospheres, or when air temperature is below 40°F (4°C), or started when the weather forecast indicates such conditions for the day. Clean all surfaces before painting. The surfaces must be dry and free from scale, grease, rust, dust, and dirt when paint is applied. The number of coats of paint applied must be per the following instructions.:

103-3.5.1.1 Galvanized Steel Towers.

Apply one priming coat of zinc dust-zinc oxide primer after erection and one body and one finish of white or orange paint (as required by the color scheme) after erection.

103-3.5.1.2 Ungalvanized Steel Towers.

After erection, one priming coat of corrosion-inhibiting primer and one body and one finish coat of white or orange paint (as required by the color scheme). Thin the above specified orange and white ready-mixed paints for the body coats per the manufacturer’s recommendations. In the absence of such recommendations, the following applies.

103-3.5.1.3 Body Coats.

Do not add more than ½ pint (0.24 liters) of turpentine to each gallon (liter) of ready-mixed paint for body coats.

103-3.5.1.4 Finish Coats.

Use the ready-mixed paint as it comes from the container for finish coats.

103-4 METHOD OF MEASUREMENT

103-4.1 The quantity to be paid for under this item is the number of airport beacon towers installed as completed units in place, accepted, and ready for operation.

103-5 BASIS OF PAYMENT

103-5.1 Payment is made at the contract unit price for each completed and accepted job. This price is full compensation for o[removal of existing beacon tower;] 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 is made under:

Item L-103-5.1	[List type here] Beacon Tower and Foundation, in Place per unit

103-6 REFERENCES

103-6.1 This list of publications forms 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	*Installation and Design Details for Airport Visual Aids*

Master Painters Institute (MPI)

MPI Reference #8	*Alkyd, Exterior, Flat (MPI Gloss Level 1)*
MPI Reference #9	*Alkyd, Exterior, Gloss (MPI Gloss Level 6)*

Federal Standard (FED STD)

FED STD 595	*Colors Used in Government Procurement*

Mil Standard

MIL-DTL-24441C/19B	*Paint, Epoxy-Polyamide, Zinc Primer, Formula 159, Type III*

National Fire Protection Association (NFPA)

NFPA 780	*Standard for the Installation of Lightning Protection Systems*

END OF ITEM L-103

Item L-107 Airport Wind Cones

107-1 DESCRIPTION

107-1.1 This item consists 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 includes the furnishing and installation of a support for mounting the wind cone, the specified interconnecting wire, and a concrete foundation. The item must include all cable connections, conduit 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 Resident Project Representative (RPR).

****

When removal of an existing airport wind cone and associated equipment is required as a part of the project, the Engineer edits specification as necessary to cover removal, disposal, and ownership. Include necessary details and information on the plan's specifications.

****

107-2 EQUIPMENT AND MATERIALS

107-2.1 General.

107-2.1.1 Airport lighting equipment and materials covered by Advisory Circulars (ACs) must be certified in AC 150/5345-53, *Airport Lighting Equipment Certification Program (ALECP)*, and listed in the ALECP Addendum.

107-2.1.2 All other equipment and materials covered by other referenced specifications is subject to acceptance through manufacturer's certification of compliance with the applicable specification when the RPR requests.

107-2.1.3 Manufacturer's certifications do 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 must be removed and replaced with materials that comply with these specifications, at the Contractor's cost.

107-2.1.4 All materials and equipment to be used to construct this item must be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings must be provided. Present submittal data 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 must identify the equipment to which they apply on each submittal sheet. Make markings 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.

107-2.1.5 The data submitted must be sufficient, in the RPRs opinion, to determine compliance with the plans and specifications. **[** `The Contractor’s submittals must be neatly bound in a properly sized 3-ring binder, tabbed by specification section.` **|**`in electronic pdf format, tabbed by specification section.` **]** The RPR reserves the right to reject any and all equipment, materials or procedures, not meeting the system design and the standards and codes, specified in this document.

107-2.1.6 All equipment and materials furnished and installed under this section must be warranted against defects in materials and workmanship for at least **[** `twelve months` **]** from the date of final acceptance by the Owner. The defective materials and/or equipment must be repaired or replaced, as the RPR directs, with no additional cost to the Owner.

****

The Engineer specifies the form in which submittals are received and the number of copies.

The length of time for guarantee of materials and workmanship should be as stated in the contract between the Owner and Contractor and the contract special provisions.

See Engineering Brief (EB)-67D for information on light-emitting diode (LED) warranty. EB-67D states “All LED light fixtures with the exception of obstruction lighting (AC 150/5345-43) must be warranted by the manufacturer for a minimum of 4 years after date of installation inclusive of all electronics.” Obstruction lighting warranty is set by the individual manufacturer.

****

107-2.2 Wind Cones.

The **[** `primary` **|** `supplemental` **]** wind cone assembly must be Type **[__]**, Style **[__]**, Size **[ ]**.

****

Refer to AC 150/5345-27, *Specification for Wind Cone Assemblies.*

The illuminated wind cone must present constant brightness to the pilot. Identify the source of power for the wind cone circuit. Where a constant voltage is available, the wind cone may be connected directly to the constant voltage circuit. Where the series lighting circuit is used as a power source to the wind cone, a 6.6-amp constant current input power must be specified. The wind cone illumination must remain at a constant intensity regardless of the current step selected for other lighting systems on the circuit. See "Appendix F Application Notes" of AC 150/5340-30 for further concepts for maintaining component lighting intensity independent of current step.

Specify the wind cone and power adapter combination recommended by the manufacturer when the power source for the wind cone circuit will be the series lighting circuit.

****

107-2.3 Electrical Wire and Cable.

Cable rated up to 5,000 volts in conduit must be certified to AC 150/5345-7, *Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits.* Use Type THWN-2 rated up to 600 volts, conforming to Commercial Item Description A-A-59544A. It must be moisture and heat resistant thermoplastic. Furnish wires of the type, size, number of conductors, and voltage as shown in the plans or in the proposal.

107-2.4 Conduit.

Rigid steel conduit and fittings must 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 must meet the following requirements:

- UL 514B covers W-C-1094 - Conduit fittings all types, Classes 1 through 3 and 6 through 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

Conduit must meet Underwriters Laboratories Standard UL-651 and be:

- Type I–Schedule 40 PVC suitable for underground use either direct-buried or encased in concrete.
- Type II–Schedule 40 PVC suitable for either above ground or underground use.

Glue conduits and fittings using plastic conduit adhesive manufactured specifically for the purpose of gluing the type of plastic conduit and fitting.

107-2.6 Concrete.

`[ The concrete for foundations must be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. ]`

****

If P-610 is not used elsewhere on the project, it is acceptable to replace this paragraph with the following:

Concrete foundations must be proportioned, placed, and cured per state department of transportation structural concrete with minimum 25% Type F coal ash, and a minimum allowable compressive strength of 4,000 psi (28 MPa).

****

107-2.7 Paint.

107-2.7.1 Use a high solids alkyd primer paint for non-galvanized metal surfaces compatible with the manufacturer's recommendations for the intermediate or topcoat.

107-2.7.2 Use a zinc dust zinc oxide primer paint for galvanized metal surfaces conforming to MIL-DTL-24441C/19B. Use MIL-24441 for thinner per paint manufacturer's recommendations.

107-2.7.3 Use orange paint for the body and the finish coats on metal and wood surfaces must consist of a ready-mixed non-fading paint per Master Painters Institute (MPI) Reference #9 (gloss). The color must be per Federal Standards 595, International Orange, Number 12197.

107-2.7.4 White paint for body and finish coats on metal and wood surfaces must be ready-mixed paint conforming to the MPI, Reference #9, Exterior Alkyd, Gloss.

107-2.7.5 Mix priming paint for wood surfaces on the job by thinning the above specified aviation-orange or white paint by adding ½ pint (0.24 liter) of raw linseed oil to each gallon (liter).

107-3 CONSTRUCTION METHODS

107-3.1 Installation.

Install the **[** `hinged support or hinged pole` **]** on a concrete foundation per the plans.

****

Installation details must show on the plans. Refer to "Wind Cone Mounting Structures" in AC 150/5340-30 for additional information on mounting structure types for L-806 (supplemental wind cones) and L-807 (primary wind cones).

****

107-3.2 Support Pole Erection.

The Contractor must erect the pole level and secure on the foundation following the manufacturer's requirements and erection details. See plans and AC 150/5340-30, Figure A-77, Externally Lighted Wind Cone Assembly (Frangible), for reference.

107-3.3 Electrical Connection.

The Contractor furnishes all labor and materials and make complete electrical connections, per the wiring diagram furnished with the project plans. The electrical installation must conform to the requirements of the latest edition of National Fire Protection Association, NFPA 70, *National Electric Code (NEC)*. Install underground cable and duct according to 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 Booster Transformer.

[`Install the booster transformer be as indicated in the plans. |Not used.` **]**

****

Refer to AC 150/5340-30 for requirements. Install a booster transformer, if required, to compensate for voltage drop to the beacon in a suitable weatherproof housing under or on the tower platform or at the base of the tower.

If the booster transformer is required for installation remote from the beacon, edit measurement and payment specifications as required.

****

107-3.5 Ground Connection and Ground Rod.

The Contractor must 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, as specified in L-108. Drive the ground rod 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. Grounding electrodes per description in NFPA 780, *Standard for the Installation of Lightning Protection Systems*, Article 4.13 may be used in lieu of ground rods. The grounding cable must consist of No. **[** 6 **|** 4 **|** 2 **]** American wire gauge (AWG) minimum stranded copper wire or larger and be firmly attached to the ground rod by exothermic welding or using connectors approved for direct burial in soil or concrete per UL 467. Securely attach the other end of the grounding cable to a leg of the frame or to the base of the pipe support. The resistance to ground must 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 ten feet from the first rod. If desired resistance to ground levels is still not achieved, see FAA-STD-019 for guidance on the application of coke breeze.

107-3.6 Painting.

Apply three coats of paint (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. Give the wind cone assembly, if already painted upon receipt, one finish coat of paint in lieu of the three coats specified above. The paint must be per MPI Reference #9 (gloss). The color must be per Federal Standard 595, International Orange, Number 12197.

107-3.7 Light Sources.

The Contractor furnishes and installs light source(s) per the manufacturer’s instruction book.

107-3.8 Chain and Padlock.

The Contractor furnishes and installs a suitable operating chain for lowering and raising the hinged top section. Attach the chain to the pole support in a manner to prevent the light fixture assembly from striking the ground in the lowered position. The Contractor furnishes a padlock on the 8-foot (2.4-m) wind cone for securing the hinged top section to the fixed lower section. Deliver keys for the padlock to the RPR.

107-3.9 Segmented Circle.

Construct the segmented circle as shown on the Plans.

****

Show segmented circle details on the plans. Refer to AC 150/5340-5, *Segmented Circle Airport Marker System.*

****

107-4 METHOD OF MEASUREMENT

107-4.1 The quantity to be paid is the number of wind cones installed as completed units in place, accepted, and ready for operation.

107-4.2 The quantity of segmented circle airport marker systems to be paid for is the number of systems installed as completed units in place, accepted, and ready for operation.

107-5 BASIS OF PAYMENT

107-5.1 Payment is made at the contract unit price for each completed and accepted job. This price is 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.

107-5.2 Payment is made at the contract unit price for each segmented circle airport marker system. This price is 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 is made under:

Item L-107-5.1	**[** `List type, style, size` **]** Wind Cone and Foundation, in Place -- per Each
Item L-107-5.2	Segmented Circle Marker System, in Place -- per Each

107-6 REFERENCES

107-6.1 This list of publications forms 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)*

Federal Standard (FED STD)

FED STD 595	*Colors Used in Government Procurement*

Master Painters Institute (MPI)

MPI Reference #9	*Alkyd, Exterior, Gloss (MPI Gloss Level 6)*

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)*
NFPA 780	*Standard for the Installation of Lightning Protection Systems*

END OF ITEM L-107

Item L-108 Underground Power Cable for Airports

108-1 DESCRIPTION

108-1.1 This item consists 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 Resident Project Representative (RPR). This item must not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for Federal Aviation Administration (FAA) owned/operated facilities.

108-2 EQUIPMENT AND MATERIALS

108-2.1 General.

108-2.1.1 Airport lighting equipment and materials covered by Advisory Circulars (AC) must be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.

108-2.1.2 All other equipment and materials covered by other referenced specifications must be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the RPR.

108-2.1.3 Manufacturer's certifications do not relieve the Contractor of the responsibility to provide materials per these specifications. When the RPR directs, remove materials supplied and/or installed not complying with these specifications and replace with materials complying with these specifications at the Contractor's cost.

108-2.1.4 Submit all materials and equipment used to construct this item to the RPR for approval prior to ordering the equipment. Provide submittals consisting of marked catalog sheets or shop drawings. Present submittal data 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 must identify the equipment to which they apply on each submittal sheet. Make markings 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.

108-2.1.5 The data submitted must be sufficient, in the RPR's opinion, to determine compliance with the plans and specifications. **[** `The Contractor's submittals must be neatly bound in a properly sized 3-ring binder, tabbed by specification section. |electronically submitted in pdf format.` **]** The RPR reserves the right to reject any and all equipment, materials, or procedures not meeting the system design and the standards and codes, specified in this document.

108-2.1.6 All equipment and materials furnished and installed under this section must be guaranteed against defects in materials and workmanship for at least **[** `twelve months` **]** from the date of final acceptance by the Owner. The defective materials and/or equipment must be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. The Contractor must maintain a minimum insulation resistance according to paragraph 108-3.10.5 with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period when tested according to AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

****

The Engineer specifies the form in which submittals are to be received and number of copies.

The length of time for guarantee of materials and workmanship is as stated in the contract between the Owner and Contractor and the contract special provisions.

Only Third-Party certified manufacturers, listed in AC 150/5345-53, Appendix 3 Addendum (as required) and meeting the Buy American preference requirements, can provide equipment and materials specified in the Contract Documents. Include documentation certifying compliance with the Buy American preference rules for Airport Improvement Program (AIP) cited in 49 USC §50101) with each equipment and material submittal.

****

108-2.2 Cable.

Underground cable for airfield lighting facilities (runway and taxiway lights and signs) must conform to the requirements of AC 150/5345-7, *Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits*, latest edition. L-824 cable conductors for use on 6.6 ampere primary airfield lighting series circuits will have a single conductor, seven strand, #8 American Wire Gauge (AWG), L-824 **[** `Type B, Type C` **]**, 5,000 volts, non-shielded, with **[** `ethylene propylene insulation, cross-linked polyethylene insulation` **]**. L-824 cable conductors for use on 20 ampere primary airfield lighting series circuits must be single conductor, seven strand, #6 AWG, L-824 **[** `Type B, Type C` **]**, 5,000 volts, non-shielded, with **[** `ethylene propylene insulation, cross-linked polyethylene insulation` **]**. L-824 cable conductors for use on the L-830 secondary of airfield lighting series circuits must be sized according to the manufacturer's recommendations. All other conductors must comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above must not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts must comply with AC 150/5345-7, *Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits*, latest edition, and/or Commercial Item Description A-A-59544A and must be type THWN-2, 75°C for installation in conduit and RHW-2, 75°C for direct burial installations. L-824 cable conductors for parallel (voltage) circuits must be type and size and installed according to NFPA 70, *National Electric Code*.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 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 THWN-2, 600-volt insulated conductors. The Contractor makes the necessary increase in conduit/duct sizes for other types of wire insulation. In no case is the conduit/duct size reduced. The minimum power circuit wire size is #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor must be able to accept 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 must be considered incidental to the respective pay items provided. Cable type, size, number of conductors, strand and service voltage must 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 must be No. **[** `6` **|** `4` **|** `2` **]** AWG bare solid copper wire for counterpoise and/or No. **[** `6` **|** `4` **|** `2` **]** AWG insulated stranded for grounding bond wire per ASTM B3 and ASTM B8, and must be **[** `bare copper wire` **|** `tinned copper wire per ASTM B33` **]**. For voltage powered circuits, the equipment grounding conductor must comply with NEC Article 250. See AC 150/5340-30, paragraph 12.5, Counterpoise (Lightning Protection System), for additional information.

Ground rods must be **[** `solid stainless steel` **|** `copper` **]** or **[** `copper-clad steel` **|** `sectional copper-clad steel` **]**. The ground rods must be of the length and diameter specified on the plans, but should not be less than **[** `8 feet (2.4 m)` **|**`10 feet (2.54 m)` **]** long and **[** `⅝ inch (16 mm)` **|**`¾ inch (19 mm)` **]** in diameter.

****

The Engineer should evaluate the soils in the vicinity of proposed counterpoise and ground rod installations and determine if soil conditions would adversely affect copper. The Engineer specifies the type of ground rod and counterpoise wire to be installed in consideration of the soil conditions. If tinned copper counterpoise or ground wire is specified, include requirement for UL listing.

The Engineer should select the counterpoise conductor size based upon sound engineering practice and lightning strike density. NFPA 780 Class I materials (for structures not exceeding 75 feet in height) require the main copper conductor/cable to have a minimum cross-sectional area of 57,400 circular mils. A 2 AWG solid copper conductor is 66,360 circular mils. The 2 AWG solid copper conductor is a few thousand circular mils larger than the required Class I conductor (57,400 circular mils). However, a 2 AWG conductor is the smallest standard size AWG conductor that complies with the NFPA 780 Class I requirements (4 AWG = 41,740 circular mils, 3 AWG = 52,620 circular mils). The minimum counterpoise conductor size is 6 AWG solid copper.

See AC 150/5340-30 for additional details about counterpoise and grounding bond wire types and installation.

****

108-2.4 Cable Connections.

108-2.4.1 In-line connections or splices of underground primary cables must be of the type called for on the plans and must be one of the types listed below. No separate payment is made for cable connections.

108-2.4.1.1 The Cast Splice.

A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M^{TM} Company, “Scotchcast” Kit No. 82-B, or an approved equivalent, used for potting the splice is acceptable.

108-2.4.1.2 The Field-attached Plug-in Splice.

Install field attached plug-in splices as shown on the plans. The Contractor determines 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 must be according to the manufacturer’s requirements. Primary Connector Kits manufactured by

Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.

****

Figure 3 of AC 150/5345-26, *Specification for L-823 Plug and Receptacle, Cable Connectors*, employing connector kits, is acceptable for field attachment to single conductor cable.

****

108-2.4.1.3 The Factory-molded Plug-in Splice.

Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

108-2.4.1.4 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 must be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing must be factory coated with a thermoplastic adhesive-sealant that adheres 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 must be factory kits designed for the application. Heat shrinkable tubing and tubing kits must be manufactured by Tyco Electronics/Raychem Corporation, Energy Division, or approved equivalent.

108-2.4.2 In all the above cases, make connections of cable conductors using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. Make all L-823/L-824 splices and terminations per the manufacturer’s recommendations and listings. Make all connections of counterpoise, grounding conductors and ground rods by the exothermic process or approved equivalent, except that a light base ground clamp connector is used for attachment to the light base. Make all exothermic connections per the manufacturer’s recommendations and listings.

****

Include splice details on the plans if required. See AC 150/5340-30 for additional information about methods of attaching a ground to a galvanized light base.

****

108-2.5 Splicer Qualifications.

Every airfield lighting cable splicer must be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor submits proof of the qualifications to the RPR of each proposed cable splicer for the airport cable type and voltage level to be worked on. Cable splicing/terminating personnel must have a minimum of three years continuous experience in terminating/splicing medium voltage cable.

108-2.6 Concrete.

[`Concrete must 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 must conform to the requirements of Item P-153, Controlled Low Strength Material.

108-2.8 Cable Identification Tags.

Cable identification tags must be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags must be the type detailed on the plans.

108-2.9 Tape.

Electrical tapes must be Scotch™ Electrical Tapes –Scotch 88 (1½ 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 must 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 must be tested, in the RPR's presence. Perform this test per this item and prior to any activity that affects the respective circuit. The Contractor records the results on forms acceptable to the RPR. When the work affecting the circuit is complete, the circuit's insulation resistance must be checked again, in the RPR's presence. The Contractor records the results on forms the RPR accepts. The second reading must be equal to or greater than the first reading or the Contractor must make the necessary repairs to the existing circuit to bring the second reading above the first reading. The Contractor incurs all repair costs including a complete replacement of the L-823 connectors, L-830 transformers, and L-824 cable, if necessary. Submit all test results in the Operation and Maintenance (O&M) Manual. **[__]**

****

Include information as needed for standard and alternative methods, and safety practices for measuring insulation resistance. See AC 150/5340-26C, *Maintenance of Airport Visual Aid Facilities*, for standard and alternative methods, and safety practices for measuring insulation resistance.

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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 must be polyethylene film with a metalized foil core and must be three-six inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables must be orange. Detectable warning tape color code must comply with the APWA Uniform Color Code.

108-3 CONSTRUCTION METHODS

108-3.1 General.

The Contractor installs the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, install all cable required to cross under pavements expected to carry aircraft loads in concrete encased duct banks. Run Cable without splices, from fixture to fixture.

Cable connections between lights are only permitted at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor is responsible for providing cable in continuous lengths for home runs or other long cable runs without connections unless otherwise the RPR authorizes it in writing or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points must be installed at locations shown on the plans. Install cable circuit identification markers on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

****

The Engineer determines and specifies on the plans an adequate number of locations for installing L-823 connectors to provide maintenance and test points.

****

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 the RPR designated.

Primary airfield lighting cables installed must 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 must be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than ¼ inch (6 mm) in size. The cable circuit identification must 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 must be per the latest version of the National Electric Code (NEC), or the code of the local agency or authority having jurisdiction.

The Contractor does not make any 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 ? selected the shortest routes and that any potential interference is avoided.

Install duct banks or conduits as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor runs 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 must be compatible with the conduit size. The Contractor swabs out all conduits/ducts and cleans light bases, manholes, interiors, etc., immediately prior to pulling cable. Once cleaned and swabbed, keep the light bases and all accessible points of entry to the duct/conduit system 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 must be re-cleaned at the Contractor’s expense. The Contractor verifies existing ducts proposed for use in this project as clear and open. The Contractor notifies the RPR of any blockage in the existing ducts.

Install the cable in a manner that prevents damage to the insulation, or damage to the outer protective covering. Seal the ends of all cables with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk. Or alternately, heat shrinkable tubing before pulling into the conduit and leave it sealed until connections are made. Where more than one cable is to be installed in a conduit, pull all cable 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. Do not exceed the cable manufacturer’s recommended maximum pulling tensions. Use a non-hardening cable-pulling lubricant recommended for the type of cable being installed where required.

The Contractor submits the recommended pulling tension values to the RPR prior to any cable installation. If the RPR requires monitor pulling tension values for cable pulls by a dynamometer in the RPRs' presence. The Contractor records cable pull tensions the RPR reviewed. The Contractor removes and replaces cables exceeding the maximum allowable pulling tension values at their expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) applies. Cable installation, handling, and storage must be per manufacturer's recommendations. During cold weather, pay particular attention to the manufacturer's minimum installation temperature. Do not install cable 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. Do not drag cable 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 must not use a cable plow for installing the cable. Cable must be unreeled uniformly in place alongside or in the trench and must be carefully placed along the bottom of the trench. Do not unreel and pull the cable into the trench from one end. Place slack cable sufficient to provide strain relief in the trench in a series of S curves. Where cables must cross over each other, provide a minimum of 3 inches (75 mm) vertical displacement with the topmost cable depth at or below the minimum required depth below finished grade.

108-3.3.1 Trenching.

Carefully strip and properly store turf if it is well established and the sod can be removed. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches must be essentially vertical so that a minimum of surface is disturbed. Do not use graders to excavate the trench with their blades. The bottom surface of trenches must be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches must 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 must be 36 inches (91 cm) unless otherwise specified.
- Minimum cable depth when crossing under a railroad track, must be 42 inches (1 m) unless otherwise specified.

The Contractor excavates all cable trenches to a width not less than 6 inches (150 mm). Unless otherwise specified on the plans, install all cables in the same location and running in the same general direction in the same trench.

When rock is encountered, remove the rock to a depth of at least 3 inches (75 mm) below the required cable depth and replace it with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a ¼-inch (6.3 mm) sieve. Flowable backfill material may alternatively be used.

****

The Engineer determines the type of soil or rock to be excavated and, if rock is indicted to be encountered, indicate on the plans.

****

Replace duct bank or conduit markers temporarily removed for trench excavations, 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 ensures that these cables are adequately protected. Do not allow splices where crossings are unavoidable, in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur proceeds as follows:

1. Locate existing cables manually. Inspect unearthed cables to ensure absolutely no damage has occurred.
2. Then, with the RPR's approval, trenching proceeds, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable. If any previously identified cable is damaged during construction, the Contractor is responsible for the complete repair or replacement.

108-3.3.2 Backfilling.

After the cable has been installed, backfill the trench. The first layer of backfill in the trench encompasses all cables; be 3 inches (75 mm) deep, loose measurement; and must be either earth or sand containing no mineral aggregate particles that would be retained on a ¼-inch (6.3 mm) sieve. Do not compact this layer. The second layer is 5 inches (125 mm) deep, loose measurement, and must not contain any particles that would be retained on a 1-inch (25.0 mm) sieve. The remaining third and subsequent layers of backfill must not exceed 8 inches (20 cm) of loose measurement and be excavated or imported material and must not contain stone or aggregate larger than 4 inches (100 mm) maximum diameter.

Thoroughly tamp and compact the second and subsequent layers 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 must be **[** `a minimum of 100% of ASTM D1557` **|**`backfill with controlled low strength material (CLSM) according to P-153` **]**.

****

CLSM is recommended under pavements.

****

Trenches must not contain pools of water during backfilling operations. The trench must be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling must be stopped at an appropriate depth consistent with the type of turfing operation to be accommodated. A proper allowance for settlement is provided. Remove any excess excavated material and dispose of per the plans and specifications.

Install underground electrical warning (caution) tape in the trench above all direct-buried cable. The Contractor submits a sample of the proposed warning tape for acceptance by the RPR. If not shown on the plans, locate the warning tape 6 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. Install a 3-6 inch (75 - 150 mm) wide polyethylene film detectable tape, with a metalized foil core, above all direct buried cable or counterpoise. The tape must be of the color and have a continuous legend as indicated on the plans. Install the tape 8 inches (200 mm) minimum below finished grade.

108-3.3.3 Restoration.

Following restoration of all trenching near airport movement surfaces, the Contractor visually inspects the area for foreign object debris (FOD) and removes anything found. Where soil and sod has been removed, replace it as soon as possible after the backfilling is completed. Restore all areas disturbed by work s to its original condition. The restoration includes the **[** `sodding` **|**`topsoiling` **|** `fertilizing` **|**`liming` **|**`seeding` **|**`sprigging` **|** `mulching` **]** as shown on the plans. The Contractor is held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration must 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 must be **[** `to a minimum of 100% of ASTM D1557` **|**`backfill with controlled low strength material (CLSM) according to P-153` **]**. Restoration is considered incidental to the pay item of which it is a component part.

****

The Engineer is to specify the correct method of turfing and include in the construction documents the appropriate FAA turfing specification for restoration related to the installation of the power cables.

Under pavements, CLSM is recommended.

Under certain conditions, it may be beneficial to install cables by cable plowing. This type of installation method should only be specified where sandy soils are prevalent and with no rocks or other debris that would nick or cut the cable insulation. The Engineer specifies the equipment to be used so the cables are placed at a minimum depth of 18 inches (0.5 m) below finished grade. The cable should be manually unreeled off the spool as the machine travels, such that the earth is not unreeling the spool.

****

108-3.4 Cable Markers for Direct-buried Cable.

Mark the location of direct buried circuits by a concrete slab marker, 2 feet (60 cm) square and 4-6 inch (10-15 cm) thick, extending approximately 1 inch (25 mm) above the surface. Mark each cable run from a line of lights and signs to the equipment vault at approximately every 200 feet (61 m) along the cable run, with an additional marker at each change of direction of cable run. Mark all other direct-buried cable in the same manner. Install cable markers directly above the cable. The Contractor impresses the word “CABLE” and directional arrows on each cable marking slab. The letters must be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke ½ inch (12 mm) and ¼ inch (6 mm) deep. Use stencils for cable marker lettering. Hand lettering is not permitted.

At the location of each underground cable connection/splice, except at lighting units, or isolation transformers, install a concrete marker slab to mark the location of the connection/splice. The Contractor impresses the word “SPLICE” on each slab. The Contractor also impresses additional circuit identification symbols on each slab as the RPR directed. Paint all cable markers and splice markers international orange. Paint must be specifically manufactured for uncured exterior concrete. After placement, all cable or splice markers must be given one coat of high-visibility aviation orange paint as the RPR approved. Furnishing and installation of cable markers is incidental to the respective cable pay item.

108-3.5 Splicing.

Experienced personnel regularly engaged in this type of work must make the connections of the type shown on the plans as follows:

108-3.5.1 Cast Splices.

Make splices by using crimp connectors for jointing conductors. Assemble molds, and mix and pour the compound per the manufacturer's instructions and to the RPR's satisfaction.

108-3.5.2 Field-attached Plug-in Splices.

Assemble these per the manufacturer's instructions. Make these splices by plugging directly into mating connectors. Finish the joint where the connectors come together 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, half lapped, extending at least 1½ inches (38 mm) on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1½ 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.

108-3.5.3 Factory-molded Plug-in Splices.

Make these splices by plugging directly into mating connectors. Finish the joint where the connectors come together 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, half lapped, extending at least 1½ inches (38 mm) on each side of the joint. (2) Covered with heat shrinkable tubing with integral sealant extending at least 1½ 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.

108-3.5.4 Taped or Heat-shrink Splices.

Make a taped splice in the following manner.

1. 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 ¼ inch (6 mm) of bare conductor on each side of the connector. Prior to splicing, pencil the two ends of the cable insulation 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. Thoroughly clean the copper conductors. 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 ensure that the entire surface over which the tape is 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.

2. Apply high-voltage rubber tape half lapped over bare conductor. Tension the tape 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. Follow the manufacturer's recommendation for stretching tape during splicing. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1½ times cable diameter over the body of the splice with ends tapered approximately 1 inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape 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. Install heat shrinkable tubing following manufacturer's instructions. Direct flame heating is not permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application must be clean and free of contaminates prior to application.

108-3.5.5 Assembly.

Prepare surfaces of equipment or conductors being terminated or connected according to industry standard practice and manufacturer's recommendations. Thoroughly clean all surfaces to be connected to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Remove paints and other nonconductive coatings to expose base metal. Clean all surfaces at least ¼ 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, install bare solid **[** `#6 AWG` **]** copper counterpoise wire for lightning protection of the underground cables. The RPR selects one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

108-3.6.1 Equipotential may be used for areas having high rates of lightning strikes. The Engineer determines the counterpoise size. The equipotential method is applicable to all airfield lighting systems; e.g., 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.

Install counterpoise wire 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. Install the counterpoise conductor 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. Permit the minimum counterpoise conductor height above the raceway or cable to be protected, to be adjusted subject to coordination with the airfield lighting and pavement designs.
2. Calculate the counterpoise conductor height above the protected raceway(s) or cable(s) to ensure the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90-degree angle).

Bond the counterpoise conductor 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 must 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-019E, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.

108-3.6.2 Isolation.

Isolation is used in areas where lightning strikes are not common. The Engineer selects the counterpoise size. 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. THE NFPA 780 uses 15 feet to define “adjacent to”.

Install the counterpoise conductor halfway between the pavement edge and the light base, mounting stake, raceway, or cable being protected.

Install the counterpoise conductor 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.

****

The Engineer selects the method of lightning protection for the airfield lighting circuit.

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108-3.6.3 Common Installation Requirements.

[When using a metallic light base, bond the grounding electrode 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, bond the grounding electrode 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, *National Electrical Code*, or NFPA 780.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, it is permitted to install the counterpoise conductor concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise wire must 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 must be continuous and terminate at the transformer vault or at the power source. Securely attach it to the vault or equipment external ground ring or other made electrode-grounding system. Make the connections as shown on the plans and in the specifications.

Where an existing airfield lighting system is being extended or modified, interconnect the new counterpoise conductors to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

108-3.6.4 Parallel Voltage Systems.

Provide grounding and bonding according to NFPA 70, *National Electrical Code*.

108-3.7 Counterpoise Installation Above Multiple Conduits and Duct Banks.

Install counterpoise wires 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 must 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, place the counterpoise 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, terminate the new counterpoise wiring at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. Bond the new counterpoise conductor to the existing counterpoise system.

108-3.9 Exothermic Bonding.

Bonding of counterpoise wire must be by the exothermic welding process or equivalent method as approved by the RPR. Only personnel experienced in and regularly engaged in this type of work may make these connections. The Contractor demonstrates 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 must comply with the manufacturer’s recommendations and the following:

1. Remove all slag from welds.
2. 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.
3. If called for in the plans, thoroughly coat all buried copper and weld material at weld connections 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.

108-3.10.1 The Contractor furnishes all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor performs all tests in the RPR’s presence. The Contractor demonstrates the electrical characteristics to the RPR’s satisfaction. 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:

1. Submit earth resistance testing methods to the RPR for approval. Earth resistance testing results must be recorded on an approved form. Perform testing in the RPR's presence. All such testing is at the Contractor's sole expense.
2. If the counterpoise or ground grid conductors incur damage, or be suspected of being damaged by construction activities, the Contractor tests the conductors for continuity with a low resistance ohmmeter. Isolate the conductors so that no parallel path exists and tested for continuity. The RPR must approve the test method selected. All such testing is at the Contractor's sole expense.

108-3.10.2 After installation, the Contractor tests and demonstrates the following to the RPR's satisfaction.

1. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.
2. That all affected circuits (existing and new) are free from unspecified grounds.
3. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than **[__]** megohms. Verify continuity of all series airfield lighting circuits prior to energization.

****

Engineers determine minimum insulation resistance value based upon system design criteria and area experience. Minimum value is that recommended in AC 150/5340-26.

****

4. 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.
5. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.
6. That all affected circuits (existing and new) are operable. Conduct tests that include operating each control not less than ten times and the continuous operation of each lighting and power circuit for not less than ½ hour.
7. That the impedance to ground of each ground rod does not exceed **[__]** ohms prior to establishing connections to other ground electrodes. Use the fall-of-potential ground impedance test, 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. Submit test equipment and its calibration sheets for review and RPR approval prior to performing the testing.

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Engineers determine maximum earth resistance value (25 ohm is maximum value permitted). Design and install the earth resistance value to minimize the ground potential rise and to protect people or equipment under normal and fault conditions.

****

108-3.10.3 The Contractor supplies the RPR with two copies of tabulated results of all cable tests performed. Where connecting new cable to existing cable, perform insulation resistance tests 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.

108-4 METHOD OF MEASUREMENT

108-4.1 **[** Measure trenching by the linear feet (meters) of trench, including the excavation, backfill, and restoration, completed, measured as excavated, and accepted as satisfactory. When specified, make separate measurements for trenches of various specified widths. **]**

[The cost of all excavation, backfill, dewatering and restoration regardless of the type of material encountered is included in the unit price bid for the work. **]**

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The Engineer selects whether trenching is measured separately or included in the cable or counterpose installation. Modify paragraphs 108-4.1 and 108-5.1 accordingly.

****

108-4.2 Measure cable or counterpoise wire installed in trench, duct bank, or conduit by the number of linear feet (meters) installed and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory. Make separate measurements for each cable or counterpoise wire installed in trench, duct, bank, or conduit. The measurement for this item **[** will **|** will not **]** be included additional quantities required for slack.

****

The Engineer decides if the quantity of cable provided in the bid tabulations includes an estimated quantity for slack. If so, this should be clearly identified on the plans and specifications. If not, add the following language at the end of paragraph 108-4.2:

"Cable and counterpoise slack is considered incidental to this item and is included in the Contractor's unit price. No separate measurement or payment will be made for cable or counterpoise slack."

****

108-4.3 No separate payment is made for ground rods.

108-5 BASIS OF PAYMENT

108-5.1 Payment is 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 the RPR accepted. This price is 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 is made under:

Item L-108-5.1	Trenching for direct-buried cable, 18-inch minimum depth - per linear foot (meter)
Item L-108-5.2	**[** No. 8 AWG **|** No. 6 AWG **], [** 5 kV **|** 600V **]**, L-824, **[** Type C **|** Type B **]** Cable, Installed in Trench, Duct Bank or Conduit - per liner foot (meter)

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Engineer to specify appropriate size of cable. If more than one size is required on the project, provide additional item numbers, one for each size and type.

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Item L-108-5.3	No. **[** 6 **|** 4 **|** 2 **]** AWG, Solid, Bare Copper Counterpoise Wire, Installed **[** in Trench **]**,

	[Above the Duct Bank or Conduit **]**, Including Connections/Terminations - per linear foot (meter)
Item L-108-5.4	No. **[** 6 **|** 4 **|** 2 **]** AWG, **[** Bare **|** Insulated **]**, Stranded Equipment **[** bonding **|** Ground **]**, Installed in Duct Bank or Conduit – per linear foot (meter).

108-6 REFERENCES

108-6.1 This list of publications forms 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 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

109-1 DESCRIPTION

109-1.1 This item consists of **[** `removing an existing airport transformer vault and equipment and;` **]** constructing an airport transformer vault or a prefabricated metal housing per these specifications and per the design and dimensions shown in the plans. This work includes the installation of conduits in the floor and foundation, painting and lighting of the vault or metal housing, and the furnishing of all incidentals that are necessary to produce a completed unit. Included as a separate part under this item, or as a separate item where an existing vault is to be used, is the furnishing of all vault equipment, wiring, electrical buses, cable, conduit, potheads, and grounding systems. This work must also include the painting of equipment and conduit; the marking and labeling of equipment and the labeling or tagging of wires; the testing of the installation; and the furnishing of all incidentals necessary to place it in operating condition as a completed unit to the RPR's satisfaction.

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When removal of an existing airport transformer vault and associated equipment is required as a part of the project, the Engineer edits the specification as necessary to cover removal, disposal, and ownership. Include necessary details and information on the plans and specifications.

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109-2 EQUIPMENT AND MATERIALS

109-2.1 General.

109-2.1.1 Airport lighting equipment and materials covered by Advisory Circulars (AC) must be certified in AC 150/5345-53, *Airport Lighting Equipment Certification Program (ALECP)*, and listed in the ALECP Addendum.

109-2.1.2 All other equipment and materials covered by other referenced specifications must be subject to acceptance through manufacturer's certification of compliance with the applicable specification when the RPR requested.

109-2.1.3 Manufacturer's certifications do not relieve the Contractor of the responsibility to provide materials per these specifications. Remove materials supplied and/or installed not complying with these specifications (when the RPR directs) and replace with material complying with these specifications at the Contractor's cost.

109-2.1.4 Submit all materials and equipment used to construct this item to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings must be provided. Present submittal data 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 must identify the equipment to which they apply on each submittal sheet. Make markings 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.

109-2.1.5 The data submitted must be sufficient, in the RPR's opinion, to determine compliance with the plans and specifications. The Contractor's submittals must be **[** `neatly bound in a properly sized 3-ring binder, tabbed by specification section.` **|**`provided in electronic pdf format, tabbed by specification section.` **]** The RPR reserves the right to reject any and all equipment, materials or procedures not meeting the system design and the standards and codes, specified in this document.

109-2.1.6 All equipment and materials furnished and installed under this section must be guaranteed against defects in materials and workmanship for a period of at least **[** `twelve months` **]** from final acceptance by the Owner. At the Owner's discretion, repair and replace defective materials and/or equipment, at the Owner's discretion, with no additional cost to the Owner.

****

The Engineer should specify the form in which submittals are to be received and number of copies.

The length of time for guarantee of materials and workmanship should be as stated in the contract between the Owner and Contractor and the contract special provisions.

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109-3 CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-3.1 Electrical Vault Building.

The electrical vault building must comply with NEC Article 110.31, Enclosure for Electrical Installations, Item (A) Electrical Vaults. Construct the building of materials having adequate structural strength for the conditions and installed location, has a minimum fire rating of two or three hours as determined by the authority having jurisdiction (AHJ), and is bullet resistant to minimum UL 752 Level 4.

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Include appropriate details on the plans. For additional information see AC 150/5340-30, *Design and Installation Details for Airport Visual Aids*.

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109-3.2 Concrete.

[`Proportion, place, and cure concrete per Item P-610, Concrete for Miscellaneous Structures.` **]**

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If P-610 is not used elsewhere on the project, it is acceptable to replace this paragraph with the following:

Proportion, place, and cure concrete per State Department of transportation (DOT) structural concrete with minimum 25% Type F coal ash, and a minimum allowable compressive strength of 4,000 psi (28 MPa).

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109-3.3 Precast Concrete Structures.

A plant meeting National Precast Concrete Association Plant Certification Program Precast concrete structures, or another RPR approved third party, must furnish certification program. Precast concrete structures must conform to ASTM C478.

109-3.4 Reinforcing Steel.

Reinforcing steel bars must be intermediate or structural grade deformed-type bars and per ASTM A615.

109-3.5 Brick.

Brick must be per ASTM C62, Grade SW.

109-3.6 Rigid Steel Conduit.

Rigid steel conduit and fittings must be per Underwriters Laboratories Standards 6 and 514B.

109-3.7 Plastic Conduit and Fittings.

Plastic Conduit and fittings must 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 must be of a vapor-proof type.

109-3.9 Outlets.

Convenience outlets must be heavy-duty duplex units designed for industrial service.

109-3.10 Switches.

Vault or metal-housing light switches must be single-pole switches.

109-3.11 Paint.

1. Priming paint for non-galvanized metal surfaces must be a high solids alkyd primer compatible with the manufacturer’s recommendations for the intermediate or topcoat.
2. White paint for body and finish coats on metal and wood surfaces must be ready-mixed paint conforming to the Master Painters Institute (MPI), Reference #9, Exterior Alkyd, Gloss.
3. Priming paint for wood surfaces must be mixed on the job by thinning the specified white paint by adding ½ pint (0.24 liter) of raw linseed oil to each gallon (liter).
4. Paint for the floor, ceiling, and inside walls must be per Porter Paint Company 69, 71, and 79 or equivalent. Walls and ceiling must be light gray and the floor must be medium gray.
5. The roof coating must 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 must be ⅛ × ¾ inch (3 × 19 mm) minimum copper bus bar.

109-3.13 Square Duct.

The duct must be square like 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 must consist of hinged or removable cover for ready access to the interior. The cross-section of the duct must be not less than 4 × 4 inch (100 × 100 mm) except where otherwise shown in the plans.

109-3.14 Ground Rods.

Ground rods must be according to Item L-108.

109-3.15 Vault Prefabricated Metal Housing.

The prefabricated metal housing must 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 must 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 must be supplied. In all cases, equipment must be new and a first-grade product. Supply equipment must be in the quantities required for the specific project and incorporate the electrical and mechanical characteristics specified in the proposal and plans. Equipment the Contractor selects and installs by the Contractor maintains the interrupting current rating of the existing systems or specified rating whichever is greater.

109-3.18 Electrical Wire and Cable.

Wire (in conduit) rated up to 5,000 volts must be per AC 150/5345-7, *Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits*. For ratings up to 600 volts, use moisture and heat resistant thermoplastic wire conforming to Commercial Item Description A-A-59544A Type THWN-2. The wires must be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

109-3.18.1 Control Circuits.

Unless otherwise indicated on the plans, wire must be not less than No. 12 American wire gauge (AWG) and must be insulated for 600 volts. If telephone control cable is specified, use No. 19 AWG telephone cable per ANSI/Insulated Cable Engineers Association (ICEA) S-85-625 specifications.

109-3.18.2 Power Circuits.

1. 600 volts maximum – Wire must be No. 6 AWG or larger and insulated for at least 600 volts.
2. 3,000 volts maximum – Wire must be No. 6 AWG or larger and insulated for at least 3,000 volts.
3. Over 3,000 volts-Wire must 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, based upon the equipment provided, includes as a part of the submittal process the electrical system “Short Circuit/Coordination/Device evaluation/Arc Flash Analysis”. Perform the analysis by the equipment manufacturer and submitted in a written report. Sign and seal the analysis by a registered professional Engineer from the state in which the project is located. The analysis must 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 must perform data gathering for analysis completion and device settings, perform device setting as recommended by the analysis, and furnish and install the arc flash labels. The components worst case incident energy is considered the available arc flash energy at that specific point in the system. Submit three written copies and one electronic copy of the report.

109-4 CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-4.1 General.

The Contractor must construct the transformer vault or prefabricated metal housing at the location indicated in the plans. Use reinforced concrete, concrete masonry, or brick wall for vault construction, as specified. The metal housing must be prefabricated equipment enclosure to be supplied in the size specified. The mounting pad or floor details, installation methods, and equipment placement are shown in the plans. Furnish precast concrete structures by a plant meeting National Precast Concrete Association Plant Certification Program or another Engineer-approved third party certification program.

The Contractor must clear, grade, and seed the area around the vault or metal housing for a minimum distance of 10 feet (3 m) on all sides. The slope must not be any less than ½ inch per foot (12 mm per 0.3 m) away from the vault or metal housing in all directions. The vault must provide adequate protection against weather elements, including rain, wind-driven dust, snow, ice and excessive heat. The vault must have sufficient filtered ventilation, to ensure that the interior room temperatures and conditions do not exceed the recommended limits of the electrical equipment to be installed in the vault. The Contractor is responsible for contacting the manufacturer of the equipment to be installed to obtain environmental limitations of the equipment to be installed. **[** `Refer to the electrical vault detail plan sheets for construction requirements. The prefabricated building must include roof, walls, and floor according to the details and these specifications.` **]**

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The electrical vault must provide reasonable protection of the equipment that it is intended to house. Because most of the equipment located in the vault is likely housed in NEMA 1 enclosures, the vault itself must be designed to provide sufficient protection against weather elements.

Assure that the vault that is to be supplied has sufficient environmental controls to provide adequate ventilation to maintain temperatures within operational requirements of the equipment to be installed. In addition, make sure that vault has sufficient seals and/or filters on doors and other openings to assure that wind-driven dust does not affect the operation of equipment.

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109-4.2 Foundation and Walls.

109-4.2.1 Reinforced Concrete Construction.

The Contractor must construct the foundation and walls per the details shown in the plans. Unless otherwise specified, internal ties must be of the mechanical type so that when the forms are removed the ends of the ties must be at least 1 inch (25 mm) beneath the concrete surface; the holes must be plugged and finished to prevent discoloration. Reinforcing steel must be placed, as shown in the drawings, and secured in position to prevent displacement during the concrete placement. Thoroughly work the external surfaces of the concrete during placing operations to force all coarse aggregate from the surface. Thoroughly work the mortar against the forms to produce a smooth finish free from air pockets and honeycomb.

Remove the surface film of all pointed surfaces before setting occurs. As soon as the pointing has set sufficiently, thoroughly wet with water the entire surface inside and outside of the vault and rub with a No. 16 carborundum stone, or equivalent quality abrasive, bringing the surface to a paste. Remove all form marks and projections. Ensure the produced surface is smooth and dense without pits or irregularities. Uniformly spread or brush materials ground into a paste during the rubbing process over the entire surface (except the interior surfaces to be painted have all paste removed by washing before painting) and permitted to reset. Obtain the final exterior finish by rubbing with No. 30 carborundum stone, or an equivalent quality abrasive. Rub the surface until the entire surface is smooth and uniform in color.

109-4.2.2 Brick and Concrete Construction.

When this type of construction is specified, the foundation must be concrete conforming to the details shown in the plans. The outer edge of the foundation at the floor level must be beveled 1½ inches (38 mm) at 45 degrees. Brick walls must be 8 inches (200 mm) thick, laid in running bond with every sixth course a header course. Brick must be laid in cement mortar (one part masonry cement and three parts sand) with full mortar bed and shoved joints. Completely fill all joints with mortar, and back-parge facing brick with mortar as work progresses. Make all joints ⅜ inch (9 mm) thick, exterior joints tooled concave, and interior joints struck flush. Clean both interior and exterior brick surfaces, nail holes, cracks, and other defects filled with mortar. When specified, add a nonfading mineral pigment mortar coloring to the mortar. Set steel reinforcing bars, ⅜ inch (9 mm) in diameter and 12 inches (300 mm) long, vertically in the center of the brick wall on not more than 2 feet (60 cm) centers to project 2½ inches (60 mm) into the concrete roof slab. Lintels for supporting the brickwork over doors, windows, and louvers must consist of two 4 × 3 × ⅜-inch (100 × 75 × 9 mm) steel angles. Paint lintels with one coat of corrosion-inhibiting primer before installation and paint all exposed parts like doors and window sash after installation.

Window sills may be concrete poured in place or precast concrete as indicated in the plans. All exposed surfaces must have a rubbed finish as specified under reinforced concrete construction. After completion, scrub all interior and exterior faces of walls with a solution of muriatic acid and water in the proportions of not less than one part acid to ten parts of water. Remove all traces of efflorescence, loose mortar, and mortar stain, and wash the walls with clear water.

109-4.2.3 Concrete Masonry Construction.

When this type of construction is specified, the foundation must be concrete conforming to the details shown in the plans. The concrete masonry units must be standard sizes and shapes and conform to ASTM C90 and include the closures, jambs, and other shapes required by the construction as shown in the plans. Follow standard construction practice for this type of work including mortar, joints, reinforcing steel for extensions into roof slab, etc. Plaster for interior walls, if specified, must be Portland Cement plaster.

109-4.3 Roof.

The roof must be reinforced concrete as shown in the plans. Place reinforcing steel as shown in the drawing and secure in position to prevent displacement during the concrete pouring. Pour the concrete monolithically and free of honeycombs and voids. The surface is a steel-troweled finish and sloped as shown in the drawing. Finish the underside of the roof slab in the same manner as specified for walls. Apply one brush or mop coat of hot asphalt roof coating to the top surface of the roof slab. Heat the asphalt material to within the range specified by the manufacturer and immediately applied to the roof. The finished coat must be continuous over the roof surface and free from holidays and blisters. Remove smears and dribbles of asphalt on the roof edges and building walls.

109-4.4 Floor.

Construct building foundation according to the details shown in the plans. The floor must be reinforced concrete as shown in the drawings. When present, remove all sod, roots, refuse, and other perishable material from the area under the floor to a depth of 8 inches (200 mm), unless a greater depth is specified in the invitation for bids. Backfill this area with materials consisting of sand, cinders, gravel, or stone. Place fill in layers not to exceed 4 inches (100 mm) and thoroughly compact by tamping or rolling. Place a layer of building paper over the fill prior to placing concrete. The floor surfaces must have a steel-troweled finish. The floor must be level unless a drain is specified, in which case the floor must be pitched ¼ inch (6 mm) per foot downward toward the drain. Place a ¼-inch (6-mm) asphalt felt expansion joint between floor and foundation walls. Pour the floor monolithically and ensure it is free of honeycombs and voids.

109-4.5 Floor Drain.

If shown in the plans, install a floor drain and dry well in the center of the floor of the equipment room. Excavate the dry well 4 × 4 feet (1.2 × 1.2 m) square and to a depth of 4 feet (1.2 m) below the finished floor elevation and backfill to the elevation of the underside of the floor with gravel - which must pass a 2-inch (50 mm) mesh sieve and be retained on a ¼-inch (6.3 mm) mesh sieve. Place the gravel backfill in 6-inch (150 mm) maximum layers, and tamp the entire surface of each layer with a mechanical tamper or with a hand tamper weighing not less than 25 lbs (11 kg) and having a face area of not more than 36 square inches (232 square cm) or less than 16 square inches (103 square cm). Set the drain inlet flush in the concrete floor. The drain must have a clear opening of not less than 8 inches (200 mm) in diameter.

109-4.6 Conduits in Floor and Foundation.

Install conduits in the floor and through the foundation walls per the details shown in the plans. Paint all underground conduit with an asphalt compound. Install conduit with a coupling or metal conduit adapter flush with the top of the floor. Close all incoming conduit with a pipe plug to prevent the entrance of foreign material during construction. Leave space conduit entrances closed.

109-4.7 Doors.

Doors must be metal-clad fireproof Class A (three-hour rated) doors conforming to requirements of the National Electrical Code (NEC) and local electrical codes. Install panic bar exit hardware per NEC requirements. Refer to the new electrical vault detail plan sheets for construction requirements.

109-4.8 Painting.

Give the floor, ceiling, and inside walls of concrete construction a hardening treatment, after which the Contractor applies two coats of paint as specified below, except that interior face brick walls need not be painted. The hardening treatment consists of applying two coats of either a commercial floor hardener or a solution made by dissolving 2 lbs (0.9 kg) of magnesium fluorosilicate or zinc sulfate crystals in one gallon (liter) of water. Allow each coat to dry at least 48 hours before the next application. After the second treating coat has dried, brush the surfaces clean of all crystals and thoroughly wash with clear water. Paint for walls and ceiling must be a light gray color the RPR approved. The floor paint must be a medium gray color the RPR approved. Surfaces must be dry and clean before painting. Thin the first coat by adding $^{2}/_{3}$ quart (0.63 liters) of spar varnish and ⅓ quart (0.31 liters) of turpentine to each gallon (liter) of paint. Apply the second coat without thinning. Clean all doors, lintels, and windows to remove any rust or foreign material. Give one body and one finish coat of white paint. Give bare metal surfaces a prime coat of corrosion-inhibiting primer prior to the body and finish coats.

109-4.9 Lights and Switches.

The Contractor furnishes and installs a minimum of two duplex convenience outlets in the vault room. Where a control room is specified, install at least two duplex outlets.

109-5 INSTALLATION OF EQUIPMENT IN VAULT OR PREFABRICATED METAL HOUSING

109-5.1 General.

The Contractor furnishes, installs, and connects all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to ensure a complete and operable electrical distribution center for the airport lighting system as specified and shown in the plans. When specified, an emergency power supply and transfer switch is provided and installed. The equipment installation and mounting must comply with the requirements of the National Electrical Code and local code agency having jurisdiction. All electrical work must comply with the NEC and local code agency having jurisdiction including the separation of under 600V work from 5,000V work.

109-5.2 Power Supply Equipment.

Furnish and install transformers, regulators, booster transformers, and other power supply equipment items at the location shown in the plans or as the RPR directed. Set the power supply equipment on steel “H” sections, “I” beams, channels, or concrete blocks to provide a minimum space of 1½ inch (38 mm) between the equipment and the floor. Place the equipment so it does not obstruct the oil-sampling plugs of the oil-filled units and do not obscure nameplates, as much as possible. If specified in the plans and specifications, furnish, and install equipment for an alternate power source or an emergency power generator. The alternate power supply installation includes all equipment, accessories, an automatic changeover switch, and all necessary wiring and connections. The emergency power generator set must be the size and type specified.

109-5.3 Switchgear and Panels.

Oil switches, fused cutouts, relays, transfer switches, panels, panel boards, and other similar items must be furnished and installed at the location shown in the plans or as the RPR directed. Attach wall or ceiling mounted items to the wall or ceiling with galvanized bolts of not less than ⅜-inch (9 mm) diameter engaging metal expansion shields or anchors in masonry or concrete vaults.

109-5.4 Duct and Conduit.

The Contractor furnishes and installs square type exposed metallic ducts with hinged covers for the control circuits in the vault. Mount these ducts along the walls behind all floor-mounted equipment and immediately below all wall-mounted equipment. Place the hinged covers to open from the front side with the hinges at the front bottom. Install wall brackets for square ducts at all joints 2 feet (60 cm) or more apart with intermediate brackets as specified. Use conduit between square ducts and equipment or between different items of equipment when the equipment is designed for conduit connection. When the equipment is not designed for conduit connection, conductors must enter the square-type control duct through insulating bushings in the duct or on the conduit risers.

109-5.5 Wiring and Connections.

The Contractor must make all necessary electrical connections in the vault per the project plans and specifications or wiring diagrams from the equipment manufacturer; any changes must be approved by the RPR. In wiring to the terminal blocks, the Contractor must leave sufficient extra length on each control lead for future changes in connections at the terminal block. Accomplish this by running each control lead the longest way around the box to the proper terminal. Neatly lace leads in place.

109-5.6 Marking and Labeling.

Tag all equipment, control wires, terminal blocks, etc., marked or labeled as specified below.

109-5.6.1 Wire Identification.

The Contractor furnishes and installs 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, must be of the self-sticking preprinted type and of the manufacturer's recommended size for the wire involved. Identification -markings designated in the plans must be followed. Tags, if used, must be of fiber not less than ¾ inch (19 mm) in diameter and not less than $^{1}/_{32}$ inch (1 mm) thick. Identification markings designated in the plans must be stamped on tags by means of small tool dies. Each tag must be securely tied to the proper wire by a nonmetallic cord.

109-5.6.2 Labels.

The Contractor stencils 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 must not be less than 1 inch (25 mm) in height and be of proportionate width. The Contractor also marks the correct circuit designations per the wiring diagram on the terminal marking strips, which are a part of each terminal block.

109-6 METHOD OF MEASUREMENT

109-6.1 The quantity of vaults to be paid for under this item consists of the number of vaults constructed in place and accepted as a complete unit.

109-6.2 The quantity of prefabricated metal housings to be paid for under this item consists of the number of housings constructed in place and accepted as a complete unit.

109-6.3 The quantity of equipment to be paid for under this item consists of all equipment installed, connected and accepted as a complete unit ready for operation within an existing vault or prefabricated metal housing.

109-7 BASIS OF PAYMENT

109-7.1 Payment is made at the contract unit price for each completed and accepted vault or prefabricated metal housing equipment installation. This price is 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 is made under:

Item L-109-7.1	Construction of Airport Transformer Vault in Place - per unit
Item L-109-7.2	Installation of Airport Transformer Vault Equipment in Place - per unit
Item L-109-7.3	Construction of **[** `Prefabricated Metal Housing` **|** `Prefabricated Concrete Building` **]** and Foundation in Place - per unit
Item L-109-7.4	Installation of Equipment within existing vault or prefabricated metal housing in Place - per unit

109-8 REFERENCES

109-8.1 This list of publications forms 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 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 Painters 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

110-1 DESCRIPTION

110-1.1 This item consists 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 includes furnishing and installation of all underground electrical duct banks and individual and multiple underground conduits **[** `and removal of existing duct banks` **]**.

It also includes all turfing 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 also includes 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.

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When removal of existing electrical duct banks and associated equipment is required as a part of the project, the Engineer edits the specification as necessary to cover removal, disposal, and ownership. Include necessary details and information on the plan's specifications.

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110-2 EQUIPMENT AND MATERIALS

110-2.1 General.

110-2.1.1 All equipment and materials covered by referenced specifications is subject to acceptance through manufacturer's certification of compliance with the applicable specification when the RPR requested.

110-2.1.2 Manufacturer's certifications do not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the RPR. Remove materials supplied and/or installed not complying with these specifications when the RRP directs and replace with materials that do comply with these specifications, at the Contractor's cost.

110-2.1.3 Submit all materials and equipment used to construct this item to the RPR for approval prior to ordering the equipment. Provide submittals consisting of marked catalog sheets or shop drawings. Present submittal data 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 must identify the equipment for which they apply on each submittal sheet. Make markings 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.

110-2.1.4 The data submitted must be sufficient, in the RPR's opinion, to determine compliance with the plans and specifications. The Contractor's submittals must be **[** `neatly bound in a properly sized 3-ring binder, tabbed by specification section.` | `electronically submitted in pdf format, tabbed by specification section.` **]** The RPR reserves the right to reject any and all equipment, materials or procedures not meeting the system design and the standards and codes specified in this document.

110-2.1.5 All equipment and materials furnished and installed under this section must be guaranteed against defects in materials and workmanship for a period of at least **[** `twelve months` **]** from final acceptance by the Owner. The defective materials and/or equipment must be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

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The Engineer specifies the form in which submittals are to be received and number of copies. The length of time for guarantee of materials and workmanship should be as stated in the contract between the Owner and Contractor and the contract special provisions.

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110-2.2 Steel Conduit.

Rigid galvanized steel (RGS) conduit and fittings must be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories (UL) Standards 6, 514B, and 1242. Paint all RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments with a 10-mil thick coat of asphaltum sealer or a factory-bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel must be coated with 10 mils of asphaltum sealer. Exercise care when using PVC coated RGS conduit, so not to damage the factory PVC coating. Repair damaged PVC coating per the manufacturer's written instructions. In lieu of PVC coated RGS, corrosion wrap tape must be permitted to be used where RGS is in contact with direct earth."

110-2.3 Plastic Conduit.

Plastic conduit and fittings must conform to the following requirements:

1. UL 514B covers W-C-1094-Conduit fittings all types, Classes 1 through 3 and 6 through 10.
2. UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
3. UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
4. UL 651A covers W-C-1094-Rigid PVC Conduit and high-density polyethylene (HDPE) Conduit type III and Class 4.
5. Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code (NEC) must 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 is as recommended by the conduit/fitting manufacturer.

110-2.4 Split Conduit.

Split conduit must be pre-manufactured for the intended purpose and be made of steel or plastic.

110-2.5 Conduit Spacers.

Conduit spacers must be prefabricated interlocking units manufactured for the intended purpose. They must be of double wall construction made of high-grade, high-density polyethylene complete with interlocking cap and base pads. They must be designed to accept No. 4 reinforcing bars installed vertically.

110-2.6 Concrete.

`[ Concrete must be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. ]`

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If P-610 is not used elsewhere on the project, it is acceptable to replace this paragraph with the following:

Concrete must be proportioned, placed, and cured per state department of transportation structural concrete with minimum 25% Type F coal ash, and a minimum allowable compressive strength of 4,000 psi (28 MPa).

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110-2.7 Precast Concrete Structures.

Precast concrete structures must be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program. Precast concrete structures must conform to ASTM C478.

110-2.8 Flowable Backfill.

Flowable material used to back fill conduit and duct bank trenches must 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 must be polyethylene film with a metallized foil core and be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

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Specify color and legend.

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110-3 CONSTRUCTION METHODS

110-3.1 General.

The Contractor must install underground duct banks and conduits in the locations shown on the plans unless changes have been approved by the RPR. Duct banks and conduits must be of the size, material, and type indicated on the plans or specifications. When no size is indicated on the plans or in the specifications, conduits must not be any less than 2 inches (50 mm) inside diameter or comply with the NEC based on the cable to be installed, whichever is larger. All duct bank and conduit lines must be laid to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades must 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 must be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Avoid pockets or traps where moisture may accumulate. Under pavement, the top of the duct bank must not be less than 18 inches (0.5 m) below the subgrade; in other locations, the top of the duct bank or underground conduit not be any less than 18 inches (0.5 m) below finished grade.

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For a closed conduit/duct bank system, the system should be designed to be connected to, and thus drain into, the airfield storm drainage system.

The Engineer needs to be careful to define the term "subgrade" as it relates to pavement construction. In areas of pavement construction requiring the placement of embankment, or in areas requiring over-excavation to remove unsuitable material, the desired location of the top of the duct bank needs to be clearly identified in areas susceptible to frost, the top of the duct bank should be placed at or below the level of the frost line.

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The Contractor must mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than ¼ inch (6 mm) smaller than the bore of the conduit must be pulled or pushed through each conduit. The mandrel must have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor must 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 must 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 must be recleaned at the Contractor's expense. All accessible points must be kept closed when not installing cable. The Contractor must verify existing ducts proposed for use in this project as clear and open. The Contractor notifies the RPR of any blockage in the existing ducts.

For pulling the permanent wiring, provide each individual conduit, whether the conduit is direct-buried or part of a duct bank, with a 200-pound (90 kg) test polypropylene pull rope. Secure the ends and leave sufficient length in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, plug the open ends with removable tapered plugs, designed for this purpose.

Securely fasten all conduits fastened in place during construction and plug to prevent contaminants from entering the conduits. Do not install any conduit section having a defective joint. Ducts must be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m). Unless otherwise shown on the plans, use concrete encased duct banks 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, encase conduit and duct banks using flowable fill for protection. Terminate all conduits within concrete encasement of the duct banks 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, carefully strip and properly store it.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case excavate with mechanical trenching equipment. Walls of trenches must be essentially vertical so that a minimum of shoulder surface is disturbed. Do not use blades of graders to excavate the trench. When rock is encountered, remove the rock to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth, and replace it with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a ¼-inch (6.3 mm) sieve. Alternatively, use flowable backfill.

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The Engineer determines the type of soil or rock to be excavated and, if rock is indicted to be encountered, indicate on the plans.

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Install underground electrical warning (Caution) tape in the trench above all underground duct banks and conduits in unpaved areas. The Contractor submits a sample of the proposed warning tape for RPR approval. If not shown on the plans, locate the warning tape 6 inches above the duct/conduit or the counterpoise wire if present. Prepare joints in plastic conduit per the manufacturer’s recommendations for the conduit type. Pre-prepare plastic conduit by applying a plastic cleaner, and brushing a plastic solvent on the outside of the conduit ends and the inside of the couplings. Slip the conduit fitting 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, stagger joints in the conduit a minimum of 2 feet (60 cm).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, must 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 the RPR determined, remove the unsuitable material per Item P-152 and replace with suitable material. Install additional duct bank supports as the RPR approved. All excavation must be unclassified and is 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, remove, and dispose of excavated materials the RPR deems unsuitable for use in backfill or embankments offsite. Fill any excess excavation with suitable material the RPR approved 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 must ensure that these cables are adequately protected. Where crossings are unavoidable, no splices are permitted in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur must proceed as follows:

1. Manually located existing cable. Inspect unearthed cables to ensure absolutely no damage has occurred.
2. Trenching, etc., in areas of existing cables must proceed with care to minimize potential for damage or disruption. Prior to proceeding with excavation in areas of existing cables, the RPR must approve the means and methods of excavation, installation, and backfill.

110-3.2 Duct Banks.

Unless otherwise shown in the plans, install duct banks 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 when 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 must 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 must 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 must be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. The Contractor spaces the conduits not less than 3 inches (75 mm) apart (measured from outside wall to outside wall). Place all such multiple conduits using conduit spacers applicable to the type of conduit. As the conduit laying progresses, place concrete around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. Terminate all conduits 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.

Install conduits forming the duct bank using conduit spacers. Do not drive any No. 4 reinforcing bars 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, fasten down the spacers with locking collars attached to the vertical bars. Install spacers at 5-foot (1.5-m) intervals. Spacers must be in the proper sizes and configurations to fit the conduits. Submit locking collars and spacers to the RPR for review prior to use.

When specified, the Contractor reinforces the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor supplies additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, support the complete duct structure on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals. All pavement surfaces to have ducts installed musts be neatly saw cut to form a vertical face. All excavation must 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 three 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, carefully locate and expose the cable by hand tools. Prior to being placed in duct, notify the RPR so that he may inspect the cable and determine that it is in good condition. Where required, split duct must be installed as shown on the drawings or as the RPR required.

110-3.3 Conduits Without Concrete Encasement.

Trenches for single-conduit lines must be not less than 6 inches (150 mm) or more than 12 inches (300 mm) wide. The trench for two or more conduits installed at the same level must be proportionately wider. Trench bottoms for conduits without concrete encasement must be made to conform accurately to grade to provide uniform support for the conduit along its entire length.

Unless otherwise shown on the plans, place a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) in the bottom of the trench as bedding for the conduit. The bedding material must consist of soft dirt, sand, or other fine fill, and must not contain any particles that would be retained on a ¼-inch (6.3 mm) sieve. Tamp the bedding material until firm. Flowable backfill may alternatively be used. Unless otherwise shown on plans, conduits must 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. Install conduits outside the Airport’s secured area 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 must 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 must be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and lot less than 6 inches (150 mm) apart in a vertical direction.

Open trenches 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. Install conduits using conduit spacers. Drive No. 4 reinforcing bars vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, fasten down the spacers with locking collars attached to the vertical bars. Install spacers at 5-foot (1.5-m) intervals. Spacers must be in the proper sizes and configurations to fit the conduits. Submit locking collars and spacers to the RPR for review prior to use.

110-3.4 Markers.

The location of each end, each change of direction of conduits, and duct banks is marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately 1 inch (25 mm) above the surface. Locate the markers directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Mark each cable or duct run from a line of lights and signs to the equipment vault 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 must impress the word “DUCT” or “CONDUIT” on each marker slab. The RPR must approve the impression of letters, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, give all markers one coat of high-visibility orange paint, as the RPR approved. The Contractor must also impress on the slab the number and size of conduits beneath the marker, along with all other necessary information the RPR determined. The letters must be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke ½ inch (12 mm) and ¼ 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) must be placed around the conduits ducts and carefully tamped around and over them with hand tampers. Backfill and compact the remaining trench per Item P-152, except that material used for back fill must be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used. Trenches must not contain pools of water during back filling operations. Completely backfill and tamp level the trench with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling must stop at a depth equal to the thickness of the sod to be used, with proper allowance for settlement. Remove and dispose of any excess excavated material per the RPR’s instructions.

110-3.6 Backfilling for Duct Banks.

After the concrete has cured, backfill and compact the remaining trench per Item P-152 “Excavation and Embankment” except the material used for backfilling must 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, make one moisture/density test per lift each 250 linear feet (76 m) of duct bank or one work period’s construction, whichever is less.

Alternatively, use flowable backfill. Trenches must not contain pools of water during backfilling operations. Completely backfill and tamp level the trench with the adjacent surface; except where sod is to be placed over the trench. If sod is placed over the trench, stop backfilling at a depth equal to the thickness of the sod being used, with proper allowance for settlement. Remove and dispose any excess excavated material of per the RPRs instructions.

110-3.7 Restoration.

Where sod has been removed, replace it as soon as possible after the backfilling is completed. Restore any areas disturbed by the work to its original condition. The restoration must include **[** `sodding` **|** `topsoiling` **|** `fertilizing` **|** `liming` **|** `seeding` **|** `sprigging` **|** `mulching` **]** shown on the plans. The Contractor is held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration must be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor thoroughly visually inspects the area for foreign object debris (FOD) and removes any such FOD that is found. This FOD inspection and removal is considered incidental to the pay item of which it is a component part.

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The Engineer specifies the correct method of turfing and includes in the construction documents the appropriate FAA turfing specification for restoration related to the installation of such duct banks and conduits.

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110-3.8 Ownership of Removed Cable. [__]

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The ownership of any cable to be removed should be specified in this section. If the Owner retains, specify how the removed cable is to be coiled, banded to pallets, delivered to, etc.

****

110-4 METHOD OF MEASUREMENT

110-4.1 Underground conduits and duct banks must 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 must be made for the various types and sizes.

110-5 BASIS OF PAYMENT

110-5.1 Payment is 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 is 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 these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

****

The Engineer must show existing duct banks and conduits that require removal and disposal on the plans.

****

Payment is made under:

Item L-110-5.1 **[** `Concrete Encased` **|**`Non-Encased` **]** Electrical Duct Bank, **[** `# and Size` **]** - per linear foot (meter)

Item L-110-5.2 **[** `Concrete Encased` **|**`Non-Encased` **]** Electrical Conduit, **[** `# and Size` **]** - per linear foot (meter)

****

Select “Concrete Encased” or “Non-Encased” for the duct bank description. Electrical ducts are defined as electrical conduits suitable for use underground or embedded in concrete (but most of the time, we think of them as being concrete encased conduits). When more than the normal minimum 18-inch (0.5 m) depth is required, then list it in the pay item description. This is permitted. The specification states, “unless otherwise shown on the Plans.” This is a pay item requirement and NOT a modification to standard MOS. You may need minimum 24 inches (600 mm), then minimum 30-inch (762 mm) for secondary services, and minimum 42 inches (1 m) or 48 inches (120 cm) if installing empty conduits for utility primary30” conductors.

Examples below. Duct banks are noted to have additional minimum cover requirements, and conduits are acceptable at 18-inch (0.5 m) minimum cover. No added text is needed (unless there is conduit requiring additional minimum cover).

<u>For Duct Banks:</u>

Concrete Encased, Electrical Duct Bank, 4-Way 4-inch (100 mm) C, 24-inch (600 mm) Minimum Cover – per Linear Foot

Non-Encased, Electrical Duct Bank, 4-Way 4-inch (100 mm) C, 24-inch (600 mm) Minimum Cover – per Linear Foot

For Conduits:

Concrete Encased, Electrical Conduit, 1-Way 2-inch (50 mm) C – per Linear Foot

Non-Encased, Electrical Conduit, 1-Way 2-inch (50 mm) C – per Linear Foot

Note: The concrete utilized above would be a minimum 3000 psi up to 4000 psi concrete, as specified in Item L-110-2.6.

Note: If you have paved shoulders and are using "Flowable Fill" around the one conduit, then have a pay item for it so it is very clear the fill material being allowed.

Flowable Fill Encased, Electrical Conduit, 1-Way 2-inch (50 mm) C – per Linear Foot

Note: All markers are incidental to the cable or duct pay item.

Note: Clearing existing duct is incidental to the cable installation pay item. However, special circumstances may mean clearing existing duct pay items for existing ducts, unknown ducts, etc., especially when not re-installing a cable. It is very important to always remove old and abandoned cables and not leave them in the duct bank or conduit or handhole/manhole system. Be sure to include notes to this affect in your drawings that old and abandoned cables are removed.

****

110-6 REFERENCES

110-6.1 This list of publications forms 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)

AC 150/5340-30	*Design and Installation Details for Airport Visual Aids*
AC 150/5345-53	*Airport Lighting Equipment Certification Program*

ASTM International

ASTM A615	*Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement*

National Fire Protection Association (NFPA)

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

115-1 DESCRIPTION

115-1.1 This item consists of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the Resident Project Representative (RPR). This item includes the installation 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 RPR's satisfaction **[** `including removal of existing manholes and junction structures as shown on the plans` **]**.

****

When removal of existing electrical manholes and junction structures is required as a part of the project, the Engineer edits specification as necessary to cover removal, disposal, and ownership. Include necessary details and information on the plan's specifications.

****

115-2 EQUIPMENT AND MATERIALS

115-2.1 General.

115-2.1.1 All equipment and materials covered by referenced specifications is subject to acceptance through manufacturer's certification of compliance with the applicable specification when the RPR requests.

115-2.1.2 Manufacturer's certifications do not relieve the Contractor of the responsibility to provide materials per these specifications. When the RPR directs, remove materials supplied and/or installed not complying with these specifications and replace with materials that comply with these specifications at the Contractor's cost.

115-2.1.3 Submit all materials and equipment used to construct this item to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings must be provided. Submittal data must 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 must identify the equipment to which they apply on each submittal sheet. Make markings 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.

115-2.1.4 The data submitted must be sufficient, in the s RPR's opinion, to determine compliance with the plans and specification. The Contractor's submittals must be **[** `neatly bound in a properly sized 3-ring binder, tabbed by specification section.` |`electronically submitted in pdf format, tabbed by specification section.` **]** The RPR reserves the right to reject any and all equipment, materials or procedures not meeting the system design and the standards and codes, specified in this document.

115-2.1.5 All equipment and materials furnished and installed under this section must be guaranteed against defects in materials and workmanship for a period of at least **[** `twelve months` **]** from the date of final acceptance by the Owner. At the Owner's discretion, the defective materials and/or equipment, with no additional cost to the Owner.

****

The Engineer specifies the form in which submittals are to be received and number of copies.

The length of time for guarantee of materials and workmanship should be as stated in the contract between the Owner and Contractor and the contract special provisions.

****

115-2.2 Concrete Structures.

Concrete must be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. Cast-in-place concrete structures must be as shown on the plans.

115-2.3 Precast Concrete Structures.

Precast concrete structures must 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 must be an approved standard design of the manufacturer. Precast units must have mortar or bitumastic sealer placed between all joints to make them watertight. The structure must be designed to withstand **[[__]** `lb` `aircraft` **]** loads, unless otherwise shown on the plans. Provide openings or knockouts in the structure as detailed on the plans.

****

The Engineer specifies load characteristics for precast concrete structure based on the design aircraft. This specification's intent is for the Design Engineer to design a cast-in-place structure, detailed on the plans, suitable for the design loads and subgrade soil characteristics. If the Contractor proposes to use a substitute structure design, submit design calculations according to the procedure in the General Provisions.

****

Threaded inserts and pulling eyes must be cast as shown on the plans.

If the Contractor proposes a different structural design, sign and seal shop drawings, design calculations, and other information the RPR requested. The Contractor must submitted the plan to allow for the RPR's full evaluation. The RPR must review per the process defined in the General Provisions.

115-2.4 Junction Boxes.

Junction boxes must be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases encased in concrete. The light bases must 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 must be passivated and free from any discoloration. Covers must be ⅜-inch (9-mm) thickness for L-867 and ¾-inch (19-mm) thickness for L-868. Provide all junction boxes with both internal and external ground lugs.

115-2.5 Mortar.

The mortar composition is one part cement and two parts of mortar sand, by volume. Cement must be per the requirements in ASTM C150, Type I. The sand must 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 must meet the requirements of ASTM C206. Water must 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 must conform to the requirements of Item P-610, Concrete for Miscellaneous Structures.

115-2.7 Frames and Covers.

The frames must conform to one of the following requirements:

1. ASTM A48 Gray iron castings

2. ASTM A47 Malleable iron castings
3. ASTM A27 Steel castings
4. ASTM A283, Grade D Structural steel for grates and frames
5. ASTM A536 Ductile iron castings
6. ASTM A897 Austempered ductile iron castings

All castings specified must withstand a maximum tire pressure of **[__]** psi and maximum load of **[__]** lbs.

****

The Engineer specifies load characteristics for castings based on the design aircraft.

****

All castings or structural steel units must conform to the dimensions shown on the plans and must be designed to support the loadings specified. Provide each frame and cover the unit with fastening members to prevent it from being dislodged by traffic, but which allows easy removal for access to the structure. Thoroughly clean all castings. After fabrication, galvanize structural steel units to meet the requirements of ASTM A123.

Th word “ELECTRIC” or other approved designation. must be cast on each cover, Each frame and cover must be as shown on the plans or approved equivalent. No cable notches are required. Provide each manhole with a “DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER” safety warning sign as detailed in the Contract Documents and according to Occupational Safety and Health Administration (OSHA) 1910.146 (c)(2).

115-2.8 Ladders.

Ladders, if specified, must be galvanized steel or as shown on the plans.

115-2.9 Reinforcing Steel.

All reinforcing steel must 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 must be as shown on the plans.

115-2.11 Flowable Backfill.

Flowable material used to backfill must conform to the requirements of Item P-153, Controlled Low Strength Material.

115-2.12 Cable Trays.

Cable trays must be **[** `galvanized steel` **|**`plastic` **|**`aluminum` **]**. Cable trays must be located as shown on the plans.

****

Engineer to specify cable tray based on the type of structure and user preference.

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115-2.13 Plastic Conduit.

Plastic conduit must comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

115-2.14 Conduit Terminators.

Conduit terminators must 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 must 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, ½ inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, install a rustproof sleeve at the hooking point and encapsulate all exposed surfaces with a polyester coating to prevent corrosion.

115-2.16 Ground Rods.

Ground rods must be one piece, **[** `solid stainless steel` **|**`copper` **]** or **[** `copper clad steel` **].** The ground rods must be of the length and diameter specified on the plans, but in no case must they be less than 8 feet (2.4 m) long or less than ⅝ inch (16 mm) in diameter.

****

The Engineer should evaluate the soils in the vicinity of proposed counterpoise and ground rod installations and determine if soil conditions would adversely affect copper. The Engineer specifies the type of ground rod and counterpoise wire to be installed in consideration of the soil conditions.

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115-3 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, is repaired or replaced to the RPR’s without additional expense to the Owner. The Contractor performs excavation for structures and structure footings to the lines and grades or elevations shown on the plans or the RPR staked. The excavation must be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. All excavation is unclassified and 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.

Remove boulders, logs and all other objectionable material encountered in excavation. Clean all rock and other hard foundation material of all loose material and cut to a firm surface either level, stepped or serrated, as the RPR directed. Remove all seams, crevices, disintegrated rock, and thin strata. When concrete is to rest on a surface other than rock, take special care not to disturb the bottom of the excavation. Do not make excavation to final grade until just before the concrete or reinforcing is to be placed.

The Contractor provides 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 is included in the unit price bid for the structure. Unless otherwise provided, bracing, the Contractor removes sheeting, and shoring involved in the construction of this item after the completion of the structure. Effect removal in a manner that will not disturb, or mar finished masonry. The cost of removal is included in the unit price bid for the structure.

After each excavation is completed, the Contractor notifies the RPR. Place structures after the RPR has approved the depth of the excavation and the suitability of the foundation material. Prior to installation the Contractor provides a minimum of 6 inches (150 mm) of sand or a material the RPR approved, as a suitable base to receive the structure. At the proper elevation, compact and grade level 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.

Build concrete structures on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods must conform to the requirements specified in Item P-610. Any reinforcement required must be placed as indicated on the plans and the RPR approved before placing the concrete.

115-3.3 Precast Unit Installations.

Install precast units plumb and true. Make joints watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Remove excess sealant and severe surface projections on exterior of neck.

115-3.4 Placement and Treatment of Castings, Frames, and Fittings.

Place all castings, frames, and fittings in the positions indicated on the Plans or as the RPR directed and 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 must be in place and positioned before the concrete or mortar is placed. Do not disturb the unit until the mortar or concrete has set.

Make field connections with bolts, unless indicated otherwise. Welding is not permitted unless shown otherwise on the approved shop drawings and written approval is granted by the casting manufacturer. Erection equipment must 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 must be reported immediately to the RPR and approval of the method of correction must be obtained. Approved corrections are made at Contractor’s expense. Properly located anchor bolts and anchors build into connection work. Preset bolts and by using templates, or such other methods as may be required to locate the anchors and anchor bolts accurately. Locate pulling-in irons opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Set pulling-in irons directly into the concrete walls of the structure.

115-3.5 Ladder Installation.

Install ladders so they are removable. Supply mounting brackets top and bottom and 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, withdraw all sheeting and bracing used to support the sides of trenches or other open excavations as the trenches or other open excavations are being refilled. Withdraw that portion of the sheeting extending below the top of a structure, 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. Carefully refill voids left by the sheeting with selected material and rammed tight with tools especially adapted for the purpose or otherwise as approved. The RPR may direct the Contractor to delay the removal of sheeting and bracing if, in their 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, backfill the area around it in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Deposit each layer all around the structure to approximately the same elevation. The top of the fill must meet the elevation shown on the plans or as the RPR directed.

Do not place backfill against any structure until the RPR s approves. In the case of concrete, such approval is not given, until tests made by the laboratory under the RPR’s supervision, 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 their own expense, sufficient water during compaction to ensure a complete consolidation of the backfill. The Contractor is 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, place reinforcement rods in the structure wall and form, and tie into duct bank reinforcement at the time the duct bank is installed.

115-3.9 Grounding.

Install a ground rod in the floor of all concrete structures so the top of rod extends 6 inches (150 mm) above the floor. Install the ground rod within one foot (30 cm) of a corner of the concrete structure. Install ground rods prior to casting the bottom slab. Where soil conditions do not permit driving the ground rod into the earth without damage to the ground rod, the Contractor drills a 4-inch (100 mm) diameter hole into the earth to receive the ground rod. Fill the hole around the ground rod throughout its length, below slab, with Portland Cement grout. Install ground rods in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Watertight seal the bottom slab penetration with Portland Cement grout around the ground rod.

Exothermically bond a grounding bus of 4/0 bare stranded copper to the ground rod and loop the concrete structure walls. The ground bus must 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 pigtails must bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus must be exothermic. If an exothermic weld is not possible, make connections to the grounding bus by using connectors approved for direct burial in soil or concrete per Underwriters Laboratory (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, repair damaged areas by applying a liquid cold-galvanizing compound per MIL-P-21035. Prepare and compound surfaces applied per the manufacturer’s recommendations. Prior to acceptance, clean the entire structure of all dirt and debris.

115-3.11 Restoration.

After the backfill is completed, the Contractor disposes of all surplus material, dirt, and rubbish from the site. The Contractor restores all disturbed areas equivalent to, or better than, the original condition. All sodding, grading, and restoration is considered incidental to the respective Item L-115 pay item. The Contractor grades around structures as required to provide positive drainage away from the structure. Backfill areas with special surface treatment, such as roads, sidewalks, or other paved areas, compact to match surrounding areas, and repair surfaces using materials comparable to original materials. Following restoration of all trenching near airport movement surfaces, the Contractor thoroughly visually inspects the area for foreign object debris

(FOD) and removes any such FOD that is found. This FOD inspection and removal is considered incidental to the pay item of which it is a component part. After all work is completed, the Contractor removes all tools and other equipment, leaving the entire site free, clear and in good condition.

115-3.12 Inspection.

Prior to final approval, thoroughly inspect the electrical structures for conformance with the plans and this specification. Further investigate and correct, any indication of defects in materials or workmanship. The earth resistance to ground of each ground rod must not exceed 25 ohms. Test each ground rod using the fall-of-potential ground impedance test per American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. Perform this test prior to establishing connections to other ground electrodes.

115-3.13 Manhole Elevation Adjustments.

The Contractor adjusts the tops of existing manholes in areas designated in the Contract Documents to the new elevations shown. The Contractor is responsible for determining the exact height adjustment required to raise or lower the top of each manhole to the new elevations. Determine the existing top elevation of each manhole in the field and subtract/add from the proposed top elevation.

The Contractor removes/extends the existing top section or ring and cover on the manhole structure or manhole access. The Contractor installs precast concrete sections or grade rings of the required dimensions to adjust the manhole top to the new proposed elevation or cuts the existing manhole walls to shorten the existing structure, as required by final grades. The Contractor reinstalls the manhole top section or ring and cover on top and check the new top elevation. The Contractor constructs a concrete slab around the top of adjusted structures located in graded areas that are not to be paved. The concrete slab must conform to the dimensions shown on the plans.

****

The Engineer should require the precast sections be designed per paragraph 115-2.3.

****

115-3.14 Duct Extension to Existing Ducts.

Where extending existing concrete encased ducts, the duct extension must be concrete encased plastic conduit. The fittings to connect the ducts together must be standard manufactured connectors designed and approved for the purpose. Install the duct extensions according to the concrete encased duct detail and as shown on the plans.

115-4 METHOD OF MEASUREMENT

115-4.1 Measure electrical manholes and junction structures by each unit completed in place and accepted. The following items are 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.

115-4.2 Measure manhole elevation adjustments by the completed unit installed, in place, completed, and accepted. Separate measurement are not made for the various types and sizes.

115-5 BASIS OF PAYMENT

115-5.1 The accepted quantity of electrical manholes and junction structures is paid for at the Contract unit price per each, complete and in place. This price is 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.

115-5.2 Payment is made at the contract unit price for manhole elevation adjustments. This price is 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, including but not limited to, spacers, concrete, rebar, dewatering, excavating, backfill, topsoil, sodding, and pavement restoration, where required, to complete this item as shown in the plans and to the RPR’s satisfaction.

Payment is made under:

Item L-115-5.1	Electrical Manhole **[** `size and type` **]** - Per Each
Item L-115-5.2	Electrical Junction Structure **[** `size and type` **]** - Per Each
Item L-115-5.3	Existing Electrical Manhole/Junction Structure Elevation Adjustment **[** `size and type` **]** – Per Each
Item L-115-5.4	Electrical Handhole **[** `size and type` **]** –Per Each

115-6 REFERENCES

115-6.1 This list of publications forms 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*

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)*

ASTM International

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-119 Airport Obstruction Lights

119-1 DESCRIPTION

119-1.1 This item consists of furnishing and installing obstruction lights per these specifications. Included in this item is the furnishing and installing of wood poles, steel or iron pipes, or other supports as required in the plans or specifications and according to the requirements in Advisory Circular (AC) 70/7460-1, *Obstruction Marking and Lighting.*

This item also includes all wire and cable connections, the furnishing and installation of all necessary conduits and fittings, insulators, pole steps, pole cross arms, and the painting of poles and pipes. In addition, it includes the furnishing and installation of all lamps and, if required, the furnishing and installation of insulating transformers, the servicing and testing of the installation, and all incidentals necessary to place the lights in operation as completed units to the of the Resident Project Representative's (RPR's) satisfaction. **[** `including the removal of existing obstruction lights as shown on the plans` **]**.

****

When removal of existing airport obstruction lights and associated equipment is required as a part of the project, the Engineer edits specification as necessary to cover removal, disposal, and ownership. Include necessary details and information on the plans and specifications.

****

119-2 EQUIPMENT AND MATERIALS

119-2.1 General.

119-2.1.1 Airport lighting equipment and materials covered by specifications must be certified under AC 150/5345-53, *Airport Lighting Equipment Certification Program (ALECP),* and listed in the ALECP Addendum.

119-2.1.2 All other equipment and materials covered by other referenced specifications must be subject to acceptance through manufacturer's certification of compliance with the applicable specification when the RPR requests.

119-2.1.3 Manufacturer's certifications do not relieve the Contractor of the responsibility to provide materials per these specifications. Remove materials supplied and/or installed not complying with these specifications (when the RPR directs) and replace with materials that comply with these specifications at the Contractor's cost.

119-2.1.4 Submit all materials and equipment used to construct this item to the RPR for approval prior to ordering the equipment. Provide submittals consisting of marked catalog sheets or shop drawings. Present submittal data 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 must identify the equipment to which they apply on each submittal sheet. Make markings bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that accrue directly or indirectly from late submissions or resubmissions of submittals.

119-2.1.5 **[** The Contractor's submittals must be **[** neatly bound in a properly sized 3-ring binder, tabbed by specification section. **|** submitted electronically in pdf format, tabbed by specification section. **]]** The RPR reserves the right to reject any and all equipment, materials, or procedures not meeting the system design and the standards and codes, specified in this document.

119-2.1.6 All equipment and materials furnished and installed under this section must be guaranteed against defects in materials and workmanship for at least **[** twelve months **]** from final acceptance by the Owner. The defective materials and/or equipment must be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

****

The Engineer specifies the form in which submittals are to be received and number of copies.

****

119-2.2 Obstruction Lights.

The obstruction lighting assembly must be Type **[__]** meeting the requirements of AC 150/5345-43, *Specification for Obstruction Lighting Equipment*.

119-2.3 Isolation Transformers.

Where required for series circuits, the isolation transformers must conform to the requirements of AC 150/5345-47, *Specification for Series to Series Isolation Transformers for Airport Lighting Systems*.

119-2.4 Transformer Housing.

Transformer housings, if specified, must be per AC 150/5345-42, *Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories*.

119-2.5 Conduit.

Steel conduit and fittings must be per Underwriters Laboratories (UL) Standards 6, 514B, and 1242.

119-2.6 Plastic Conduit (For Use Below Grade Only).

Plastic conduit and fittings must be per:

- UL 514B covers W-C-1094 - Conduit fittings all types, classes 1 through 3 and 6 through 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

and must be one of the following, as shown on the plans:

- Type I–Schedule 40 PVC suitable for underground use either direct-buried or encased in concrete.
- Type II–Schedule 40 PVC suitable for either above ground or underground use.

119-2.7 Electrical Wire and Cable.

For ratings up to 600 volts, use moisture and heat resistant thermoplastic wire conforming to Commercial Item Description A-A-59544A, Type THWN-2. The wires must be of the type, size, number of conductors, and voltage shown in the plans or in the proposal. Overhead line wire from pole to pole, where specified, must be per American National Standards Institute/Insulated Cable Engineers Association (ANSI/ICEA) S-70-547-2007.

119-2.8 Miscellaneous.

Paint, poles, pole steps, insulators, and all other miscellaneous materials necessary for the completion of this item must be new and first-grade commercial products. These products must be as specified in the plans or specifications.

119-3 CONSTRUCTION METHODS

119-3.1 Obstruction Lights Placement.

The Contractor furnishes and installs single-or double-obstruction lights as specified and shown in the plans. Mount the obstruction lights on poles, buildings, or towers at approximately the location shown in the plans. The RPR must approve the exact location according to AC 70/7460-1, *Obstruction Marking and Lighting*.

119-3.2 Pole Installation.

Where obstruction lights are to be mounted on poles, each obstruction light must be installed with its hub at least as high as the top of the pole. Run all wiring in no less than 1 inch (25 mm) galvanized rigid steel conduit. If specified, furnish, and install pole steps, the lowest step being 5 feet (1.5 m) above ground level. Install steps alternately on diametrically opposite sides of the pole to give a rise of 18 inches (0.5 m) for each step. Fasten conduit to the pole with galvanized steel pipe straps and secure by galvanized lag screws. Paint poles as shown in the plans and specifications. When obstruction lights are installed on existing telephone or power poles, install a large fiber insulating sleeve of adequate diameter and not less than 4 feet (1.2 m) long, to extend 6 inches (150 mm) above the conductors on the upper cross arm. In addition, the sleeve must be at least 18 inches (0.5 m) below the conductors on the lower cross arm. The details of this installation must be per the plans.

119-3.3 Beacon Tower Installation.

Where obstruction lights are installed on a beacon tower, mount two obstruction lights on top of the beacon tower using 1 inch (25 mm) conduit. Screw the conduit directly into the obstruction light fixtures and support them at a height of not less than 4 inches (100 mm) above the top of the rotating beacon. If obstruction lights are specified at lower levels, the Contractor installs not less than 1 inch (25 mm) galvanized rigid steel conduit with standard conduit fittings for mounting the fixtures. Mount the fixtures in an upright position in all cases. Fasten the conduit to the tower members with Wraplock® straps (or equivalent), clamps, or approved fasteners spaced approximately 5 feet (1.5 m) apart. Apply three coats of international orange paint per Federal Specification 595, Number 12197 (one prime, one body, and one finish coat) to all exposed material installed.

119-3.4 Building, Tower, Smokestack Installation, etc.

Where obstruction lights are installed on buildings or similar structures, make the installation per the details shown in the plans. The hub of the obstruction light must be not less than one foot (30 cm) above the highest point of the obstruction except in the case of smokestacks where the uppermost units must be mounted not less than 5 feet (1.5 m), no more than 10 feet (3 m) below the top of the stack. Fasten conduit supporting the obstruction light units to wooden structures with galvanized steel pipe straps and secure by 1½ inch (38 mm) No. 10 galvanized wood screws. Fasten conduit to masonry structures by using expansion shields, screw anchors, or toggle bolts using No. 10, or larger, galvanized wood or machine screws. Conduit fastened to structural steel must have the straps held with not less than No. 10 roundhead machine screws in drilled and tapped holes. Fastenings must be approximately 5 feet (1.5 m) apart. Apply three coats of paint (one prime, one body, and one finish coat) with color per Federal Specification 595, international orange, number 12197 paint to all exposed material installed.

119-3.5 Series Isolation Transformers.

If designed for use in a series lighting circuit, the L-810 series obstruction light does not include a film cutout. So, an isolation transformer is required with each series lamp. Double series units of this type require two isolation transformers. House the transformer in a light base per paragraph 119-2.4 or buried directly in the earth per the details shown in the plans.

119-3.6 Wiring.

The Contractor furnishes all necessary labor and materials. The Contractor makes complete electrical connections from the underground cable or other source of power per the wiring diagram furnished with the project plans. If underground cable is required for the power feed, and if duct is required under paved areas, install the cable and duct per and paid for as described in Item L-108, Underground Power Cable for Airports, and Item L-110, Airport Underground Electrical Duct Banks and Conduit.

119-3.7 Lamps.

The Contractor furnishes and installs one or two lamps in each unit that are per the manufacturer’s requirements. Provide two lamp sets as spares.

119-3.8 Tests.

The Contractor, in the presence of the RPR, must test the installation as a completed unit by continuous operation for not less than ½ hour. In addition, each control must be used not less than 10 times.

119-4 METHOD OF MEASUREMENT

119-4.1 The quantity of lights paid for under this item is the number of single- or double-type obstruction lights installed and accepted as completed units, in place, ready for operation.

119-5 BASIS OF PAYMENT

119-5.1 Payment is made at the contract unit price for each completed obstruction light installed, in place by the Contractor, and the RPR accepted. This price is 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 is made under:

Item L-119-5.1	Airport Obstruction Light, in Place - per each

119-6 REFERENCES

119-6.1 This list of publications forms 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 70/7460-1	*Obstruction Marking and Lighting*
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 150/5345-42	*Specification for Airport Light Bases, Transformer Housing, Junction Boxes, and Accessories*
AC 150/5345-43	*Specification for Obstruction Lighting Equipment*
AC 150/5345-47	*Specification for Series to Series Isolation Transformers for Airport Lighting Systems*
AC 150/5345-53	*Airport Lighting Equipment Certification Program*

American National Standards Institute/Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/ICEA S-70-547	*Standards for Weather-Resistant Polyolefin Covered Connectors Commercial Item Description (CID)*
A-A-59544A	*Cable and Wire, Electrical (Power, Fixed Installation)*

Federal Standard (FED STD)

FED STD 595	*Colors used in Government Procurement*

National Fire Protection Association (NFPA)

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 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*

END OF ITEM L-119

Item L-125 Installation of Airport Lighting and Signs

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Use Item L-125 to indicate type of lights, signs, approach lights and other lighting equipment included in project. The plans and specifications should include sufficient information for the Contractor to procure and install any specified equipment.

Additional equipment types may be added with coordination with the Federal Aviation Administration (FAA). Delete non-applicable equipment types.

Include information in light and sign schedules in the plans.

****

125-1 DESCRIPTION

125-1.1 This item consists of airport lighting systems furnished and installed according to this specification, the referenced specifications, and the applicable Advisory Circulars (ACs). Install the systems at the locations and according to the dimensions, design, and details shown in the plans. This item includes the furnishing of all equipment, materials, services, and incidentals necessary to place the systems in operation as completed units to the satisfaction of the Resident Project Representative (RPR).

125-2 EQUIPMENT AND MATERIALS

125-2.1 General.

125-2.1.1 Airport lighting equipment and materials covered by the Federal Aviation Administration (FAA) specifications must be certified under the Airport Lighting Equipment Certification Program according to AC 150/5345-53, current version. FAA-certified airfield lighting must 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.

125-2.1.2 Manufacturer’s certifications do not relieve the Contractor of their responsibility to provide materials according to these specifications and the RPR accepts. When the RPR directs, remove materials supplied and/or installed not complying with these specifications and replace with materials, which do comply with these specifications, at the sole cost of the Contractor.

125-2.1.3 Submit all materials and equipment used, to the RPR for approval, prior to ordering the equipment. Provide submittals consisting of marked catalog sheets or shop drawings. 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 must identify the equipment to which they apply on each submittal sheet. Markings must be clearly made with arrows or circles (highlighting is not acceptable). The Contractor is responsible for delays in the project accruing directly or indirectly from late submissions or resubmissions of submittals.

125-2.1.4 The data submitted must be sufficient, in the RPR's opinion, to determine compliance with the plans and specifications. The Contractor's submittals must be submitted in **[** `a neatly bound, properly sized three-ring binder, tabbed by specification section.` **|**`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.

****

The Engineer selects the format required for submission of the data. The Engineer should specify the form in which submittals are to be received and number of copies

****

125-2.1.5 All equipment and materials furnished and installed under this section must be guaranteed against defects in materials and workmanship for a period of at least **[** `twelve months` **]** from final acceptance by the Owner. Repair or replace the defective materials and/or, at the Owner's discretion, with no additional cost to the Owner.

****

The manufacturer must warranty all LED light fixtures, except for obstruction lighting (AC 150/5345-43), for a minimum of four years after date of installation inclusive of all electronics." Obstruction lighting warranty is set by the individual manufacturer.

****

125-2.2 Conduit/Duct.

Conduit must conform to Specification Item L-110 Airport Underground Electrical Duct Banks and Conduits.

125-2.3 Cable and Counterpoise.

Cable and Counterpoise must conform to Item L-108 Underground Power Cable for Airports.

125-2.4 Tape.

Rubber and plastic electrical tapes must 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 must conform to Item L-108 Installation of Underground Cable for Airports.

125-2.6 Retroreflective Markers.

[`Retroreflective markers must be type L-853 and must conform to the requirements of AC 150/5345-39.` |`Not required.`]

125-2.7 Runway and Taxiway Lights.

Runway and taxiway lights must conform to the requirements of AC 150/5345-46. Lamps must be of size and type indicated, or as required by fixture manufacturer for each lighting fixture required under this contract. Filters must be of colors conforming to the specification for the light concerned or to the standard referenced.

Table 125-2.7: Lights for Project

Type	Class	Mode	Style	Option	Base	Filter	Transformer	Notes
[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]	[__]

****

Indicate type of light, base and transformer including class, mode, style, and option as appropriate for project. On elevated lights indicate height. Add rows to table as necessary to indicate all light types required for project. In the Notes column, indicate bulb type if that is an option as well as fixture height for edge lights.

See AC 150/5340-30 for design and spacing requirements of light system.

See AC 150/5345-46 for specific characteristics of each fixture type.

Indicate fixture height of elevated fixtures.

The Engineer is required to edit all text enclosed in brackets.

See FAA Engineering Brief No. 67 "*Light Sources other than Incandescent and Xenon for Airport Lighting and Obstruction Lighting Fixtures* for additional information on LED fixtures.

Show installation details on the plans with fixtures shown in section view. See AC 150/5340-30 for examples of installation details.

****

125-2.8 Runway and Taxiway Signs.

Runway and taxiway guidance signs should conform to the requirements of AC 150/5345-44.

Table 125-2.8: Signs for Project

Type	Size	Style	Class	Mode	Notes
[__]	**[__]**	**[__]**	**[__]**	**[__]**	**[__]**

****

Indicate type, size, style class, and mode of signs for project, adding rows as necessary.

See AC 150/5340-18 for guidance on sign legends and locations.

See AC 150/5345-44 for information about sign sizes, styles, class, and mode.

****

125-2.9 Runway End Identifier Light (REIL).

[The REIL fixtures must meet the requirements of AC 150/5345-51, Type **[** L-849V **|**L-849I **]**, Style **[** A **|**B **|**C **|**D **|**E **|** F **]**. **|**Not required. **]**

125-2.10 Precision Approach Path Indicator (PAPI).

[The light units for the PAPI must meet the requirements of AC 150/5345-28, Type **[** L-880 **|**L-881 **]**, Style **[** A **|**B **]**, Class **[** I **|**II **]**. **|**Not required. **]**

****

Plans should indicate details for location and installation of REILs and PAPIs. See AC 150/5340-30 for requirements for locating and installing REIL and PAPI equipment.

****

125-2.11 Circuit Selector Cabinet.

The circuit selector cabinet must meet the requirements of AC 150/5345-5, Type L-847, **[** `one` **|** `two` **|** `three` **|** `four` **]** circuit control **[** `as indicated` **]**, Class **[** `A, indoor` **|** `B, outdoor` **]**, Rating **[** `1, for 6.6 amperes` **|** `2, for 20 amperes` **]**.

125-2.12 Light Base and Transformer Housings.

Light Base and Transformer Housings should conform to the requirements of AC 150/5345-42. Light bases must be Type **[** `L-867` **|** `L-868` **]**, Class **[** `1A` **|** `1B` **|** `2A` **|** `2B` **]**, Size **[** `A` **|** `B` **|** `C` **]** and must be provided as indicated or as required to accommodate the fixture or device installed thereon. Provide base plates, cover plates, and adapter plates to accommodate various sizes of fixtures.

****

Use Type L-867 bases for applications not subject to aircraft or heavy vehicle loading. Use Type L-868 for applications subjected to aircraft or vehicle loading.

****

125-2.13 Isolation Transformers.

Isolation Transformers must be Type **[** `L-830` **|** `L-831` **]**, size as required for each installation. Transformer must conform to AC 150/5345-47.

125-3 INSTALLATION

****

Include construction and/or installation details on the plans. Include project installation requirement in the specifications from AC 150/5345-30.

****

125-3.1 Installation.

The Contractor furnishes, installs, connects, and tests 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 must comply with the requirements of the National Electrical Code (NEC) and state and local code agencies having jurisdiction. The Contractor installs the specified equipment according to the applicable ACs and the details shown on the plans.

[`Insert project specific installation information from AC 150/5345-30 as required.` **]**

125-3.2 Testing.

Fully test all lights by continuous operation for not less than 24 hours as a completed system prior to acceptance. The test must include operating the constant current regulator in each step not less than ten times at the beginning and end of the 24-hour test. The fixtures must illuminate properly during each portion of the test.

125-3.3 Shipping and Storage.

Ship equipment in suitable packing material to prevent damage during shipping. Store and maintain equipment and materials in areas protected from weather and physical damage. The Contractor replaces any equipment and materials, in the RPR’s opinion, damaged during construction or storage at no additional cost to the Owner. Repair painted or galvanized surfaces that are damaged according to the manufacturer’s recommendations.

125-3.4 Elevated and In-pavement Lights.

Remove all water, debris, and other foreign substances prior to installing fixture base and light. Use a jig or holding device when installing each light fixture to ensure positioning to the proper elevation, alignment, level control, and azimuth control. Orient light fixtures with the light beams parallel to the runway or taxiway centerline and facing in the required direction. Ensure the outermost edge of fixture is level with the surrounding pavement. Remove surplus sealant or flexible embedding material. The holding device remains in place until sealant has reached its initial set.

125-4 METHOD OF MEASUREMENT

125-4.1 Measure reflective markers by the number installed as completed units in place, ready for operation, and the RPR accepted. Measure runway and taxiway lights by the number of each type installed as completed units in place, ready for operation, and the RPR accepted. Measure guidance signs by the number of each type and size installed as completed units, in place, ready for operation, and the RPR accepted. Measure REIL by each system installed as a completed unit in place, ready for operation, and the RPR accepted. Measure the PAPI by each system installed as a completed unit, in place, ready for operation, and the RPR accepted. Measure the Abbreviated Precision Approach Path Indicator (APAPI) by each system installed as a completed unit, in place, ready for operation, and the RPR accepted.

****

Delete non-applicable equipment types. Additional equipment types may be added with FAA coordination.

****

125-5 BASIS OF PAYMENT

125-5.1 Payment is 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 the RPR accepted. This payment is 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 is made under:

[`Item` **]** **[** `Description` **]**–**[** `each` **]**

****

Add in item, description, and measurement for all lights and signs included in the project.

****

125.6 REFERENCES

125-6.1 This list of publications forms 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 67	*Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures*

END OF ITEM L-125

OMB Control Number: 2120-0746
EXPIRATION DATE: 11/30/2024

Advisory Circular Feedback

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If you find an error in this AC, have recommendations for improving it, or have suggestions for new items/subjects to be added, you may let us know by (1) mailing this form to Manager, Airport Engineering Division, Federal Aviation Administration ATTN: AAS-100, 800 Independence Avenue SW, Washington D.C. 20591 or (2) faxing it to the attention of the Office of Airport Safety and Standards at (202) 267-5383.

Subject: AC 150/5370-10J Date: ________________________

Please check all appropriate line items:

☐ An error (procedural or typographical) has been noted in paragraph __________ on page _____.

☐ Recommend paragraph ______________ on page ______________ be changed as follows:

____
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☐ In a future change to this AC, please cover the following subject:
(Briefly describe what you want added.)

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☐ Other comments:

____
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☐ I would like to discuss the above. Please contact me at (phone number, email address).

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Submitted by: ____________________________________ Date: _________________

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