PROJECT MANUAL

AIRFIELD PAVEMENT REPAIRS
HOUSTON AIRPORT SYSTEM

PROJECT No.: 460C_HOU, 460C_IAH, 460C_EFD
CIP No.: A-0513

ISSUED FOR BID
VOLUME NO. 2 OF 5

PN 460C_HOU
Divisions 02 through 16

July 2018

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NOTICE:
The new HAS project number is 460D. All references to project 460C should now be referred to as 460D.
ITEM G-100
MOBILIZATION & GENERAL CONDITIONS

DESCRIPTION

100-1.1 This item shall consist of work and operations, but is not limited to, work and operations necessary for the movement of personnel, equipment, material and supplies to and from the project site for work on the project except as provided in the contract as separate pay items. The work specified in this item shall also include the preparatory work and operations in mobilizing for beginning work on the project, including, but not limited to, those operations necessary for the establishment of temporary offices, buildings, guard houses, utilities, safety equipment and first aid supplies, sanitary facilities and any other work not included in other contract pay items. The cost of bonds and any required insurance and any other preconstruction expenses necessary for the start of the work, excluding the cost of construction materials, shall also be included in this section. Item G-100 is meant to supplement FAA General Provision 105. Should a conflict arise between FAA General Provision 105 and Item G-100, FAA General Provision 105 shall govern.

100-1.2 Posted notices. Prior to commencement of construction activities, the Contractor must post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the prime Contractor and by all employees of subcontractors engaged by the prime Contractor: Equal Employment Opportunity (EEO) Poster “Equal Employment Opportunity is the Law” in accordance with the Office of Federal Contract Compliance Programs Executive Order 11246, as amended; Davis Bacon Wage Poster (WH 1321) - DOL “Notice to All Employees” Poster; and Applicable Davis-Bacon Wage Rate Determination. These notices must remain posted until final acceptance of the work by the Owner.

METHOD OF MEASUREMENT

100-2.1 Measurement of the item Mobilization and General Conditions, as specified herein, will be on a lump sum basis.

BASIS OF PAYMENT

100-3.1 The work and incidental costs covered under this item will be paid for at the Contract lump sum price per Bid Schedule. The Engineer shall make the final determination of the allowable percentage of completion for the payment of mobilization and shall approve the percentage paid based on the percent of contract amount actually earned which will be based upon actual work completed.

Partial payments will be allowed as follows:

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

* The Percent of Contract Amount Earned equals the work completed to date (including the total of all previous mobilization) plus or minus work completed associated with executed change orders, if any, divided by the Total Original Contract Amount plus or minus the Total Executed Change Order Amounts, if any.

** In the event the lump sum bid for mobilization exceeds 7.5 percent of the original contract amount for the project, the amount in excess of 7.5% will not be paid until the project is complete and the Engineer and Owner have issued a statement of final acceptance as of the date when the Contractor has furnished
all of the required reports, certifications and other documentation. The date of final acceptance by the Engineer and Owner will govern, in accordance with statutes and regulations, for payment of retainage or other monies due to the Contractor.

***Payments associated with mobilization are subject to approval of the submitted Trench Safety Program, Construction Schedule, required photographs, and Quality Control Program by the City Engineer. Reference Section 01290 Payment Procedures for additional information.

Payment shall be made under:

Item G-100-3.1 Mobilization and General Conditions -- Per Lump Sum.

TESTING REQUIREMENTS

100-4.1 None.

END OF ITEM G-100
ITEM G-102
SAFETY AND SECURITY

DESCRIPTION

102-1.1 General. This work shall consist of complying with the provisions of the Construction Safety and Phasing Plan (CSPP) and as contained in this specification and other contract documents. A complete understanding of all safety and security procedures and requirements contained in the contract documents is required to ensure safety during construction. The CSPP is a part of this Contract and deviations from the requirements established herein will be sufficient cause for the Contract termination. The CSPP can be found in The Contract Documents.

Required reference material associated with this safety plan includes the current versions of the following documents:

- FAA AC 150/5200-18, Airport Safety Self-Inspection
- FAA AC 150/5210-5, Painting, Marking and Lighting of Vehicles Used on an Airport
- FAA AC 150/5340-1, Standards for Airport Markings
- FAA AC 150/5370-2, Operational Safety on Airports During Construction
- FAA AC 150/5370-13, Off-peak Construction of Airports Using Hot-Mix Asphalt

Copies of these documents are available for download at www.faa.gov

CONTRACTOR SAFETY AND SECURITY OFFICER

102-2.1 Contractor Safety and Security Officer (CSSO). The Contractor shall appoint its on-site Construction Superintendent or other qualified individual(s) as its duly authorized representative to serve as Contractor Safety and Security Officer (CSSO) for the duration of the Contract. The CSSO shall thoroughly understand the safety and security requirements of the Contract, the necessity for them and shall have sufficient authority to implement its provisions without significant deviation. The Contractor shall notify the Engineer in writing of the name of the individual(s) selected for the assignment.

The CSSO shall represent the Contractor on safety and security requirements compliance. The CSSO shall be especially knowledgeable regarding the requirements of FAA AC's 150/5200-18, Airport Self Inspection Guide and 150/5370-2 Operational Safety on Airports During Construction, current editions.

102-2.2 Responsibilities of the Contractor Safety and Security Officer. Prior to the desired date for commencement of any work on the project, the CSSO shall accomplish the following:

a. Develop and submit in writing a detailed work sequence schedule with dates and times specified for all milestone events. This sequence schedule shall conform, as a minimum, to the events specified in Section 3.1, Construction Sequence, and shall be subject to the approval of the Engineer. To assure adequate time for coordination, this document shall be submitted at least one week prior to the date of the Preconstruction Conference.

b. Develop and submit in writing a Safety Plan Compliance Document (SPCD). See the Contract Documents for requirements and guidelines regarding the SPCD. The SPCD shall, as a minimum, be a detailed outline of the procedures to be followed showing how the Contractor will comply with the CSPP. The SPCD shall detail, but not be limited to, how the Contractor plans to maintain safety and
security of both Contractor operations and the integrity of airport landside and airside operations during the prosecution of contract work and the procedures to be followed in the event of an emergency or accident. These procedures shall be subject to the approval of the Engineer and reflect any change as may be deemed necessary. The development of the required SPCD shall be considered incidental to G-102-10.1 Safety & Security.

c. Conduct at least one meeting of all Contractor supervisory personnel prior to the start of contract work for each Bid Schedule. The purpose of this meeting is to review the approved Work sequence schedule and safety and security procedures. Attendance at this meeting by the CSSO, all Contractor supervisory personnel and the Engineer is mandatory. This meeting shall also be open to other employees of the Contractor and others as the Engineer may deem appropriate. Minutes of this meeting shall be taken by the CSSO, copies provided to each supervisor and kept on file in the Contractor’s construction office for periodic review and updating.

d. Develop a safety and security orientation program and provide a briefing for all employees of the Contractor and subcontractors that will be used on the project. A similar briefing will be given to new employees prior to their use on contract work. In addition, the CSSO shall be responsible for briefing, from time to time, all Contractor personnel on any changes to safety and security measures deemed necessary.

CONSTRUCTION SEQUENCING

102-3.1 Construction Sequence. The Contractor shall prepare a construction schedule and submit to the Engineer at least one (1) week prior to the pre-construction meeting.

102-3.2 Closing Surfaces. The Contractor shall acquaint his supervisors and employees with the sequence of construction and its relationship to airport activity and aircraft operations that are inherent to this airport. No runway, taxiway, apron or airport roadway shall be closed without the written approval of the Owner, to enable necessary NOTAMS and/or advisories to airport fixed based operators (FBOs), tenants and users.

The Contractor shall submit a WAN, as specified in Section 01761, Protection of Existing Services, and the plans, prior to any requested closing.

The Contractor shall contact the Engineer a minimum of ten (10) days prior to any requested closing.

Any construction activity within 250 feet of the centerline of an active runway or within 193 feet of the centerline of an active ADG VI taxiway, 160-feet of the centerline of an active ADG V taxiway, 129.5-feet of an active ADG IV taxiway, 93-feet of an active ADG III taxiway or 167-feet of the centerline of an active ADG VI Taxilane, 138-feet of an active ADG V Taxilane, 112.5-feet of an active ADG IV Taxilane, 81-feet of an active ADG III taxilane or apron requires closure of the impacted area. These safety and object free areas are shown on the phasing plan and detailed in the CSPP.

The Engineer will arrange for an inspection, prior to return to service, of any facility that has been closed for work, on or adjacent thereto, or that has been used for a crossing point or haul route by the Contractor.

MARKING AND LIGHTING

102-4.1 Proper marking and lighting of areas on the airfield associated with the construction shall be the responsibility of the Contractor. This will include properly marking and lighting closed runways, taxiways, taxilanes, and aprons, the limits of construction, material storage areas, equipment storage areas, haul routes, parking areas and other areas defined as required for the Contractor's exclusive use. The Contractor shall erect and maintain around the perimeter of these areas suitable marking and warning devices visible for day and night use. Temporary barricades, flagging, and flashing warning lights shall be required at critical access points. The type and location of marking and warning devices will be as shown
on the plans and approved by the Engineer.

Special emphasis shall be given to open trenches, excavations, heavy equipment marshalling areas, and stockpiled material located in the airport operations area, which shall be predominantly marked by the Contractor with flags and lighted by approved light units during hours of restricted visibility and darkness. All marking shall be in accordance with FAA Advisory Circular (AC) 150/5340-1L, current edition, latest change.

TRAFFIC CONTROL

102-5.1 Vehicle Identification. The Contractor shall establish and maintain a list of Contractor and subcontractor vehicles authorized to operate on the site. Contractor employee vehicles shall be restricted to the Contractor’s staging area and are not allowed in the Airport Operations Area (AOA) at any time. To be authorized to operate on the airport, each Contractor or subcontractor’s vehicle shall:

a. Display a flashing amber (yellow) dome-type light on top of the vehicle and of such intensity to conform to local codes for maintenance and emergency vehicles. A 3 feet x 3 feet or larger, orange and white checkerboard construction safety flag, each checkerboard color being 1-foot, above the vehicle, may be used to supplement the flashing light or for transient vehicles or those specifically onsite for the day to complete a specific task during daytime operations only. Any vehicle operating in the AOA during the hours of darkness shall be equipped with a flashing amber (yellow) dome-type light.

b. Be identified with a sign / placard with company logo and phone number of the Contractor and be of sufficient size to be identified at a distance of 150 feet. Vehicles needing intermittent identification could be marked with tape or with commercially available magnetically attached markers. Vehicles that are not appropriately identified shall be escorted by a vehicle that conforms to this requirement. Vehicles requiring escort shall be identified on the list.

c. Be escorted under the control of a contractor escort monitoring ground control radio frequency.

d. Be operated in a manner that does not compromise the safety of either landside or airside airport operations. If, in the opinion of the Engineer, any vehicle is operated in a manner not fully consistent with this requirement, the Engineer has the right to restrict operation of the vehicle or prohibit its use on the airport.

102-5.2 Access to the Site of Construction. The Contractor’s access to the site shall be as shown in the plans. No other access points shall be allowed unless approved by the Engineer. All Contractor traffic authorized to enter the site shall be experienced in the route or guided by Contractor personnel. The Contractor shall be responsible for traffic control to and from the various construction areas on the site, and for the operation and security of the access gate to the site. A Contractor’s flagman or traffic control person shall monitor and coordinate all Contractor traffic at the access gate with Airport Security. The Contractor shall not permit any unauthorized construction personnel or traffic on the site. Access gates to the site shall be locked and secured at all times when not attended by the Contractor. If the Contractor chooses to leave any access gate open, it shall be attended by Contractor personnel who are familiar with the requirements of the Airport Security Program. The Contractor is responsible for the immediate cleanup of any debris deposited along the access route as a result of his construction traffic. Directional signing from the access gate along the delivery route to the storage area, plant site or work site shall be as directed by the Engineer. In addition, the following requirements are applicable:

a. All Contractor traffic authorized to travel on the airport shall have been briefed as part of the Contractor’s construction safety and security orientation program, be thoroughly familiar with the access procedures and route for travel or be escorted by personnel authorized by the Contractor Safety and Security Officer (CSSO).

b. The Contractor shall install work site identification signs at the authorized access point(s). If, in the opinion of the Engineer, directional signs are needed for clarity, they shall be installed along the route
authorized for access to each construction site.

c. Under no circumstance will Contractor personnel be permitted to drive their individually owned vehicles to any construction site on the airport. All vehicles must be parked in the area designated for employee parking and out of secured airport property.

d. In addition to the inspection and cleanup required at the end of each shift, the Contractor is responsible for the immediate cleanup of any debris generated along the construction site access route(s) as a result of construction related traffic or operations whether or not created by Contractor personnel.

102-5.3 Material Suppliers. All material suppliers, subcontractors and visitors to the work site are obligated to follow the same safety and security operating procedures as the Contractor. All material suppliers shall make their deliveries using the same access points and routes as the Contractor and shall be advised of the appropriate delivery procedures at the time the materials order is placed. The Contractor shall not use the Airport address for any delivery but shall use the street address appropriate to the location of the entrance to the work site. If it is not practical to conform to the vehicle identification requirements of Section 102-5.1 and the safety and security operations program requirements of Section 102-2.2, the Contractor shall be prepared to escort all suppliers, subcontractors and visitors while they are on the airport.

102-5.4 Personnel Identification. All employees, agents, vendors, invitees, etc. of the Contractor or subcontractors requiring access to the construction site shall, conform to the Security Program.

GENERAL SAFETY REQUIREMENTS

102-6.1 All Contractor vehicles that are authorized to operate on the airport outside of the designated construction area limits or haul routes as defined herein shall display in full view above the vehicle a flashing amber (yellow) dome-type light or a three-foot by three-foot, or larger, orange and white checkerboard flag, each checkerboard color being one-foot square. Vehicles must be under control of a Contractor mobile (two-way) radio operator (flagmen) monitoring the Airport frequency. Vehicle operators must be vigilant for conflict with any aircraft and give way to any operating aircraft at all times.

All Contractor vehicles that are required to operate outside of the construction area limits as defined herein and cross active taxiways, aprons, or runway approach clear zones shall do so under the direct control of a flagman who is monitoring the Airport frequency. Flagmen and two-way radios shall be furnished by the Contractor. Flagmen shall be instructed in the use and operation of two-way radios on an active airfield prior to use. All aircraft traffic on taxiways and aprons shall have priority over Contractor's traffic. Any movement of the Contractor's vehicles and equipment on or across landing areas shall only be under escort by Airport Operations or when the runway is closed.

Construction vehicles not in use for extended periods during the work day, or during nights and weekends (nonwork periods) shall be parked away from active runways, taxiways, and aprons in designated vehicle marshalling areas.

102-6.2 In order to protect all aircraft traffic, aviation related businesses, terminal apron areas, etc. from potential damage caused by foreign object debris (FOD) generated by construction activities, the Contractor shall provide a vacuum truck as required at the startup of construction to daily vacuum all pavements affected by construction. The vacuum truck shall remain on-site for the duration of the project and shall be available at the discretion of the Owner to vacuum pavement areas adjacent to the construction areas to ensure no FOD is present on pavements within 500 feet of any construction area. Protecting the aircraft, airport tenants, users, public, etc. against FOD is a critical safety issue therefore the cost of the vacuum truck will be included in the cost established for this specification item.

CONSTRUCTION CONTROL

G102-4
ver. 07-20-2016
102-7.1 A primary and alternate responsible Contractor's representative shall be designated by the Contractor. The Contractor's representatives shall be available locally on a 24-hour basis. Names of the primary and alternate, including phone number, shall be made available to the Engineer by the Contractor. The Contractor shall insure that the names and phone numbers are kept current and made available to the Engineer.

CONSTRUCTION TECHNIQUES

102-8.1 Construction shall be planned and conducted throughout this project in such a manner as to maintain safe airport operations. Every effort shall be made to reduce the impact of construction activity on overall airport operations. To this end, the Contractor's activities shall be conducted in such a manner so as to preclude, except where absolutely required, open excavations, trenches, ditches and above ground obstacles such as booms on cranes. The primary responsibility for assuring that safe construction techniques are followed rests with the Contractor Safety and Security Officer (CSSO).

METHOD OF MEASUREMENT

102-9.1 The item of Safety and Security shall be measured as a lump sum item when required and furnished for the life of the Contract.

BASIS OF PAYMENT

102-10.1 Payment for safety and security measures for personnel, labor, equipment, materials and incidentals related to this specification item and required to satisfy the specified objectives will be paid at the contract lump sum price. In the event the contract completion date is extended, no additional payment will be made for Safety and Security. This compensation shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

No payment will be made under safety and security for each calendar day during which there are substantial deficiencies in compliance with the Specification requirements of any subsection of this Section as determined by the Engineer.

The amount of such calendar day non-payment will be determined by dividing the lump sum amount bid for Safety and Security by the number of calendar days between the date the Contractor commences work and the date of completion as designated in this proposal, without regard to any extension of time. If the Contractor fails to maintain and protect traffic adequately and safely for a period of 24 hours, the Owner shall correct the adverse conditions by any means it deems appropriate and shall deduct the cost of the corrective work from any monies due the Contractor. The cost of this work shall be in addition to any liquidated damages and non-payment for Safety and Security listed above.

However, where major non-conformance with the requirements of this Specification is noted by the Engineer and prompt Contractor compliance is deemed not to be obtainable, all contract work may be stopped by direct order of the Engineer regardless of whether corrections are made by the Owner as stated above.

PARTIAL PAYMENTS. Partial payments will be made in accordance with the following schedule as the work in each Bid Schedule is completed:

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<th>Percentage of Original Contract Amount Earned</th>
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G102-5
ver. 07-20-2016
Payment shall be made under:

Item G-102-10.1 Safety and Security -- Per Lump Sum.

TESTING REQUIREMENTS

102-11.1 None.

END OF ITEM G-102
ITEM G-104

PROJECT SURVEY AND STAKEOUT

DESCRIPTION

104-1.1 Under this item, the Contractor shall perform all necessary surveying required to construct all elements of the work as shown in the contract documents. This shall include, but not be limited to, stakeout, layout and elevations for grading, base courses, pavements, structures, forms and other appurtenances and items as shown and required to construct the project. Methods shall be consistent with current practices and shall be performed by qualified personnel acceptable to the Engineer. All survey work shall be provided under the direction of a licensed land surveyor.

MATERIALS

104-2.1 All instruments, equipment, stakes and any other material necessary to perform the work shall be provided by the Contractor.

All stakes used shall be of a type approved by the Engineer. It shall be the Contractor’s responsibility to maintain these stakes in their proper position and location at all times.

CONSTRUCTION METHODS

104-3.1 GENERAL. The Contractor shall trim trees, brush and other interfering objects from survey lines in advance of all survey work to permit accurate and unimpeded work by his stakeout survey crews.

The exact position of all work shall be established from control points, baseline transit points or other points of similar nature that are shown on the Contract Drawings or approved by the Engineer. Before any layout work is accomplished, the Contractor shall first verify that the control point data shown on the plans is accurate. Any error, apparent discrepancy or absence of data shown or required for accurately accomplishing the stakeout survey shall be immediately referred to the Engineer for interpretation or resolution before the control point(s) in question are used for construction layout.

The Contractor shall place layout stakes as detailed in the General Provisions and at such intermediate locations as the Engineer may direct. From computations and measurements made by the Contractor, these stakes shall be clearly and legibly marked with the correct station number, offset and cut or fill so as to permit the establishment of the exact centerline location and elevation during construction. If markings become faded or blurred for any reason, the markings shall be restored by the Contractor at the request of the Engineer. All control points shall be properly guarded and flagged for easy identification.

Drainage structures shall be staked out by the Contractor at the locations and elevations shown on the Contract Drawings or specified by the Engineer.

Reference points, baselines, stakes and benchmarks for borrow pits shall be established by the Contractor.

Permanent survey marker locations shall be established and referenced by the Contractor.

The Contractor shall be responsible for the accuracy of his work and shall maintain all reference points, stakes, etc., throughout the life of the work. Damaged or destroyed points, benchmarks or stakes, or any reference points made inaccessible by the progress of the construction, shall be replaced or transferred by the Contractor. Any of the above points which may be destroyed or damaged shall be transferred by the Contractor before they are damaged or destroyed. All control points shall be referenced by ties to acceptable objects and recorded. Any alterations or revisions in the ties shall be so noted and the information furnished to the Engineer immediately. All stakeout survey work shall be referenced to the
centerlines shown on the Contract Drawings. All computations necessary to establish the exact position of the work from control points shall be made and preserved by the Contractor. All computations, survey notes and other records necessary to accomplish the work, shall be neatly made. Such computations, survey notes and other records shall be made available to the Engineer upon request and shall become the property of the Owner and delivered to the Engineer in a timely manner.

The Contractor shall furnish, at his expense, all horizontal and vertical control and all staking and layout of construction work called for on the plans. The Engineer and Owner shall not be responsible for such work. However, the Owner and Engineer reserve the right to check all said lines, grades, and measurements with their appointed surveyor. Should the Owner’s surveyor detect errors in said lines, grades, and measurements, the Contractor shall pay for all said surveying costs and subsequent surveying costs performed to correct and verify correction of errors found in said lines, grades and measurements. Definition of an error shall be a discrepancy of 1/4" or more. In the case of a discrepancy between the technical specifications and this defined tolerance, this tolerance shall govern.

Prior to the final cross-section survey of the work by the Contractor, the Contractor shall reestablish centerline or baseline points and stationing as required by the Engineer.

Any existing stakes, iron pins, survey monuments or other markers defining property lines which may be disturbed during construction shall be properly tied into fixed reference points before being disturbed and accurately reset in their proper position upon completion of the work.

Just prior to completion of the work, the Contractor shall reestablish, if necessary, and retie all control points as permanently as possible and to the satisfaction of the Engineer.

**104-3.2 CROSS SECTIONAL DATA FOR PAYMENT.** The Contractor shall be required to submit cross sectional or Digital Terrain Model (DTM) data to the Engineer at monthly intervals prior to the Contractor submittal of the monthly application for payment so that the Engineer can verify the quantities of earthwork and other pay item volumes for payment. All cross sectional data provided will be in AutoCAD Civil 3D 2014 or higher format only. No other formats will be accepted. If the data is submitted in another format other than AutoCAD, no earthwork or other materials volumes will be calculated and approved for payment.

**104-3.3 AUTOMATED MACHINE GUIDANCE.** If the Contractor elects to use Global Positioning System (GPS) machine control grading, a work plan including, but not limited to, proposed equipment, control software, types of work to be completed and methods shall be submitted to the Engineer for approval. The use of this technology is referenced as Automated Machine Guidance (AMG). All equipment using AMG shall be able to generate end results that meet the requirements of the specifications. The Contractor shall be responsible for developing a Digital Terrain Model (DTM) of the design surfaces for use with the AMG equipment. The DTM shall be submitted to the Engineer for review and approval prior to beginning work. Perform test sections for each type of work to be completed with AMG to demonstrate that the system has the capability to achieve acceptable results. If acceptable results cannot be achieved, conform to the requirements for conventional stakeout. The Contractor shall be responsible for all errors resulting from the use of AMG and shall correct deficiencies to the satisfaction of the Engineer at no cost to the Owner.

**104-3.4 PRE-CONSTRUCTION SURVEYS.** The Contractor shall be required to survey and confirm existing field conditions prior to beginning construction in each work area. Confirmation of existing conditions shall include, but is not limited to, drainage structure locations, elevations and inverters, pipe inverters, existing ground elevations, existing pavement elevations where the proposed work will tie into, existing utility locations and elevations, and any other existing features and conditions that may impact the proposed construction. The contractor shall notify the Engineer of any discrepancies that are found in the existing conditions compared to the information contained in the plans prior to beginning work in each work area.
PROJECT SURVEY AND STAKEOUT

METHOD OF MEASUREMENT

104-4.1 Project Survey and Stakeout shall be measured for payment on a lump sum basis.

BASIS OF PAYMENT

104-5.1 Payment for Survey and Stakeout shall be made at the contract lump sum price for each authorized Bid Schedule. This price shall include the cost of furnishing all labor, equipment, instruments and all other material necessary to satisfactorily complete this item. Partial payments will be made at the discretion of the Engineer as the work progresses based generally on the percentage of actual work completed compared to the total construction cost.

Payment will be made under:

- Item G-104-5.1 Project Survey and Stakeout -- Per Lump Sum.

TESTING REQUIREMENTS

104-6.1 None.

END OF ITEM G-104
ITEM G-105
TEMPORARY CONSTRUCTION ITEMS

DESCRIPTION
105-1.1 This item consists of furnishing all labor, materials and equipment for temporary construction items necessary for the safe and proper execution of work not otherwise included in other contract bid items. The Contractor will be expected to supply and utilize the temporary construction items listed below and other items contained in the plans and specifications. Temporary construction items to be provided may include, but are not limited to, the following: construction flag persons; flaggers; gate guards; escorts; portable floodlighting; steel plates for temporary covering of excavations and structures; construction barricades; delineators; temporary haul roads; temporary safety area ramp downs; temporary signs; test pits; vacuum trucks and sweepers; portable bathroom sanitary facilities; temporary construction staging / storage areas, stockpile areas, disposal areas; waste disposal containers; runway / taxiway closure markers; temporary edge light coverings, centerline light masking, and sign coverings/modifications; temporary electrical cables, connections, and jumpering; and electrical lock-out and tag-out.

MATERIALS
105-2.1 Construction Barricades. Construction barricades shall be constructed in accordance with the details shown in the plans and shall be placed in accordance with the phasing plans and as directed by the Engineer. The term "barricade" shall be used throughout the plans and project manual to universally indicate barricades, signs, danger signals, hazard lighting, and / or any other safety measures to be installed by the Contractor prior to commencing work in an area. The Contractor shall be responsible for furnishing, installing, and maintaining the necessary barricades as required by the plans and specifications (FAA AC 150/5370-2, Operational Safety on Airports During Construction, current edition, latest change) for the protection of the work and the safety of the public for both land and air traffic.

105-2.2 Portable Lighting Units. Portable lighting shall be provided, as required, for construction that must occur during nighttime operations, defined as 30 minutes prior to sunset until 30 minutes after sunrise, and for periods of limited visibility as determined by HAS. The Contractor shall provide sufficient units so that all work areas are illuminated to a level of five (5) horizontal foot-candles. The lighting levels shall be calculated and measured in accordance with the current standards of the Illumination Engineering Society. Portable lighting units shall be equipped with light shields and positioned in such a way that they do not impact air traffic control operations and shall be approved by Airport Operations prior to use.

105-2.3 Steel Plates. Steel plates of adequate size and thickness shall be furnished as necessary to cover temporary excavations, unfinished structures or surfaces requiring protection or for safety purposes. Plates shall be securely fastened down and shall be adequate to safely support any anticipated loadings to be imposed.

105-2.4 Lighted Runway Closure Markers. Lighted runway closure markers meeting the requirements of FAA AC 150/5370-2 shall be provided by the Contractor for each temporarily closed runway end. Unlit taxiway closure markers meeting the requirements of FAA AC 150/5370-2 shall be provided by the Contractor for each temporarily closed taxiway intersecting an active runway at the entrance of the taxiway from the runway for those taxiways closed for more than 15 days. The Contractor shall maintain the markers during construction, replace any worn parts, keep them fueled and maintain all oil levels.
filters, etc. required to keep them running in good working order. The Contractor shall retain possession of the closure markers upon contract completion.

**105-2.5 Sweepers, Vacuum Trucks, and Additional Cleaning Equipment.** The Contractor shall provide an adequate number of sweepers, vacuum trucks, and additional cleaning equipment to keep all haul routes, active airfield pavements within the limits of work, and any other pavement areas traversed by the Contractor’s vehicles and equipment clean and free of mud, dirt, debris and other FOD. The Contractor shall provide a sweeper and vacuum truck at each active airfield pavement crossing, stationed outside the OFA. No less than two (2) sweepers and two (2) vacuum trucks shall be onsite for the duration of the project, regardless of the number of active airfield pavement crossings. The Contractor shall sweep and / or vacuum, as necessary, or as directed by the Owner's representative, immediately after each active airfield pavement crossing by the Contractor's vehicles or equipment. The Contractor shall additionally ensure that all active airfield pavements affected by construction operations are kept free of any and all FOD deposited as the result of any source to the satisfaction of the Engineer. The cost of all cleaning equipment, operation of said equipment, and labor and incidentals required for cleaning operations shall be included for payment under the item(s) of this specification.

**105-2.6 Haul Roads.** The Contractor shall install, maintain, repair, and remove haul roads to be traversed by construction vehicles and equipment as indicated in the plans, or as required by the Contractor. All haul roads located within 100 feet of any active airfield pavement shall be constructed of materials to prevent the introduction of FOD onto and adjacent to active airfield pavements. Haul routes shall be constructed of interlocking mats designed to support the Contractor’s equipment and material delivery vehicles without causing damage to underlying utilities or duct banks. Mats shall conform to existing uneven terrain as grading is not permitted. A sufficient number of mats shall be provided to keep all equipment and vehicles off adjacent unpaved surfaces.

**105-2.7 Temporary Construction Staging / Storage Areas, Stockpile Areas, Disposal Areas, and Batch Plant Sites.** The Contractor shall install, maintain, and repair temporary construction staging / storage areas, stockpile areas, and disposal areas in accordance with the directives in the plans and project manual at the locations indicated in the plans, or as approved by the Engineer. At the completion of the project, these areas shall be removed and conditions of these areas and surrounding areas shall be as good as or better than the condition prior to starting work, including, at minimum, repair of existing facilities, regrading, and topsoiling and establishing vegetation, as applicable.

**105-2.8 Other Miscellaneous Items.** Any other items not listed herein but which are associated directly or indirectly with temporary construction related work shall, by reference, be included in the requirements of this specification. No additional payment will be made for any temporary construction related item not specifically listed herein. The Contractor shall be responsible for providing any and all items necessary to ensure a safe, secure and functioning project construction site.

**CONSTRUCTION METHODS**

**105-3.1 Construction Barricades.** Barricades shall be placed around each phase of the work in accordance with the phasing plans and shall remain in place until completion of work in each phase or the completion of each work period as specified in the plans.

**105-3.2 Flaggers.** Flaggers shall be provided, as necessary, to control the Contractor's traffic during the prosecution of work. All Contractor vehicles or equipment that are required to cross active airfield pavement or safety areas shall do so under the direct control of a competent flagger.

a. The contractor shall provide two (2) designated flaggers at any active airfield pavement crossing, as shown in the plans, or as directed by airport operations. The flaggers will be responsible for stopping any construction traffic that crosses the path of taxing aircraft. Flaggers must be badged and must
have successfully completed the airport flagger training, in addition to the regular badge and movement training.

b. Each flagger, supervisory individual, and Contractor lead/escort vehicle shall be equipped with an approved aviation band radio.

105-3.3 Portable Lighting Units. Portable lighting units are required for construction during periods of limited visibility (i.e., nighttime). Illumination requirements shall be those contained in Paragraph 105-2.2.

METHOD OF MEASUREMENT

105-4.1 Measurement for this item shall be on a Time and Materials basis for all labor, materials, and equipment required to complete the work as described above, as provided in the plans, and/or as directed by HAS. The Contractor shall submit adequate supporting documentation, including but not limited to timesheets, invoices, receipts, and corresponding progress reports, of all actual expenses associated with the items of work.

BASIS OF PAYMENT

105-5.1 Payment will be made at a time and materials (actual cost) basis for the direct expenses for all labor, materials, and equipment associated with temporary construction items, not to exceed the total amount provided in the bid form, and as approved by HAS. Actual costs shall be increased by a 10% mark-up to cover all ancillary items including but not limited to the overhead and profit associated with this item. Payment shall be full compensation for furnishing all materials and labor for placing, moving and removing construction barricades and steel plates, providing flaggers, furnishing portable lighting units, test pitting, temporary electrical system modifications, and for any other labor, materials, equipment, tools and incidentals necessary for temporary items required for construction of this work.

Item G-105-5.1 Temporary Construction Items - Per Lump Sum

TESTING REQUIREMENTS

105-6.1 None.

END OF ITEM G-105
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ITEM G-106

REMOVAL OF PAINTED PAVEMENT MARKING

DESCRIPTION

106-1.1 General. This item shall consist of furnishing all labor, materials and equipment required for the removal of pavement markings from asphalt and concrete surfaces, which are identified to be removed, including the removal of temporary painted pavement markings installed under this contract, as directed by the Engineer.

The existing paint is known to be thick, in areas, from many years of repainting activities. In other locations indicating paint removal, a majority of the paint marking has deteriorated, leaving minimal paint to be removed. The Contractor shall inspect the conditions of the markings and provide a comprehensive plan to remove the markings without damaging the pavement, which may include multiple steps or processes to complete the removal.

EQUIPMENT

106-2.1 Equipment, tools and machines used in the performance of the removal operation shall be safe and in satisfactory working condition at all times. The Contractor shall provide satisfactory evidence that the Contractor's equipment has been used in the performance of similar work. This removal operation shall be accomplished with ultra-high pressure water blasting, or grinding. Milling and sandblasting are prohibited for the removal of either temporary or permanent markings on finished pavement surfaces. The use of chemicals will also not be permitted.

106-2.2 General. The allowable methods for paint removal may include grinding and/or water blasting or a combination of multiple methods. The combination of equipment used may be different for asphalt versus concrete surfaces and must not damage the pavement surface. The Contractor shall submit a description of the types and quantity of equipment proposed for this project. The Contractor shall submit a qualification statement indicating length of time the company has been performing paint removal on airfields and references from airports that a similar method was used.

106-2.3 Water Blasting. The water blasting equipment shall be truck mounted and shall be capable of water pressures of 2,000 to 40,000 psi. Operating pressures during paint removal shall be above 20,000 psi to prevent a hydraulic effect from the force of the water on the pavement. The equipment shall be capable of adjusting the pressure to accomplish paint removal without damaging the paving surface. The equipment shall be capable of following a straight line and be maneuverable to accommodate various pavement markings. The spray width needs to be able to accommodate lines from 4-inches to 8-inches wide. If water blasting is used to remove lines on active airfield pavements, a vacuum system will be provided to allow for timely repainting and the prevention of any debris being ingested into propellers or turbine engines once the water blasting equipment has exited the active pavements. Water Blasting equipment similar to the Stripe Hog SH8000, manufactured by Waterblasting Technologies, is preferred for these operations. Water blasting equipment shall be limited to use on concrete pavements only. Water blasting may be permitted on asphalt pavements to remove the top layers of paint only if it can be demonstrated that the water jets will not damage the asphalt.

106-2.4 Grinding. The grinding equipment may be hand operated or mounted on a skid steer or other motorized vehicle. Adjustable skids or other means to control the depth of the grinding shall be used to prevent excessive grinding depths. Grinding equipment shall be subject to approval by the engineer. Grinding equipment to be used on concrete pavements shall be used to remove the top most layers of paint, with clean up by water blasting methods. Grinding may be acceptable for full removal of pavement markings should a light grind texture be left behind. Test sections shall be performed for acceptance by the Engineer.
PERFORMANCE

106-3.1 Test Strip. The Contractor shall perform a test strip for each different pavement type and removal process used to demonstrate the ability of the equipment to do the work, ability of the operator to run the equipment and the degree of paint removal that will be satisfactory.

106-3.2 Cleanup and Restoration. The pavement surface shall be thoroughly cleaned during and after the pavement marking removal process. Dust control is imperative during removal and cleanup operations due to the proximity of the terminal building. Methods to prevent dust generation will need to be employed. Subsequent to water blasting, the pavement surface shall be flushed with high-pressure water (via water truck or similar) to remove the debris from the surface to be re-painted. Subsequent to grinding, the surface shall be vacuumed, swept and blown with compressed air to adequately remove all dust particles left on the pavement surface. Cleaning with water may be required to remove residual grit if the compressed air cannot clean the surface adequately.

Vacuum trucks alone are not sufficient means to remove all the debris and dust left after the removal process, however should be used to reduce the amount of dust generated.

106-3.3 The Contractor shall furnish all equipment, water trucks and labor for delivery of water to the job site. Water is available for the Contractor's use from hydrants on airport property as identified on the plans. If the Contractor chooses to use water from this source, he shall attach a water meter to the hydrant(s). The Contractor shall obtain all permits, pay all fees and provide to the Engineer the written approval of the authority having jurisdiction over the water source that all requirements for its use have been met.

106-3.2 The removal method applied to the surface shall not be damaging to Portland cement or asphaltic concrete surfaces, joint sealing material or light fixtures. The Contractor shall place re-bar or similar material in the concrete joints to prevent damage to the joint sealant when removing paint, when the joint sealant is to remain in place or if damage to the joint face occurs during removal. If it is deemed by the Engineer that damage to any existing facility is caused by an operational error, such as permitting a pressure water jet to dwell in one location for an extensive time, the Contractor shall repair said damage without additional compensation from the Owner. The Contractor shall cover or protect light fixtures within the removal area. Any damage to light fixtures or lenses shall be repaired at the Contractor's expense.

The removal methods shall result in a scar of no more than 1/8-inch deep on asphalt pavements and no more than 1/16-inch deep on concrete pavements. Water removal shall not allow the jets to penetrate into the pavement structure, thereby dislodging fines around large aggregate.

106-3.3 Paint removal shall be defined as the removal of the existing markings at the degree specified in the table below. The degree of removal will be determined by the Engineer by visual inspection.

<table>
<thead>
<tr>
<th>Type of Marking Removal</th>
<th>Degree of Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markings not to be Remarked</td>
<td>90% to 100%</td>
</tr>
<tr>
<td>Markings to be remarked in same location</td>
<td>85% to 95%</td>
</tr>
</tbody>
</table>

106-3.4 The removal method used shall not materially damage the structural integrity of the pavement. Any damage caused by the Contractor's operations shall be corrected at the Contractor's expense and in a manner approved by the Engineer. The Contractor shall take precautions to protect the public from any damage due to his operations. Accumulation of sand, water, dust, or other residue resulting from the removal operation shall be removed as the work progresses and legally disposed of off airport property.
METHOD OF MEASUREMENT

106-4.1 The quantity of Pavement Marking Obliteration (removal) to be paid shall be the number of square feet of pavement marking obliteration (removal), regardless of the method or number of methods required to remove the markings and shall be in accordance with the specifications and accepted by the Engineer. Multiple operations to remove the same marking will not be measured separately.

BASIS OF PAYMENT

106-5.1 Payment shall be at the contract unit price per square foot for Pavement Marking Obliteration. The price shall be full compensation for furnishing all materials and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

Item G-106-5.1 Pavement Marking Obliteration -- Per Square Foot

TESTING REQUIREMENTS

106-6.1 None.

END OF ITEM G-106
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ITEM G-109 SAWCUTTING

DESCRIPTION

109-1.1 This work shall consist of sawcutting the edge of existing portland cement and/or asphaltic concrete pavements to provide a uniform joint alignment in sound material, as shown on the Plans or as directed by the Engineer.

EQUIPMENT

109-2.1 Saws shall be power-driven, self-propelled, wheel or track-mounted, and capable of cutting to a depth of at least three (3) inches in one pass. The Contractor shall make the necessary number of passes to cut through the portland cement and/or bituminous concrete pavement. The use of a cutting wheel mounted on a roller, grader or similar equipment, or the use of pneumatically driven hand-held tools, will only be approved if the Contractor can demonstrate to the satisfaction of the Engineer that such equipment can consistently produce satisfactory results. Multi-blade arbor saws shall be used to construct sealant reservoirs.

CONSTRUCTION METHODS

109-3.1 The Contractor shall establish the line to be cut using chalkline or similar means in accordance with the details shown on the Plans or as directed by the Engineer. The finished cut shall be true to line, smooth and vertical and shall not deviate from the established line more than 1/2-inch from side to side or end to end of the pavement being sawcut.

109-3.2 The existing paving material beyond the saw cut on the construction side shall be removed to the depth of the final cut and disposed of legally off Airport property. The saw cut depth shall be full depth so that spalling or other breakage of the existing pavement along the bottom of the pavement does not occur. If spalling or other breakage of the existing pavement along the bottom of the pavement does occur, the Contractor shall relocate the saw cut line to a point deeper in the existing pavement to remove completely any spalled or broken pavement so that the subbase under the existing pavement is not damaged and the new pavement can be constructed up against the existing pavement without either the new or existing pavement strength and pavement section being compromised.

109-3.3 All dust, chips, slurry, or waste material shall be carefully collected and removed from the site in accordance with the general safety requirements of the Contract and disposed of legally off the airport property.

METHOD OF MEASUREMENT

109-4.1 The quantity of sawcutting of existing pavement shall not be measured for payment.

BASIS OF PAYMENT

109-5.1 No separate payment will be made for sawcutting. The cost of the work described in this item shall be considered incidental to installation of the various other elements included in the project. The Contractor will still be responsible for furnishing all equipment and materials; for all preparation; and for all labor, tools and incidentals necessary to complete this item.

TESTING REQUIREMENTS

109-6.1 None.
ITEM G-113

COORDINATION OF CONTRACT, PLANS, AND SPECIFICATIONS

DESCRIPTION

113-1.1 The contract, plans, specifications, and all referenced standards cited are essential parts of the contract requirements. A requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. It is the intent of these plans and specifications to ensure that construction, demolition, and all associated materials, equipment, and appurtenances are completed and installed in compliance with all applicable local, state, and federal regulations. In case of discrepancy or conflicting information, the most stringent requirement shall govern.

In general, plans shall supersede any conflicting information which was provided in the specifications. It is the intent that the plans shall be a site specific representation of the various specifications provided by each individual reviewing agency. The specifications shall be used to provide additional information which may not be displayed in the plans.

Throughout the referenced specifications, conflicting information may arise from the various reviewing agencies. The following order of governance shall define which information governs unless otherwise noted.

1. Procurement and Contracting Requirements (Division 00)
   a. Supplementary Conditions
   b. General Conditions
2. General Requirements (Division 01)
3. Technical Specifications (Divisions 02 – 16)
4. Referenced Standards

The Contractor shall immediately notify the Engineer through a written Request for Information (RFI) prior to completing any work should additional clarification be required. If an RFI is not submitted the more stringent of the conflicting information shall be assumed.

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

METHOD OF MEASUREMENT

113-2.1 None

BASIS OF PAYMENT

113-3.1 None

TESTING REQUIREMENTS

113-4.1 None

END OF ITEM G-113
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ITEM G-115

NONWOVEN GEOTEXTILE INTERLAYER

DESCRIPTION

115-1.1 This item shall govern the furnishing of materials and for placement of nonwoven geotextile interlayer as indicated on the Drawings or directed by the Engineer or designated representative. Filter Fabric shall have the capability for allowing the passage of ground water through it without transporting the soil placed around the geotextile.

MATERIALS

115-2.1 Nonwoven Geotextile Interlayer. The following properties shall be met for nonwoven geotextiles used as interlayers in concrete pavement systems.

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirements</th>
<th>Test Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextile Type</td>
<td>Nonwoven, needle-punched geotextile, no thermal treatment (calendering or IR)</td>
<td>EN 13249, Annex F (Manufacturer Certification of Production)</td>
</tr>
<tr>
<td>Color</td>
<td>Uniform/nominally same color fibers</td>
<td>(Visual Inspection)</td>
</tr>
<tr>
<td>Mass per unit area</td>
<td>≥ 450 g/m² (13.3 oz/yd²) ≤ 550 g/m² (16.2 oz/yd²)</td>
<td>ISO 9864 (ASTM D 5261)</td>
</tr>
<tr>
<td>Thickness under load (pressure)³</td>
<td>At 2 kPa (0.29 psi) ≥ 3.0 mm (0.12 in.)</td>
<td>ISO 9863-1 (ASTM D 5199)</td>
</tr>
<tr>
<td></td>
<td>At 20 kPa (2.9 psi) ≥ 2.5 mm (0.10 in.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>At 200 kPa (29 psi) ≥ 1.0 mm (0.04 in.)</td>
<td></td>
</tr>
<tr>
<td>Wide-width tensile strength³</td>
<td>≥ 10 kN/m (685 lb/ft)</td>
<td>ISO 10319 (ASTM D 4595)</td>
</tr>
<tr>
<td>Wide-width maximum elongation⁴</td>
<td>≤ 130%</td>
<td>ISO 10319 (ASTM D 4595)</td>
</tr>
<tr>
<td>Water permeability in normal direction under load (pressure)⁴</td>
<td>At 20 kPa (2.9 psi) ≥ 1×10⁻⁴ m/s (3.3×10⁻⁴ ft/s)</td>
<td>DIN 60600-4 (mod. ASTM D 5493 or ASTM D 4491)</td>
</tr>
<tr>
<td>In-plane water permeability (transmissivity⁵ under load (pressure)⁵</td>
<td>At 20 kPa (2.9 psi) ≥ 5×10⁻⁴ m²/s (1.6×10⁻⁸ ft²/s)</td>
<td>ISO 12958 (mod. ASTM D 6574 or ASTM D 4716)</td>
</tr>
<tr>
<td></td>
<td>At 200 kPa (29 psi) ≥ 2×10⁻⁴ m²/s (6.6×10⁻⁸ ft²/s)</td>
<td></td>
</tr>
<tr>
<td>Weather resistance</td>
<td>Retained Strength ≥ 60%</td>
<td>EN 12224 (ASTM D 4355 @ 500 hrs. exposure)</td>
</tr>
<tr>
<td>Alkali resistance</td>
<td>≥ 96% Polypropylene/Polylethylene</td>
<td>EN 13249, Annex B (Manufacturer Certification of Polymer)</td>
</tr>
</tbody>
</table>

CONSTRUCTION METHODS

115-3.1 The geotextile interlayer shall be installed in accordance with the manufacturer's recommendations, as indicated on the Drawings or as directed by the Engineer or designated representative. When lapping is required, it shall be in accordance with the manufacturer's recommendations. Backfilling around the geotextile interlayer shall be done in such a manner that the geotextile interlayer material will not be damaged during the placement.

115-3.2 Clean-up. Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.
METHOD OF MEASUREMENT

115-4.1 Work and acceptable material for geotextile interlayer will be measured by the square yard, complete in place.

BASIS OF PAYMENT

115-5.1 The work performed and the materials furnished and measured as provided under "Measurement" will be paid at the unit bid price for geotextile interlayer. The unit bid price, when included in the contract as a pay item, shall include full compensation for all materials, excavation and backfilling and all manipulations, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:
Item G-115-5.1 Geotextile Interlayer, per square yard

TESTING REQUIREMENTS

ASTM D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles
ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
ASTM D5493 Standard Test Method for Permittivity of Geotextiles Under Load
ASTM D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D6574 Test Method for Determining the (In-Plane) Hydraulic Transmissivity of a Geosynthetic by Radial Flow
ASTM D4716 Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
ASTM D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus

END ITEM G-115
ITEM G-117

PARTIAL DEPTH PAVEMENT REPAIR (SPALL REPAIR)

GENERAL

117-1.1 DESCRIPTION. This work includes the patching of existing spalled concrete using a multi-component polymer concrete system components. The polyester polymer concrete utilized for the project shall be Silspec Flexpatch Polymer Concrete or approved equal.

117-1.2 SUBMITTALS. The Contractor shall submit a spall repair plan no less than 15 days prior to scheduled spall repairs for Engineer review and approval. The spall repair plan shall, at minimum, include the following:

a. Schedule of work with listing of each spall repair location.

b. Description of equipment used for:
   1. Existing concrete removal.
   2. Surface preparation.
   3. Installation of joint protection materials.
   4. Measuring, mixing, placing, and finishing the polymer concrete.
   5. Screed and trowel surface for ensuring level with adjacent pavement.


d. Cure time for polymer concrete.

e. Storage and handling of polymer concrete system components.

f. Procedure for disposal of excess materials, polymer concrete, and containers.

With the spall repair plan, the Contractor shall submit the following:

a. Polymer concrete system components. Provide manufacturer certification verifying the materials are in accordance with this specification. Provide material safety data sheets for each of the polymer concrete system components.

b. At least three (3) previous projects in which the concrete system from the proposed supplier has been used and satisfactory performance has been achieved. The previous projects must have been completed within the last five (5) years and have been open to traffic for not less than one (1) year. Include in the submittal, location of project, name of polymer concrete system supplier, approximate date of project opening to traffic, owner, and owner contact person with phone number.

117-1.3 QUALITY CONTROL AND ASSURANCE.

a. Training. The Contractor shall arrange to have the polymer concrete system supplier furnish technical service related to application of materials and health and safety training for personnel that will handle and install the polymer concrete system components.

b. Trial Application. Complete a trial application before beginning proposed work as shown in the plans to demonstrate suitability of the proposed spall repair procedures, including:
   1. Removal of existing concrete and cleaning of surfaces to receive polymer concrete system components.
2. Proper use of proposed equipment.
3. Measuring, mixing, placing, and finishing the polymer concrete.

The materials, methods, and equipment used in the trial application shall be the same as those intended for use in the proposed spall repair work as shown in the plans. If at any time different materials, methods, or equipment are to be used, new trial application will be required.

The trial application shall include each of the following types of improvement areas – at a concrete panel corner, along a concrete panel joint (not extending into a corner), and at a popout. Each of the repair types within the trial application shall be replaced to a minimum area of no less than four (1) square feet.

Trial application locations shall be coordinated with the Owner’s representative. The trial application location will not be within the proposed work area as shown in the plans, but rather shall be at a nearby non-invasive location of the Owner’s representative’s choosing.

The number of trial applications required shall be as many as necessary for the Contractor to demonstrate the ability to construct an acceptable trial application section and competency to perform the work. However, the installer or proposed equipment/techniques may be rejected if not shown to be acceptable after three (3) trials.

The trial application shall not be measured for payment. It shall be considered subsidiary to the scope of work of the pay items of this specification.

c. Technical Support. The Contractor shall arrange to have a polymer concrete system supplier representative onsite during the placement of the polymer concrete system components.

MATERIALS

117-2.1 POLYMER CONCRETE. All polymer concrete system components shall be purchased from a single supplier.

The Contractor shall submit a Certified Test Report from an independent testing lab for all of the materials associated with the polymer concrete system components.

All components shall be shipped in strong, substantial containers bearing the manufacturer’s label specifying batch/lot number, brand name, and quantity. If bulk materials are to be used, the contractor shall notify the Engineer in writing with the product submittals. Bulk materials are any that are stored in containers in excess of 55 gallons.

The Owner reserves the right to retain and test samples of the polymer concrete system components. This includes requiring submittal of samples prior to the first installation or onsite sampling during construction.

a. Composite system.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Bond Strength</td>
<td>ASTM C 882</td>
<td>2,500 psi minimum</td>
</tr>
<tr>
<td>Abrasion Resistance</td>
<td>ASTM C 501</td>
<td>1.0 Max</td>
</tr>
</tbody>
</table>
CONSTRUCTION REQUIREMENTS

117-3.1 Pre-paving Conference. A Pre-paving Conference shall be held before any spall repair operations begin. Attendees shall include representatives from all parties involved in the work, including, but not limited to, the contractor, any involved subcontractors, and the polymer concrete system. If necessary, teleconferencing of attendees may be approved by the Engineer.

117-3.2 Equipment. All equipment shall be demonstrated to be in proper working order prior to commencing work.

a. Concrete Removal and Cleaning Equipment. All concrete removal and cleaning equipment shall be as specified in FAA Item P-101, Surface Preparation, or as shown on the plans.

b. Mixing Equipment: A continuous automated mixer shall be used for all polymer concrete applications. The continuous mixer shall:

1. Employ an auger screw/chute device capable of sufficiently mixing materials with dry aggregate.
2. Employ a plural component pumping system capable of handling resin and catalyst while maintaining proper ratios to achieve set/cure times within the specified limits. Catalyzed resin shall flow through a static mix tube for sufficient duration to completely mix the liquid system.
3. Be equipped with an automatic metering device that measures and records aggregate and resin volumes. Record volumes at least every five minutes, including time and date. Submit recorded volumes at the end of the work shift.
4. Have a visible readout gage that displays volumes of aggregate and resin being recorded.
5. Produce a satisfactory mix consistently during the entire placement.

A portable mechanical mixer of appropriate size for proposed batches, as recommended by the polymer concrete system supplier and approved by the Engineer, may be used.

c. Finishing Equipment. Finishing of spall repair areas shall be completed using hand concrete finishing tools. Patches shall be placed flush with the top of the surrounding pavement surface.

117-3.3 Surface Preparation. All spalled concrete areas designated for repair shall be removed in accordance with FAA Item P-101, Surface Preparation, or as shown on the plans.

The surface of concrete shall be prepared for application of the polymer concrete system components by high pressure water blasting, or as required by the polymer concrete system supplier, in order to remove all existing grease, slurry, oils, paint, dirt, striping, cure compound, rust, membrane, weak surface mortar or any other contaminants that could interfere with the proper adhesion of the system.

The final prepared surface shall adhere to the following requirements:

a. Cleaning shall not commence until all work involving the removal of areas designated for replacement has been completed and the surface is dry. The water blasting unit shall be adjusted so as to result in all unsound or loose concrete being removed, aggregates within the concrete being exposed, and open pores in the concrete exposed. If the concrete becomes contaminated before placing the polyester polymer concrete system components, the Contractor shall clean the contaminated areas to the satisfaction of the Engineer at no additional cost.

b. The areas to be receive polymer concrete system components shall be blown off with oil and
moisture free compressed air immediately prior to placement of the primer and shall be completely dry. Use of water blasting equipment shall not be allowed.

c. Cleaning methods other than those detailed in this specification or in the plans may be suggested by the polyester polymer concrete system supplier and approved by the Engineer.

d. All steel surfaces that will be in contact with the polymer concrete shall be cleaned in accordance with SSPC-SP No. 10, Near-White Blast Cleaning.

117-3.4 Application of Polymer Concrete System Components. Methods shown in this specification are typical of general installations and may be modified per the polyester polymer concrete system supplier’s recommendations as approved by the Engineer. The application of the polymer concrete system shall not begin until the concrete is completely surface dry in accordance with ASTM D4263. The concrete surface temperature shall be between 40° and 100° F. Night work may be required when temperatures cannot be met during the day.

During polymer concrete applications, the Contractor shall provide suitable coverings (e.g. heavy duty drop cloths) as needed to protect all exposed areas not to receive application. All damage or defacement resulting from this application shall be cleaned and/or repaired to the Engineer's satisfaction at no additional cost.

a. Polymer Concrete Application. The polymer concrete shall be applied after 15 minutes and within two (2) hours after the pavement has been cleaned. The polymer concrete shall be placed prior to gelling or 15 minutes following addition of initiator, whichever occurs first, or as recommended by the polymer concrete system supplier.

The resin binder shall be initiated and blended completely. Aggregate shall be added and mixed sufficiently when a portable mechanical mixer is used.

Polymer concrete shall have an initial set time of at least 30 minutes and at most 90 minutes. The set time can be determined in the field when the in-place polymer concrete cannot be deformed by pressing with a finger, indicating that the binder is no longer in a liquid state. If the initial set is not within 30-90 minutes, the material shall be removed and replaced.

Polymer concrete shall be finished as necessary through traditional concrete finishing methods, producing a slight resin bleed indicating complete consolidation of aggregates. Polymer concrete patches shall be finished by traditional concrete hand finishing methods.

Resin content shall be as specified herein to yield a polymer concrete consistency that requires surface applied consolidation and finishing to consolidate aggregates and yield a slight sheen of bleed resin on top surface, yet does not yield excess bleedresin.

A surface friction sand finish of at least 2.2 lbs. per square yard shall be broadcast onto the glossy surface immediately after sufficient finishing and before resin gelling occurs. To ensure adequate pavement friction, the completed polymer concrete surface shall be free of any smooth or "glassy" areas such as those resulting from insufficient quantities of surface aggregate. Any such surface defects shall be repaired by the Contractor in the manner recommended by the System Provider and approved by the Engineer at no additional cost.

The polymer concrete shall be textured to meet adjacent concrete surfaces.

b. Curing. The Contractor shall allow the polymer concrete to cure sufficiently before subjecting it to loads or traffic of any nature that may damage the polymer concrete. Cure time depends upon the ambient and adjacent concrete temperatures as well as initiator/accelerator levels.

The polymer concrete shall be considered cured to a traffic ready state when a minimum reading of 25 on a properly calibrated Schmidt hammer is achieved.

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c. Smoothness Quality Testing. The finished transverse and longitudinal surface elevation of the polymer concrete shall be measured using a straightedge. Areas to be measured will be as directed by the Engineer. The Contractor shall furnish an approved 10 foot straightedge, depth gauge, and operator to aid the Engineer in testing the pavement surface.

117-3.5 Corrective Work. A defective installation, or portion thereof, as determined by the Engineer, shall be removed and replaced at the Contractor’s expense. The Contractor shall submit a written corrective work proposal to the Engineer, which shall include the methods and procedures that will be used. The Contractor shall not commence corrective work until the methods and procedures have been approved in writing by the Engineer. The Engineer’s approval shall not relieve the Contractor of the responsibility of producing work in conformity with the Contract.

METHOD OF MEASUREMENT

117-4.1 “Partial Depth Pavement Repair (Spall Repair)” will be measured by the cubic foot. The volume to be paid for will be determined from calculations based on the quantity of existing concrete material removed. The Contractor shall furnish suitable measuring devices to assure correct proportioning of materials and accurate measurement for calculating payment quantities.

BASIS OF PAYMENT

117-5.1 Payment shall be at the contract unit price for the accepted quantities of “Partial Depth Pavement Repair (Spall Repair)”, measured as provided above. The price shall be full compensation for furnishing all materials and for all labor, equipment, tools and incidentals necessary to complete the item including but not limited to the sawcutting and removal of the existing concrete pavement, completion of soundness testing, protection of joints and surrounding pavement, installation of primer and polyester polymer concrete, curing, and clean-up.

Payment will be made under:

Item G-117-5.1 Partial Depth Pavement Repair (Spall Repair) - Per cubic foot.

END OF ITEM G-117
SECTION 02535

SEALING AND REPAIR OF CRACKS IN CONCRETE PAVEMENTS

DESCRIPTION

02535-1.1 General
This item shall consist of repairing and sealing existing cracks in Portland Cement Concrete (PCC) pavement in accordance with these specifications and the Plans, or as directed by the City Engineer.

MATERIALS

02535-2.1 JOINT and Crack SEALING MATERIALS. Non-sag silicone shall be used and shall meet the requirements of Specification Section 02517-Joint Sealing Item P-605 Joint Sealants for Concrete Pavements.

02535-2.2 SAND. Sand used as filler shall be clean, dry, free of extraneous materials and acceptable to the City Engineer.

CONSTRUCTION METHOD

02535-3.1 WEATHER LIMITATIONS. Do not proceed when weather conditions detrimentally affect the quality of repairing cracks and applying sealants. Apply sealants only if the atmospheric and pavement temperature is above 50 degrees F at the time of installation.

02535.3.2 EQUIPMENT. The Contractor shall furnish all equipment, tools and accessories necessary to thoroughly clean and repair the cracks in accordance with this specification, Specification 02517 Joint Sealing, manufacturer's recommendations, and approved procedures.

02535.3.3 CRACK PREPARATION.

A. General Crack Preparation. Saw cut cracks and remove extraneous material to a depth as shown on the plans, but in no case shall the vertical depth be less than 1 inch. Clean the cracks indicated for repair by the City Engineer. Do not proceed with final cleaning operations by more than one working day in advance of placing sealant. Thoroughly clean the cracks by removing dirt, unsound concrete, existing bituminous material, and other foreign material with the equipment specified herein but not limited thereto. Cleaning procedures, which damage pavement by chipping or spalling, will not be permitted. Precise shape and size of existing cracks vary, and the conditions of the cracks vary and include but are not limited to rounding, square edges, sloping chips, voids, depressions, and projections. Clean and seal only those cracks that are open wide enough to permit the entry of joint filler or a mechanical routing tool. Tightly closed cracks shall not be disturbed.

B. Cleaning of Cracks. Clean the existing cracks by sandblasting the exposed crack faces and the pavement surfaces extending one inch each way from the edges of the crack. Continue sandblasting until surfaces are free of any traces of unsound or contaminated concrete. Select sandblasting equipment to provide a minimum of 150 cubic feet per minute of air at a nozzle
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pressure of 90 pounds per square inch for final cleaning. After final cleaning and immediately
prior to sealing, blowout the cracks with compressed air free of oil and water. Use the air
compressor to remove all sand and water to ensure that the cracks are dry, dust free and clean at
the time of sealing. In some instances, sawing the cracks may be required. If sawing the cracks
is required, immediately after sawing, the resulting slurry will be completely removed from
the crack and adjacent area by flushing with a jet of water, and by use of other tools as
necessary. The crack will be allowed sufficient time to dry prior to sealing. When sawing
cracks, the reservoir ratio should be 2:1 with a 3/8-inch minimum width recommended.

The air compressors used for the purpose described above must be equipped with traps capable of
removing moisture and oil from the air. Work shall be stopped when and if it is found that there is oil
or moisture in the compressed air. Work shall not resume until suitable adjustments are made and the
air stream is found to be free of such contaminants.

Under no conditions will the Contractor be permitted to place the sealant if there is dust, moisture, or
oil. Any other suitable materials and method used for this purpose shall be subject to the approval of the
City Engineer.

C. Disposal of Debris. Sweep pavement surface to remove excess sealant material, dirt, water,
sand, and other debris by vacuum sweepers or hand brooms. Properly dispose of off the airport property.

02535.3.4 Installation of Crack Sealant. Immediately before sealing, the cracks will be
thoroughly cleaned of all remaining laitance and other foreign material. Cleaning will be
accomplished by sandblasting. Sandblasting will be accomplished in a minimum of two passes. One
pass per crack face with the nozzle held at an angle directly toward the crack face and not more than 3
inches from it. Upon completion of cleaning, the cracks will be blown out with compressed air free of
oil and water. Only air compressors with operable oil and water traps will be used to prepare the
cracks for sealing. Crack faces will be surface dry when the seal is applied. The surface of the installed
sealant material will be 1/4-inch to 3/8-inch below the existing pavement surface. Install material in
accordance with manufacturer's recommendations. Do not install crack material until the cracks to be
sealed have been inspected and approved by the Engineer. Fill the crack without formation of voids or
entraped air. Remove excess material that has been inadvertently spilled on the concrete pavement.

A. Silicone Sealants. The crack sealant will be applied uniformly solid from bottom to top and
will be filled without formation of entrapped air or voids. Backing rod material will be placed
as per sealant manufacturer’s requirements and will be both non-reactive and non-adhesive to
the pavement and the sealant material. A direct connecting pressure type extruding device
with nozzles shaped for insertion into the joint will be provided. Any sealant spilled on the
surface of the pavement, structures and/or lighting fixtures will be removed immediately.

B. Backer Rod Material. The use of backer rod material or bond breaker in the bottom of the
[joint][crack] 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
materials and bond breakers should be compatible with the sealant, should not adhere to the
sealant, should be compressible without extruding the sealant, and should recover to maintain
contact with the crack faces when the crack is open. The backer rod will be 25 percent larger
in diameter that the width of the reservoir.

02535.3.4 Traffic Control. During the protection, curing and maintenance periods recommended
by the manufacturer, do not permit vehicular or heavy equipment in the area of the cracks. At the end of
the curing period, traffic may be permitted on the pavement if approved.
02535.3.5 Acceptance. Acceptance will be based upon approved acceptance criteria. Crack material that fails to bond firmly, or is gummy, or fails in cohesion or shows excessive air voids, blisters, shows face defects, swelling, or deficiencies, shall be rejected. Such unacceptable sealer shall be removed and the crack re cleaned and resealed in accordance with the specification. This removal and reseal work shall be done promptly by and at the expense of the Contractor.

02535.3.6 DISPOSAL. Dispose of material containers and excess sealant in accordance with current environmental regulations.

METHOD OF MEASUREMENT

02535.4.1 The sealing of cracks in existing concrete pavement shall be measured by the linear foot of crack repair sealant in place, completed, and accepted. No separate measurement will be made for additives or other materials.

BASIS OF PAYMENT

02535.5.1 Payment shall be made at the contract price per linear foot for crack repair. This price shall be full compensation for furnishing all material, for all preparation, delivery, and placing of these materials, and for all labor, equipment, tools, supervision and incidentals necessary to complete the item.

Payment will be made under:

Item 02535 Crack Repair in Existing Concrete Pavement – per Linear Foot.

TESTING REQUIREMENTS

ASTMD 1644
Fed. Spec.
SS-200

Tests for Non-Volatile Content of Varnishes

MATERIAL REQUIREMENTS

Sealing Compounds, Two Component, Elastomeric, Polymer Type, Jet-Fuel Resistant, Cold Applied

END OF SECTION
ITEM P-101 SURFACE PREPARATION

DESCRIPTION

101-1.1 This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable drawings.

EQUIPMENT

101-2.1 All equipment shall be specified here and in the following paragraphs or approved by the Engineer. The equipment shall not cause damage to the pavement to remain inplace.

CONSTRUCTION

101-3.1 GENERAL

The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified herein. All work shall be subject to the inspection and approval of the Engineer. All machinery and equipment owned or controlled by the Contractor which the Contractor proposes to use on the work shall be of sufficient size to meet the requirements of the work and shall be such as to produce work to the requirements listed herein and in the plans.

Where only a portion of the existing pavement is to be demolished, special care shall be exercised to avoid damage to that portion of the pavement to remain in place. The existing pavement shall be cut to the neat lines shown on the plans or established by the Engineer, and any existing pavement beyond the neat lines so established which is damaged or destroyed by these operations shall be replaced at the Contractor's expense with no additional compensation from the Owner. The face of any sawcut shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/4 inch and no gradual offset greater than one (1) inch when tested in a horizontal direction with a 16-foot straightedge. Sawcutting depth may vary nominally and no extra payment will be allotted for varying depths.

The equipment used by the Contractor to demolish and / or remove existing pavement shall be operated in a manner that will avoid damaging underlying base and / or subbase layers, underlying structures, cables, utilities and utility ducts, pipelines, drainage structures and facilities, bridge approach slabs, bridge decks and other facilities not also designated for removal. Accordingly, heavy pavement breaking equipment that would cause a seismic disturbance of the soil, shall not be used for breaking pavement within: 50 feet of any existing water lines, fuel lines, storm sewers, sanitary sewers, or any other underlying utility or structure not also designated for removal; or within 50 feet of any edge of pavement designated to remain. Falling weight demolition equipment shall not be permitted on this project. All pavement demolition equipment shall be hydraulic equipment.

If any damage occurs, the Contractor shall cease operations immediately, notify the Owner’s representative, and repair the damage at the direction of the Engineer. Repairs shall be made timely, without change in the construction schedule, and at the sole expense of the Contractor. Any damage shall be repaired at the Contractor’s expense.

Removal and replacement of damaged areas shall be to existing joint lines, unless otherwise shown in the
airs or authorized by the Engineer. Partial concrete slab replacement will not be allowed. The Contractor shall be responsible for all costs associated with removal and replacement of damaged slabs that are scheduled to remain.

101-3.2 REMOVAL OF EXISTING PAVEMENT.

The Engineer and the Contractor shall mutually agree upon the pavement demolition and removal procedure based upon compliance with the criteria set forth in the plans and in this specification.

Removal of existing pavements shall not be measured for separate payment. Existing pavement thicknesses to be removed, denoted in the project demolition plans, are approximate and may not accurately reflect actual existing pavement thicknesses. Removal of existing pavements shall include sawcutting, removal, and disposal of all material layers of the pavement section as required to meet the removal depth requirements listed therein. No additional payment shall be made if actual pavement sections vary from the pavement sections shown in the plans or geotechnical investigation report, including thickened pavement edges. It shall be the Contractor’s responsibility, as part of the bidding process, to determine the level of effort required to remove the pavement areas shown.

a. Concrete pavement. The existing concrete pavement to be removed shall be freed from the pavement to remain by sawing through the complete depth of the slab one foot (30 cm) inside the perimeter of the final removal limits or outside the dowels, whichever is greater when the limits of removal are located on the joints. The pavement between the perimeter of the pavement removal and the saw cut shall be carefully broken up and removed using hand-held jackhammers, weighing 30 pounds (14 kg) or less, or other light-duty equipment which will not cause distress in the pavement which is to remain in place. The Contractor shall have the option of sawing through the dowels at the joint, removing the pavement saw through the existing dowels and installing new dowels.

Where keyed joints are encountered, the Contractor shall remove the “male” portion of the keyway, if it is a part of the pavement to remain in order to create a smooth vertical face. The male keyway shall be removed by saw cutting if there are no dowels or tie bars which are scheduled to be saved. If the pavement that is to remain has the “female” portion of the keyway, the Contractor shall remove the “female” portion of the keyway that is a part of the pavement scheduled to remain by sawcutting full depth 6” away from that joint. The additional 6” required for removal shall be incidental to this item.

Where the perimeter of the removal limits is not located on the joint and there are no dowels present, then the perimeter shall be saw cut the full depth of the pavement, including all underlying base and / or subbase layers also designated for removal. The pavement inside the saw cut shall be removed by methods suitable to the Engineer which will not cause distress in the pavement which is to remain in place. If the material is to be wasted on the airport site, it shall be reduced to a maximum size designated by the Engineer. The Contractor’s removal operation shall not cause damage to cables, utility ducts, pipelines, or drainage structures under the pavement. Concrete slabs that are damaged by under breaking shall be removed. Any damage shall be repaired at the Contractor’s expense.

b. Asphalt concrete pavement. Asphalt concrete pavement to be removed shall be cut to the full depth of the bituminous material around the perimeter of the area to be removed. The pavement shall be removed so the joint for each layer of pavement replacement is offset 1 foot (30 cm) from the joint in the preceding layer. This does not apply if the removed pavement is to be replaced with concrete or soil. If the material is to be wasted on the airport site, it shall—

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broken to a maximum size of —— inches (mm). } { meet the following gradation: }

c. Where only a portion of the existing pavement is to be demolished, special care shall be exercised to avoid damage to that portion of the pavement to remain in place. The existing pavement shall be cut to the neat lines shown on the plans or established by the Engineer, and any existing pavement beyond the neat lines so established which is damaged or destroyed by these operations shall be replaced at the Contractor's expense with no additional compensation from the Owner.

d. In the event the demolished Portland Cement Concrete and/or bituminous concrete pavements are used either as recycled asphalt pavement (RAP) or pavement that will be crushed and utilized as base or subbase material on the project, the cost for removal and operations performed to reuse the demolished pavements shall be included in the unit prices for which the material will be used.

101-3.3 PREPARATION OF JOINTS AND CRACKS. [Asphalt]

Remove all vegetation and debris from cracks to a minimum depth of 1 inch (25 mm). If extensive vegetation exists treat the specific area with a concentrated solution of a water-based herbicide approved by the Engineer. Fill all cracks, ignoring hairline cracks (< 1/4 inch (6 mm) wide) with a crack sealant per ASTM D6690. Wider cracks (over 1-1/2 inch wide (38 mm)), along with soft or sunken spots, indicate that the pavement or the pavement base should be repaired or replaced as stated below. Any excess joint or crack sealer on the surface of the pavement shall also be removed from the pavement surface.

101-3.4 REMOVAL OF PAINT AND RUBBER.

All paint and rubber over 1 foot (30 cm) wide that will affect the bond of the new overlay shall be removed from the surface of the existing pavement. Chemicals, high-pressure water, heater scarifier (asphaltic concrete only), cold milling, or sandblasting may be used. Any methods used shall not cause major damage to the pavement. Major damage is defined as changing the properties of the pavement or removing pavement over 1/8 inch (3 mm) deep. If chemicals are used, they shall comply with the state’s environmental protection regulations. No material shall be deposited on the runway shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans.

101-3.5 CONCRETE SPALL OR FAILED ASPHALTIC CONCRETE PAVEMENT REPAIR.

a. Repair of concrete spalls in areas to be overlaid with asphalt. The Contractors shall repair all spalled concrete as shown on the plans or as directed by the Engineer. The perimeter of the repair shall be saw cut a minimum of 3 inches (76 mm) outside the affected area and 4 inches (102 mm) deep. The deteriorated material shall be removed to a depth where the existing material is firm or cannot be easily removed with a geologist pick. The removed area shall be filled with asphaltic concrete with a minimum Marshall stability of 1,200 lbs (544 kg) and maximum flow of 20 (units of 0.01 in). The material shall be compacted with equipment approved by the Engineer until the material is dense and no movement or marks are visible. The material shall not be placed in lifts over 1 inches (100 mm) in depth. This method of repair applies only to pavement to be overlaid.

b. Asphaltic concrete pavement repair. The failed areas shall be removed as specified in paragraph 101-3.2b. All failed material including surface, base course, subbase course, and subgrade shall be removed. The base course and subbase shall be replaced if it has been infiltrated with clay, silt, or other material affecting the load-bearing capacity. Materials and methods of construction shall comply with the other applicable sections of this specification.

101-3.6 COLD MILLING.

Milling shall be performed with a power-operated milling machine or grinder, capable of producing a finished surface that provides a good bond to the new overlay. The milling machine or grinder shall operate without tearing or gouging the under laying surface. The milling machine or grinder shall be equipped with automatic grade and slope controls. All millings shall be removed and disposed of off Airport property, unless otherwise specified. If the Contractor mills or grinds deeper or wider than the plans specify, the
Contractor shall replace the material that was removed with new material at no additional cost to the Owner.

a. **Patching.** The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement and it shall have a positive method of controlling the depth of cut. The Engineer shall layout the area to be milled with a straightedge in increments of 1 foot (30 cm) widths. The area to be milled shall cover only the failed area. Any excessive area that is milled because the Contractor doesn’t have the appropriate milling machine, or areas that are damaged because of his negligence, shall not be included in the measurement for payment.

b. **Profiling, grade correction, or surface correction.** The milling machine shall have a minimum width of 7 feet and it shall be equipped with electronic grade control devices that will cut the surface to the grade and tolerances specified. The machine shall cut vertical edges. A positive method of dust control shall be provided. The machine shall have the ability to remove the millings or cuttings from the pavement and load them into a truck.

c. **Clean-up.** The Contractor shall sweep the milled surface daily and immediately after the milling until all residual aggregate and fines are removed from the pavement surface. Prior to paving, the Contractor shall wet down the milled pavement and thoroughly sweep and/or blow the surface to remove any remaining aggregate or fines.

101-3.7 **PREPARATION OF ASPHALT PAVEMENTS SURFACES.**

Existing asphalt pavements indicated to be treated with a surface treatment shall be prepared as follows:

a. Patch asphalt pavement surfaces that have been softened by petroleum derivatives or have failed due to any other cause. Remove damaged pavement to the full depth of the damage and replace with new asphalt concrete similar to that of the existing pavement in accordance with paragraph 101-3.5.

b. Repair joints and cracks in accordance with paragraph 101-3.3.

c. 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 an oil spot primer.

d. Clean pavement surface immediately prior to placing the surface treatment 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.

101-3.8 **MAINTENANCE.**

The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the Engineer. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor’s expense.

101-3.9 **PREPARATION OF JOINTS IN RIGID PAVEMENT.**

101-3.9.1 **Removal of Existing Joint Sealant.** All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch (2 mm) from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry. Allow sufficient time to dry out joints prior to sealing.

101-3.9.2 **Cleaning prior to sealing.** Immediately before sealing, joints shall be cleaned by removing any remaining laitance and other foreign material. Clean joints by sandblasting, or other method.
approved by the Engineer, on each joint face with nozzle held at an angle and not more than three inches (75 mm) from face. Following sandblasting, clean joints with air free of oil and water. Joint surfaces will be surface-dry prior to installation of sealant.

**101-3.10 PREPARATION OF CRACKS IN FLEXIBLE PAVEMENT.**

**101-3.10.1 Preparation of Crack.** Widen crack with router by removing a minimum of 1/16 inch (2 mm) from each side of crack. Immediately before sealing, joints will be blown out with a hot air lance combined with oil and water-free compressed air.

**101-3.10.2 Removal of Existing Sealant.** Existing sealants will be removed by routing. Following routing any remaining debris will be removed by use of a hot lance combined with oil and water-free compressed air.

**METHOD OF MEASUREMENT**

**101-4.1 Removal of existing concrete airfield pavements shall not be measured for separate pavement but shall be subsidiary to the various bid items as described in P-401 and P-501.**

**101-4.2 Repair of concrete spalls on existing airfield concrete pavement shall be measured and paid in accordance with Item G-117.**

**101-4.3 Crack Repair in Existing Asphalt Pavement.** Crack Repair in Existing Asphalt Pavement shall be measured by the linear feet of repair, regardless of depth, installed by the Contractor, as shown in the plans and called out for repair is the basis of payment. Any cracks repaired outside the limits of repair shown by the Contractor shall not be included in the measurement for payment unless the Contractor receives prior written approval from the Owner.

**101-4.4 Repair of concrete cracks in existing airfield concrete pavement shall be measured and paid in accordance with Item 02535.**

**BASIS OF PAYMENT**

**101-5.1 Payment.** Payment shall be made at contract unit price for the unit of measurement as specified above. This price shall be full compensation for furnishing all materials and for all preparation, hauling, and placing of the material and for all labor, equipment, tools, and incidentals necessary to complete this item.

| Item P-101-5.1 | Crack Repair in Existing Asphalt Pavement – per linear foot |

**MATERIAL REQUIREMENTS**

ASTM D6690 Standard Specification For Joint And Crack Sealants, Hot Applied, For Concrete And Asphalt Pavements

**END OF ITEM P-101**
ITEM P-152 EXCAVATION, SUBGRADE, AND EMBANKMENT

DESCRIPTION

152-1.1 This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

152-1.2 Classification. All material excavated shall be classified as defined below:

a. Unclassified excavation. Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature which is not otherwise classified and paid for under one of the following items or classified and paid for under other specification items in this contract. Unclassified excavation shall include the placement of the excavated materials at an approved and designated waste area on-site in successive lifts at the required compaction levels indicated herein.

b. Rock excavation. Rock excavation shall include all solid rock in ledges, in bedded deposits, in 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 1/2 cubic yard (0.4 m3) will be classified as “rock excavation.”

c. Muck excavation. Muck excavation shall consist of the removal and disposal of deposits or mixtures of soils and organic matter not suitable for foundation material. Muck shall include materials that will decay or produce subsidence in the embankment. It may consist of decaying stumps, roots, logs, humus, or other material not satisfactory for incorporation in the embankment.

d. Drainage excavation. Drainage excavation shall consist 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.

e. Borrow excavation. Borrow excavation shall consist of approved material required for the construction of embankments or for other portions of the work in excess of the quantity of usable material available from required excavations. Borrow material shall be obtained from areas designated by the Engineer within the limits of the airport property but outside the normal limits of necessary grading, or from areas outside the airport boundaries.

152-1.3 UNSUITABLE EXCAVATION.

Any material containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction. Material, suitable for topsoil may be used on the embankment slope when approved by the Engineer.

152-1.4 CONTAMINATED MATERIAL.

All borrow material shall be naturally occurring and originate from a source that has not been impacted from any known environmental concern, industrial process, or other uncontrolled activities such as, but not limited to, emergency responses, hazardous material incidents or discharges of any regulated/adverse chemical compounds. The borrow material shall be free of any industrial waste, sanitary waste, household waste or solid waste, and shall not exhibit any signs of sludge, staining, pitting, strong pungent noxious
odors, non-aqueous phase liquids, foreign debris, or other pollutants.

CONSTRUCTION METHODS

152-2.1 GENERAL.

Before beginning excavation, grading, and embankment operations in any area, the area shall be completely cleared and grubbed in accordance with Item P-151 and stripped in accordance with Item T-905.

The suitability of material to be placed in embankments shall be subject to approval by the Engineer. All unsuitable material shall be disposed of in waste areas shown on the plans legally off airport property by the Contractor. All waste areas shall be graded to allow positive drainage of the area and of adjacent areas. The surface elevation of waste areas shall not extend above the surface elevation of adjacent usable areas of the airport, unless specified on the plans or approved by the Engineer.

When the Contractor’s excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued and the Engineer notified per subsection 70-20. At the direction of the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Those areas outside of the limits of the pavement areas where the top layer of soil material has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4 inches (100 mm), to loosen and pulverize the soil.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor shall notify the Engineer, who shall arrange for their removal if necessary. The Contractor, at his or her expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor’s operations during the period of the contract.

152-2.2 EXCAVATION.

No excavation shall be started until the work has been staked out by the Contractor and the Engineer has obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface. All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the Engineer. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

When the volume of the excavation exceeds that required to construct the embankments to the grades indicated, the excess shall be used to grade the areas of ultimate development or disposed as directed by the Engineer. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from borrow areas.

The grade shall be maintained so that the surface is well drained at all times. When necessary, temporary drains and drainage ditches shall be installed to intercept or divert surface water that may affect the work.

a. Selective grading. When selective grading is indicated on the plans, the more suitable material designated by the Engineer shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas so that it can be measured for payment as specified in paragraph 152-3.3.

b. Undercutting. Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a
EXCAVATION, SUBGRADE, AND EMBANKMENT

minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the Engineer. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed off the airport. The cost is incidental to this item. This excavated material shall be paid for at the contract unit price per cubic yard for Undercut and Replace Unsuitable Subgrade Material with Suitable Material as Directed by the Engineer. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities. The necessary backfill is incidental to this item. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans.

Material that is high in moisture content and which yields under proof rolling does not necessarily constitute an unsuitable material. The Contractor is required to manipulate and dry the material. If the material is classified as unsuitable material, then the Contractor shall remove the material to the depth directed by the Engineer but not greater than 3-feet below subgrade. The backfill of such areas shall not begin until the volume of the unsuitable excavation is determined by cross sections or other means acceptable to the Engineer. The backfill shall be accomplished in accordance with the embankment requirements contained in this specification. The backfill material may consist of borrow excavation, unclassified excavation or select backfill or other materials acceptable to the Engineer.

c. Overbreak. Overbreak, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the Engineer. All overbreak shall be graded or removed by the Contractor and disposed of as directed by the Engineer. The Engineer shall determine if the displacement of such material was unavoidable and his or her decision shall be final. Payment will not be made for the removal and disposal of overbreak that the Engineer determines as avoidable. Unavoidable overbreak will be classified as “Unclassified Excavation.”

d. Removal of Utilities. The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by someone other than the Contractor; for example, the utility unless otherwise shown on the plans. All existing foundations shall be excavated at least 2 feet (60 cm) below the top of subgrade or as indicated on the plans, and the material disposed of as directed by the Engineer. All foundations thus excavated shall be backfilled with suitable material and compacted as specified.

e. Compaction requirements. The subgrade under areas to be paved shall be compacted to a depth of [6 inches] 12-inches and to a density of not less than [95] percent of the maximum density as determined by ASTM [D1557]. The material to be compacted shall be within ±2% of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils).

The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade. The finished grading operations, conforming to the typical cross-section, shall be completed and maintained at least 1,000 feet (300 m) ahead of the paving operations or as directed by the Engineer.

All loose or protruding rocks on the back slopes of cuts shall be pried loose or otherwise removed to the slope finished grade line. All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the Engineer.

Blasting shall not be allowed. Blasting will be permitted as directed by the Engineer and in

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accordance with the following:

Blasting will be permitted only when proper precautions are taken for the safety of all persons, the work, and the property. All damage done to the work or property shall be repaired by the Contractor. The cost of repair is incidental to this item. All operations of the Contractor in connection with the transportation, storage, and use of explosives shall conform to all Federal, state and local regulations and explosive manufacturers’ instructions, with applicable approved permits reviewed by the Engineer. Any approval will not relieve the Contractor of his or her responsibility in blasting operations.

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

In each distinct blasting area, where pertinent factors affecting blast vibrations and their effects in the area remain the same, the Contractor shall submit a blasting plan of the initial blasts to the Engineer 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 shall not be increased without the approval of the Engineer.

The Contractor shall 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.

These records shall be made available to the Engineer on a monthly basis or in tabulated form at other times as required.

f. Proof rolling. After compaction is completed, the subgrade area shall be proof rolled with a 20 ton Tandem axle Dual Wheel Dump Truck loaded to the legal limit with tires inflated to 100 psi or a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of 30,000 pounds and inflated to a minimum of 125 psi in the presence of the Engineer. Apply a minimum of 95% coverage, or as specified by the Engineer, to all paved areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be removed and replaced with suitable material or reworked to conform to the moisture content and compaction requirements in accordance with these specifications.

152-2.3 BORROW EXCAVATION.

Borrow areas within the airport property are indicated on the plans. Borrow excavation shall be made only at these designated locations and within the horizontal and vertical limits as staked or as directed by the Engineer.

When borrow sources are outside the boundaries of the airport property, it shall be the Contractor’s responsibility to locate and obtain the borrow sources, subject to the approval of the Engineer. The Contractor shall notify the Engineer at least 15 days prior to beginning the excavation so necessary measurements and tests can be made. All borrow pits shall be opened up to expose the various strata of acceptable material to allow obtaining a uniform product. All unsuitable material shall be disposed of by the Contractor. Borrow pits shall be excavated to regular lines to permit accurate measurements, and they shall be drained and left in a neat, presentable condition with all slopes dressed uniformly.

Prior to any off-site borrow source being utilized on the project, the Contractor shall submit test reports of the material properties for the borrow source. The Engineer shall approve all sources and test results prior
to any material from the borrow source being installed. The Engineer shall also have the opportunity to visit the borrow source and perform verification testing. If the tests conducted at the proposed borrow site fail the specification requirements, the cost for such testing will be paid for by the Contractor.

152-2.4 DRAINAGE EXCAVATION.

Drainage excavation shall consist of excavating for drainage ditches such as intercepting; inlet or outlet ditches; for temporary levee construction; or for any other type as designed or as shown on the plans. The work shall be performed in sequence with the other construction. Intercepting ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the Engineer. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted.

There shall be no separate payment for drainage excavation, it will be considered incidental to the drainage items requiring its use. Any de-watering operations for acceptable installation or associated excavation operations shall be incidental to the items requiring its use.

152-2.5 PREPARATION OF EMBANKMENT AREA.

Where an embankment is to be constructed to a height of 4 feet (1.2 m) or less, all sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm) and shall then be compacted as indicated in paragraph 152-2.6. When the height of fill is greater than 4 feet (1.2 m), sod not required to be removed shall be thoroughly disked and recompacted to the density of the surrounding ground before construction of embankment.

Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches (300 mm) and compacted as specified for the adjacent fill.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the quantity of excavation removed will be paid for under the respective items of work.

152-2.6 FORMATION OF EMBANKMENTS.

Embankments shall be formed in successive horizontal layers of not more than 8 inches (200 mm) in loose depth for the full width of the cross-section, unless otherwise approved by the Engineer.

The layers shall be placed, to produce a soil structure as shown on the typical cross-section or as directed by the Engineer. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each layer shall be within ±2% of optimum moisture content before rolling to obtain the prescribed compaction. To achieve a uniform moisture content throughout the layer, the material shall be moistened or aerated as necessary. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken for each 1,000 square yards (840 square meters) of material placed per layer. Based on these tests, the Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.
Rolling operations shall be continued until the embankment is compacted to not less than 95% of maximum density for noncohesive soils, and 90% of maximum density for cohesive soils as determined by ASTM D1557. Under all areas to be paved, the embankments shall be compacted to a depth of 12 inches and to a density of not less than 95 percent of the maximum density as determined by ASTM D1557.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches (100 mm).

The in-place field density shall be determined in accordance with ASTM 6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The Owner shall perform all density tests.

Compaction areas shall be kept separate, and no layer shall be covered by another layer until the proper density is obtained.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment as each layer is placed. Layer placement shall begin in the deepest portion of the embankment fill. As placement progresses, the layers shall be constructed approximately parallel to the finished pavement grade line.

When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portion of the embankment and the other material shall be incorporated under the future paved areas. Stones or fragmentary rock larger than 4 inches (100 mm) in their greatest dimensions will not be allowed in the top 6 inches (150 mm) of the subgrade. Rockfill shall be brought up in layers as specified or as directed by the Engineer and the finer material shall be used to fill the voids with forming a dense, compact mass. Rock or boulders shall not be disposed of outside the excavation or embankment areas, except at places and in the manner designated on the plans or by the Engineer.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in layers not exceeding 2 feet (60 cm) in thickness. Each layer shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The layer shall not be constructed above an elevation 4 feet (1.2 m) below the finished subgrade.

There will be no separate measurement of payment for compacted embankment. All costs incidental to placing in layers, compacting, discing, watering, mixing, sloping, and other operations necessary for construction of embankments will be included in the contract price for excavation, borrow, or other items. [*Payment for compacted embankment will be made under embankment in place and no payment will be made for excavation, borrow, or other items.*]

**152-2.7 FINISHING AND PROTECTION OF SUBGRADE.**

After the subgrade is substantially complete, the Contractor shall remove any soft or other unstable material over the full width of the subgrade that will not compact properly. All low areas, holes or depressions in the subgrade shall be brought to grade with suitable select material. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans.

Grading of the subgrade shall be performed so that it will drain readily. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes. All ruts or rough places that develop in the completed subgrade shall be graded and recompacted.

No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been approved by the Engineer.
152-2.8 HAUL.

All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

152-2.9 TOLERANCES.

In those areas upon which a subbase or base course is to be placed, the top of the subgrade shall be of such smoothness that, when tested with a 12-foot (3.7-m) straightedge applied parallel and at right angles to the centerline, it shall not show any deviation in excess of 1/2 inch (12 mm), or shall not nor shall it be more than 0.05 feet (15 mm) from true grade as established by grade hubs. Any deviation in excess of these amounts shall be corrected by loosening, adding, or removing materials; reshaping; and recompacting.

On safety areas, intermediate and other designated areas, the surface shall be of such smoothness that it will not vary more than 0.10 feet (3 mm) from true grade as established by grade hubs. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

152-2.10 TOPSOIL.

When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall not be placed within 500 feet of runway pavement or 200 feet of taxiway pavement and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the Engineer, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further rehandling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as directed, or as required in Item T-905.

No direct payment will be made for topsoil under Item P-152. The quantity removed and placed directly or stockpiled shall be paid for at the contract unit price per cubic yard (cubic meter) for “Unclassified Excavation.”

When stockpiling of topsoil and later rehandling of such material is directed by the Engineer, the material so rehandled shall be paid for at the contract unit price per cubic yard (cubic meter) for “topsoiling,” as provided in Item T-905.

METHOD OF MEASUREMENT

152-3.1 The quantity of excavation to be paid for shall be the number of cubic yards (cubic meters) measured in its original position. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

152-3.2 Borrow material shall be paid for on the basis of the number of cubic yards (cubic meters) measured in its original position at the borrow pit.

152-3.4 For payment specified by the cubic yard (cubic meter), measurement for all excavation shall be computed by the average end area method. The end area is that bound by the original ground line established by field cross-sections and the final theoretical pay line established by excavation cross-sections shown on the plans, subject to verification by the Engineer. After completion of all excavation operations and prior to the placing of base or subbase material, the final excavation shall be verified by the Engineer and Contractor by means of field cross-sections taken randomly at intervals not exceeding 500 linear feet (150 m).
sectional survey information shall be provided to the Engineer for verification in AutoCAD format.

152-3.5 The quantity of “Undercut and Replace Unsuitable Subgrade” to be paid for shall be the number of cubic yards of material excavated, as measured in its original position, as directed by the Engineer or his authorized representative in the field. Measurement shall be the actual volume measured, completed and accepted. No payment will be made for materials excavated and replaced without prior authorization of the Engineer or his authorized representative.

BASIS OF PAYMENT

152-4.1 “Unclassified excavation” payment shall be made at the contract unit price per cubic yard (cubic meter). This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

152-4.2 “Muck Excavation” payment shall be made at the contract unit price per cubic yard. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

152-4.3 The quantity of “Undercut and Replace Unsuitable Subgrade” to be paid for shall be the number of cubic yards of material excavated, as measured in its original position, as directed by the Engineer or his authorized representative in the field. Measurement shall be the actual volume measured, completed and accepted. No payment will be made for materials excavated and replaced without prior authorization of the Engineer or his authorized representative.

Payment will be made under:

Item P-152-4.1 Unclassified Excavation - per cubic yard
Item P-152-4.2 Undercut and Replace Unsuitable Subgrade - per cubic yard

TESTING REQUIREMENTS

ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN·m/m³))
ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2700 kN-m/m³))
ASTM D2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber-Balloon Method
ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

END OF ITEM P-152
ITEM P-156 TEMPORARY AIR AND WATER POLLUTION, SOIL EROSION, AND SILTATION CONTROL

DESCRIPTION

156-1.1 This item shall consist of temporary control measures as shown on the plans or as ordered by the Engineer during the life of a contract to control water pollution, soil erosion, and siltation through the use of silt fences, filter fabric barriers, berms, dikes, dams, sediment basins, fiber mats, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

The temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

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

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

156-1.2 Any permits which the Owner has obtained for any purpose such as NPDES, SPCC, etc., does not include nor cover the Contractor’s haul routes, equipment access points, staging areas, office compounds, materials stockpiles, blending and batch plant areas and operations or other project related activity areas outside the project limits or off site.

156-1.3 The Contractor shall prepare all required documentation, pay all fees and perform all services and work necessary to obtain all permits and approvals from any and all local, state and federal regulatory agencies for the Contractor’s staging, stockpile, blending and batch plant areas and operations. The cost of all permitting shall be subsidiary to other items of work.

156-1.4 The Contractor shall develop a Pollution Prevention Plan to supplement the Owner’s Stormwater Pollution Prevention Plan (SWPPP) as contained in the drawings. The plan shall be in strict compliance with the National Pollutant Discharge Elimination System (NPDES) permit issued or approved by the U.S. Environmental Protection Agency (EPA) pursuant to 40 CFR Part 122.6 and / or the Texas Pollutant Discharge Elimination System (TPDES) permit issued by the Texas Commission on Environmental Quality (TCEQ). The Plan shall address all measures to dispose of, control, or prevent the discharge of solid, hazardous and sanitary wastes to the waters of the U.S. The plan shall include procedures to control offsite tracking of soil by vehicles and construction equipment and procedures for cleanup and reporting of non-storm water discharges such as contaminated groundwater or accidental spills.

See Specification 01410 – TPDES Requirements for additional information.

The Contractor shall also be required to submit a written documentation that all required permits have been obtained to the Engineer prior to commencement of construction activities.

156-1.5 Any permits that the Owner has obtained for any purpose such as NPDES, TPDES, SPCC, etc., does not include nor cover the Contractor’s haul routes, equipment access points, staging areas, office compounds, materials stockpiles, blending and batch plant areas and operations or other project related activity areas outside the project limits or off site.

156-1.6 The Contractor shall prepare all required documentation, pay all fees and perform all services and work necessary to obtain all permits and approvals from any and all local, state and federal regulatory
agencies for the Contractor’s staging, stockpile, blending and batch plant areas and operations. The cost of all permitting shall be subsidiary to other items of work.

MATERIALS

156-2.1 GRASS.
Grass that will not compete with the grasses sown later for permanent cover per FAA Item T-901, Seeding, shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover. Selected grass species shall not create a wildlife attractant.

156-2.2 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 FAA Item T-908, Mulching. Mulches shall not create a wildlife attractant.

156-2.3 FERTILIZER.
Fertilizer shall be a standard commercial grade and shall conform to all Federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

156-2.4 SLOPE DRAINS.
Slope drains may be constructed of pipe, fiber mats, rubble, Portland cement concrete, bituminous concrete, or other materials that will adequately control erosion.

156-2.5 SILT FENCE FILTER FABRIC BARRIERS.
The silt fences filter fabric barriers shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life. Grab strength shall exceed 100 psi in any principal direction (ASTM D4632), Mullen burst strength shall exceed 200 psi (ASTM D3786), and equivalent opening sizes shall be between 50 and 140. Silt fences filter fabric barriers shall meet the requirements of ASTM D6461.

Wire Fencing shall be comprised of woven galvanized steel wire, 14 gauge by 6 inch square mesh spacing, minimum 24 inch roll or sheet width of longest practical length.

156-2.6 OTHER.
All other materials shall meet commercial grade standards and shall be approved by the Engineer before being incorporated into the project.

Refer to Section 01410, TPDES Requirements, for project SWPPP and TPDES requirements.

CONSTRUCTION REQUIREMENTS

156-3.1 GENERAL.
In the event of conflict between these requirements and pollution control laws, rules, or regulations of other Federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

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

156-3.2 SCHEDULE.
Prior to the start of construction, the Contractor shall submit schedules for accomplishment of temporary and permanent erosion control work for clearing and grubbing; grading; construction; paving; and structures
at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the Engineer.

Several methods of controlling dust and other air pollutants include, but are not limited to: exposing the minimum area of erodible earth, applying temporary mulch with or without seeding, using water sprinkler trucks, using covered haul trucks, using dust palliatives or penetration asphalt on haul roads, using plastic sheet coverings, and applying water when sawcutting.

156-3.3 CONSTRUCTION DETAILS.

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

Where erosion may be a problem, clearing and grubbing operations should be scheduled and performed so that grading operations and permanent erosion control features can follow immediately if project conditions permit; otherwise, temporary erosion control measures may be required.

The Engineer shall limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor’s capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current with the accepted schedule. If seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified as directed by the Engineer.

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

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

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

Whenever construction equipment must cross watercourses at frequent intervals, temporary structures should be provided.

Pollutants such as fuels, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, and other harmful materials shall not be discharged into any waterways, impoundments or into natural or manmade channels.

The Contractor shall provide equipment wash out areas, constructed and protected to not allow any discharge of silt, fuels, lubricants and other harmful materials into nearby impoundments, ponds or surface water drainage systems.

The Contractor shall periodically inspect the pollution control features at the intervals stated in the approved
Pollution Control Plan, and immediately after each rainfall and at least daily during prolonged rainfall and immediately correct any deficiencies. The Contractor shall review the location of pollution control features for effectiveness. If deficiencies exist, the Contractor shall correct as directed by the Engineer.

Remove sediment deposits when the deposit reaches approximately 1/3 of the volume capacity of the sediment control feature, or as otherwise required. Remove all sediment deposits when the sediment control feature is removed. Grade and dress area to restore to preconstruction condition or finish grade as called for on the plans.

If construction is suspended, the Contractor shall inspect, maintain and operate temporary pollution control features during such suspension. If suspension is part of the project phasing and sequencing plan, or if the suspension is requested by the Contractor, the Contractor shall not be paid additional or separate compensation to maintain and operate the erosion/pollution control facilities.

The Contractor is responsible for the removal of all temporary erosion/pollution control facilities and the restoration of those sites. This work will include the repair of any trenching for silt fence, removal of all silt build-up, the removal of fencing, barriers and silt bales and the associated stakes and appurtenances, and the placing of seeding or sodding to restore those sites. All inlets, catch basins and manholes constructed for this project shall be cleaned and the new drainage pipes flushed. All materials taken from the facilities or flushed from the new piping system shall be collected by the Contractor and disposed of off site.

**156-3.4 INSTALLATION, MAINTENANCE AND REMOVAL OF SILT—FENCES FILTER FABRIC BARRIERS.**

Install to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment. **Silt fences** filter fabric barriers shall extend a minimum of 16-18 inches (41 cm) and a maximum of 34-36 inches (86 cm) above the ground surface. Posts shall be set no more than 10 feet (3 on center apart), or less if so indicated on the plans. Filter fabric shall be cut from a continuous roll to the length required minimizing joints where possible. When joints are necessary, the fabric shall be spliced at a support post with a minimum 12-inch (300-mm) overlap and securely sealed. A trench shall be excavated approximately 4-inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the **silt fences** filter fabric barriers. The trench shall be backfilled and the soil compacted over the **silt fences** filter fabric barriers. The Contractor shall remove and dispose of silt that accumulates during construction and prior to establishment of permanent erosion control. The **fence** filter fabric barriers shall be maintained in good working condition until permanent erosion control is established. **Silt fences** filter fabric barriers shall be removed upon approval of the Engineer. Maintain filter fabric barriers to remain in proper position and configuration at all times.

**156-3.5 MAINTENANCE, INSPECTION, AND REPAIR.**

Maintain existing erosion and sediment controls, if any, until directed by the Engineer to remove and dispose of existing controls.

Inspect erosion and sedimentation controls daily during periods of prolonged rainfall, at end of rainfall period, and minimum once each week.

Repair or replace damaged sections immediately.

Remove eroded and sedimented products when silt reaches a depth one-third the height of the control or six (6) inches, whichever is less.

**156-3.6 EQUIPMENT MAINTENANCE AND REPAIR.**

a. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose, so fuels, lubricants, solvents, and other potential pollutants are not
washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.

b. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

c. This item shall not be measured for separate payment.

156-3.7 VEHICLE / EQUIPMENT WASHING AREAS.

a. Install wash area (stabilized with coarse aggregate) adjacent to stabilized construction exit(s), as required to prevent mud and dirt runoff. Release wash water into drainage swales or inlets protected by erosion and sediment controls. Build wash areas following Section 01575 – Stabilized Construction Exit. Install gravel or rock base beneath wash areas.

b. Wash vehicles only at designated wash areas. Do not wash vehicles such as concrete delivery trucks or dump trucks and other construction equipment at locations where runoff flows directly into watercourses or storm water conveyance systems.

c. Locate wash areas to spread out and evaporate or infiltrate wash water directly into ground, or collect runoff in temporary holding or seepage basins.

d. This item shall not be measured for separate payment.

METHOD OF MEASUREMENT

156-4.1 Temporary erosion and pollution control work required will be performed as scheduled or directed by the Engineer. Completed and accepted work will be measured as follows:

a. Installation and removal of filter fabric barriers will be measured by the linear foot.

b. Installation and removal of inlet protection barriers will be measured by the linear foot.

156-4.2 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, will not be measured and paid for directly but shall be considered as a subsidiary obligation of the Contractor.

BASIS OF PAYMENT

156-5.1 Accepted quantities of temporary water pollution, soil erosion, and siltation control work ordered by the Engineer and measured as provided in paragraph 156-4.1 will be paid for under:

a. The quantity of “Installation and Removal of Filter Fabric Barriers” to be paid for shall be the number of linear feet installed and accepted by the Engineer in accordance with the plans and specifications. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation and maintenance of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

b. The quantity of “Inlet Protection Barriers” to be paid for shall be the number and type of inlet protection barriers installed and accepted by the Engineer in accordance with the plans and specifications. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation and maintenance of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.
Payment will be made under:

Item P-156-5.1 Installation and Removal of Filter Fabric Barriers - per linear feet

Where other directed work falls within the specifications for a work item that has a contract price, the units of work shall be measured and paid for at the contract unit price bid for the various items.

Temporary control features not covered by contract items that are ordered by the Engineer will be paid for in accordance with Section 90-05 Payment for Extra work.

**MATERIAL REQUIREMENTS**

- ASTM D6461 Standard Specification for Silt Fence Materials
- AC 150/5200-33 Hazardous Wildlife Attractants

END OF ITEM P-156
ITEM P-306 LEAN CONCRETE BASE COURSE

DESCRIPTION

306-1.1 This item shall consist of a subbase material, herein termed lean concrete, that is composed of aggregate and cement uniformly blended together and mixed with water. The mixture may also include approved cementitious additives, in the form of fly ash or slag, and chemical admixtures. The mixed material shall be spread, shaped, and consolidated using concrete paving equipment in accordance with these specifications and in conformity to the lines, grades, dimensions, and typical cross-sections shown on the plans. Item P-306 – Lean Concrete Base Material may be substituted with Item P-501 – Portland Concrete Cement (PCC) Pavement with the approval of the owner’s representative and airport operations, and at no additional cost to the owner. If substitution is made, it shall follow the specification of Item P-501 entirely.

MATERIALS

306-2.1 AGGREGATE.

The coarse aggregate fraction shall be crushed stone, crushed or uncrushed gravel, crushed and adequately seasoned, air-cooled, iron blast furnace slag, crushed recycled concrete, or a combination thereof. 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 shall consist of hard, durable particles, free from an excess of flat, elongated, soft, or disintegrated pieces, or objectionable matter such as roots, sod, weeds, organic impurities, etc. 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.

The design aggregate blend shall conform to the gradation(s) shown in the table below, when tested in accordance with ASTM C136. The aggregates shall be within the limits for deleterious material contained in ASTM C33 Table 3 type 4S. Aggregates shall not contain any substance which may be deleteriously reactive with the alkalies in the cement, except as permitted in ASTM C33.

<table>
<thead>
<tr>
<th>Sieve Size (square openings)</th>
<th>Percentage by Weight Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gradation B</td>
</tr>
<tr>
<td>2 inch (50 mm)</td>
<td>--</td>
</tr>
<tr>
<td>1-1/2 inch (38 mm)</td>
<td>--</td>
</tr>
<tr>
<td>1 inch (25 mm)</td>
<td>100</td>
</tr>
<tr>
<td>3/4 inch (19 mm)</td>
<td>70-100</td>
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<tr>
<td>No. 4 (4.75 mm)</td>
<td>35-65</td>
</tr>
<tr>
<td>No. 40 (425 µm)</td>
<td>15-30</td>
</tr>
<tr>
<td>No. 200 (75 µm)</td>
<td>0-15</td>
</tr>
</tbody>
</table>
Cement shall conform to the requirements of ASTM C150, Type III, for high early strength concrete.

306-2.3 CEMENTITIOUS ADDITIVES.

Pozzolanic and slag cement may be added to the lean concrete mix. If used, each material must meet the following requirements:

a. **Pozzolan.** Pozzolanic materials must meet the requirements of ASTM C618, Class N, F, or C Fly Ash, except the loss on ignition shall be 6% for Class N and F.

b. **Ground granulated blast furnace slag (slag cement).** Slag shall conform to ASTM C989, Grade 120.

306-2.4 CHEMICAL ADMIXTURES.

The Contractor shall submit certificates indicating that the material to be furnished meets all the requirements listed below. In addition, the Engineer may require the Contractor to submit complete test data showing that the material to be furnished meets all the requirements of the cited specification.

a. **Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260.

b. **Water-reducing admixtures.** Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C494, Type A, D, E, F, or G. Water-reducing admixtures shall be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer’s printed instructions. The air entrainment agent and the water-reducing admixture shall be compatible.

c. **Retarding admixtures.** Retarding admixtures shall meet the requirements of ASTM C494, Type B or D.

d. **Accelerating admixtures.** Accelerating admixtures shall meet the requirements of ASTM C494, Type C.

306-2.5 WATER.

Water used in mixing or curing shall be potable, clean and free of oil, salt, acid, alkali, sugar, vegetable, or other deleterious substances injurious to the finished product.

306-2.6 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.

**COMPOSITION OF MIXTURE**

306-3.1 MIX DESIGN.

The lean concrete mix design shall be based on trial batch results conducted in the laboratory. The lean concrete shall be designed to meet the criteria in this section.

306-3.1.1 COMpressive strength.

Compressive strength shall not be less than 500 pounds per square inch (3,445 kPa) nor greater than 800 pounds per square inch (5,516 kPa) at seven (7) days. Three-day and seven-day strengths shall be taken as the average of two compressive strength test results. All compressive strength specimens shall be prepared and tested in accordance with ASTM C192 and ASTM C39, respectively.
If the 3-day strength is greater than 500 pounds per square inch (3,447 kPa), the Contractor shall construct transverse joints in the lean concrete layer in accordance with paragraph 306-5.10.2.

If there is a change in aggregate sources, type of cement used, or pozzolanic materials, a new mix design must be submitted.

306-3.1.2 AIR CONTENT.

The percentage of air entrainment shall be 6%, ±1/2%. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

306-3.2 SUBMITTALS.

At least 30 days prior to the placement of the lean concrete, the Contractor shall submit certified test reports to the Engineer for those materials proposed for use during construction, as well as the mix design information for the lean concrete material. Tests older than six (6) months shall not be used. The certification shall show the appropriate ASTM or 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 shall include the following:

a. Sources of materials, including aggregate, cement, admixtures, and curing and bond breaking materials.

b. Physical properties of the aggregates, cement, admixtures, curing and bond breaking materials.

c. Mix design:
   - Mix identification number
   - Weight of saturated surface-dry aggregates (fine and coarse)
   - Combined aggregate gradation
   - Cement factor
   - Water content
   - Water-cementitious material ratio (by weight)
   - Volume of admixtures and yield for one cubic yard (cubic meter) of lean concrete

d. Laboratory test results:
   - Slump
   - Air content
   - Compressive strength at 3, 7, and 28 days (average values)
   - Freeze-thaw weight loss (when applicable)

In addition, where applicable, the Contractor shall submit for approval by the Engineer a jointing plan for transverse joints in the lean concrete layer.

During production, the Contractor shall submit batch tickets for each delivered load.

EQUIPMENT

306-4.1 All equipment necessary to mix, transport, place, compact, and finish the lean concrete material shall be furnished by the Contractor. The equipment shall be subject to inspection and approval by the Engineer.
306-4.2 MIXING.

Lean concrete may be mixed in a stationary mixer (central batch plant or at the site), or in a truck mixer. The mixer type and capacity shall be inspected and approved by the Engineer before production begins. Each mixer shall have attached in a prominent place a manufacturer’s nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

306-4.2.1 STATIONARY PLANT MIXER.

The batch plant and equipment shall conform to the requirements of ASTM C94. The Engineer shall have unrestricted access to the plant at all times for inspection of the plant’s equipment and operation and for sampling the lean concrete mixture and its components.

The mixers shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades.

306-4.2.2 TRUCK MIXERS.

Truck mixers used for mixing lean concrete shall conform to the requirements of ASTM C94. Lean concrete may be entirely mixed in a truck mixer or partially mixed in a stationary mixer with mixing completed in a truck mixer. Truck mixers shall be equipped with an accurate continuous registering electronically or mechanically activated revolution counter, to verify the number of drum revolutions.

306-4.3 HAULING.

Mixed lean concrete shall be hauled from the stationary plant to the job site in a truck agitator, a truck mixer operating at agitating speed, or a non-agitating truck. All equipment shall conform to the requirements of ASTM C94. When truck mixers are used to mix lean concrete, they may be transported to the job site in the same truck operating at agitating speeds, truck agitators, or a non-agitating truck. The bodies of non-agitating trucks shall be smooth, metal containers and shall be capable of discharging the concrete at a controlled rate without segregation.

306-4.4 PLACING AND FINISHING.

306-4.4.1 FORMS.

Straight side forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall have a depth equal to the pavement thickness at the edge. Flexible or curved forms of proper radius shall be used for curves of 100 feet (30 m) radius or less. Forms shall be provided 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. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the Engineer.

The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when accepted by the Engineer.

306-4.4.2 FIXED FORM OR SLIP-FORM PAVERS.

Lean concrete can be placed using fixed form or slip-form pavers. The paver shall 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 shall be capable of finishing the surface so that hand finishing is not required. The paver shall 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. The slip-form paver shall be equipped with electronic or hydraulic horizontal...
vertical control devises using guide wires or stringlines on both sides of the machine. Slope control will not be allowed.

a. **Concrete pavers.** Concrete pavers are approved as paver-finishing machines for lean concrete, providing they are capable of handling the amount of lean concrete required for the full-lane width specified, and consolidating the lean concrete full depth. A concrete paver is a power-driven machine with augers, strike-off and tamper bars ahead of a pan screed, with at least one trailing oscillating screed or belt finisher.

b. **Bridge deck pavers.** Bridge deck pavers are approved as paver-finishing machines for lean concrete, providing they are capable of handling the amount of lean concrete required for the full-lane width specified, and consolidating the lean concrete full depth. A bridge deck paver is an automatic truss paving machine, with paving carriage that strikes off, vibrates, paves, and textures the lean concrete with augers, internal vibration, paving rollers, and drag pan.

### 306-4.5 CONSOLIDATION.

For side-form construction, vibrators may be either the surface pan type for pavements less than 8 inches (200 mm) thick or the internal type with either immersed tube or multiple spuds for the full width of the slab. They may be attached to the spreader or the finishing machine, or they may be mounted on a separate carriage. They shall not come in contact with the joint, subgrade, or sideforms.

For slip-form construction, the paver shall vibrate the lean concrete for the full width and depth of the strip of pavement being placed. Vibration shall be accomplished by internal vibrators.

The number, spacing, frequency, and eccentric weights of vibrators shall be provided to achieve acceptable consolidation without segregation and finishing quality. Adequate power to operate all vibrators at the weight and frequency required for a satisfactory finish shall be available on the paver. The internal vibrators may be supplemented by vibrating screeds operating on the surface of the lean concrete. The Contractor shall constantly monitor the frequency of each of the individual vibrators and shall provide constant monitoring of the consolidation process to avoid honeycombing or segregation. Areas that are visually determined to be honeycombed or segregated shall be corrected at the Contractor’s expense.

The vibrators and tamping elements shall be automatically controlled so that they stop operation as forward motion ceases. Any override switch shall be of the spring-loaded, momentary-contact type.

Hand held vibrators may be used in irregular areas.

### 306-4.6 JOINTING.

The Contractor shall provide sawing equipment adequate in number of units and power to produce contraction or construction joints of the required dimensions as shown on the plans. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations.

### CONSTRUCTION METHODS

#### 306-5.1 WEATHER LIMITATIONS.

##### 306-5.1.1 COLD WEATHER.

Unless authorized by the Engineer, the temperature of the mixed lean concrete shall not be less than 50°F (10°C) at the time of placement. In addition, the lean concrete shall not be placed 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. Under no circumstances shall the lean concrete be placed on frozen underlying courses or mixed when the aggregate is frozen.
When mixing and placing is authorized during cold weather, the Engineer may require the water and/or the aggregates to be heated to not less than 70°F (21°C) nor more than 150°F (66°C). The aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials. The Contractor shall adhere to the practices recommended in American Concrete Institute (ACI) 306R, Guide to Cold Weather Concreting.

306.5.1.2 HOT WEATHER.

To prevent rapid drying of newly constructed lean concrete, the lean concrete temperature from initial mixing through final cure shall not exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the lean concrete temperature at or not more than the specified maximum. Ice or ice water may be substituted for the mixing water for this purpose. The Contractor shall adhere to the practices recommended in ACI 305R.

In addition, during periods of warm weather when the maximum daily air temperature exceeds 85°F (30°C), the forms and/or the underlying material shall be sprinkled with water immediately before placing the lean concrete.

306.5.1.3 RAIN.

All mixing and batching operations should be halted during rain showers and any plastic lean concrete placed should be covered immediately. The lean concrete shall be kept covered with plastic sheeting or other waterproof material until such time that the rain does not make any surface indentation on the lean concrete layer. Areas damaged by rain shall be refinished or replaced.

306.5.2 FORM SETTING.

Forms shall be set sufficiently in advance of the lean concrete placement to ensure continuous paving operation. After the forms have been set to correct grade, the grade shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place with not less than three (3) pins for each 10 feet (3 m) section. A pin shall be placed at each side of every joint.

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/4 inch (6 mm) at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the placing of lean concrete.

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the lean concrete. When any form has been disturbed or any grade has become unstable, the form shall be reset and rechecked.

306.5.3 PREPARATION OF UNDERLYING COURSE.

The underlying course shall be checked by the Engineer before placing and spreading operations are started, to ensure it is free of any ruts, depressions, or bumps and is finished to the correct grade. Any ruts or soft yielding places in the underlying course shall be corrected at the Contractor’s expense before the lean concrete mixture is placed. The underlying course should be wetted down in advance of placing the lean concrete to ensure a firm, moist condition at the time of lean concrete placement. The underlining course shall be protected from frost. Usage of chemicals to eliminate frost is not permissible.

306.5.4 GRADE CONTROL.

Grade control between the edges of the pavement shall be accomplished at intervals of 50 feet (15 m) or less on the longitudinal grade and at 25 feet (7.5 m) or less on the transverse grade. To protect the underlying course and ensure proper drainage, the lean concrete paving shall begin along the centerline of the pavement on a crowned section or on the greatest contour elevation of a pavement with variable cross slope.
306-5.5 HANDLING, MEASURING, AND BATCHING MATERIAL.

The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours transit will be accepted as adequate binning if the car bodies permit freedrainage.

Batching plants shall be equipped to proportion aggregates and bulk cement, by weight, automatically using approved interlocked proportioning devises. When bulk cement is used, the Contractor shall use a suitable method such as a chute, boot or other device approved by the Engineer to handle the cement between the weighing hopper and the transporting container or into the batch itself for transportation to the mixer, to prevent loss of cement. The device shall provide positive assurance that each batch has the specified cement content.

306-5.6 MIXING.

All lean concrete shall be mixed and delivered to the site per the requirements of ASTM C94. The mixing time should be adequate to produce lean concrete that is uniform in appearance, with all ingredients evenly distributed. Mixing time shall be measured from the time all materials are emptied into the drum (provided all the water is added before one-fourth the preset mixing time has elapsed) and continues until the time the discharge chute is opened to deliver the lean concrete.

If mixing in a plant, the mixing time shall not be less than 50 or greater than 90 seconds. If mixing in a truck, the mixing time shall not be less than 70 or more than 125 truck-drum revolutions at a mixing speed of not less than six (6) or more than 18 truck-drum revolutions per minute.

Re-tempering lean concrete by adding water or by other means will not be permitted, except when lean concrete is delivered in truck mixers. With truck mixers, additional water may be added to the batch materials and additional mixing performed to allow proper placement of the material, provided (a) the addition of water is performed within 45 minutes after the initial mixing operations and (b) the slump and water/cementitious ratio specified in the mix design is not exceeded.

306-5.7 HAULING.

The elapsed time from the addition of cementitious material to the mix until the lean concrete is deposited in place at the work site shall not exceed 45 minutes when the concrete is hauled in nonagitating trucks, or 90 minutes when it is hauled in truck mixers or truck agitators.

306-5.8 PLACING, CONSOLIDATING, AND FINISHING.

Prior to placement of the lean concrete layer, the prepared underlying course shall be moistened with water, without saturating, to prevent rapid loss of moisture from the lean concrete. In cold weather, the underlying course shall be protected so that it will be entirely free of frost when lean concrete is placed.

The Contractor has the option of side-form or slip-form paving. Either option shall require the hauled lean concrete material to be discharged onto the prepared underlying course such that segregation of the mix is minimized and minimum handling of the mix is needed. The lean concrete shall be placed continuously at a uniform rate without unscheduled stops except for equipment failure or other emergencies. Avoid contamination of plastic lean concrete with foreign material on construction equipment, workman’s footwear, or any other sources. Lean concrete shall not be mixed, placed, or finished when the natural light is insufficient, unless an adequate artificial lighting system is provided.

306-5.8.1 SIDE-FORM CONSTRUCTION.

For side-form placement, the Contractor shall verify the elevations of the fixed forms so the thickness and
finished grade of the lean concrete layer will be in accordance with the requirements of the project plans and specifications. The lean concrete shall be spread uniformly between the forms immediately after it is placed using a spreading machine. Necessary hand spreading shall be done with shovels. Rakes shall not be allowed for spreading lean concrete.

The spreading shall be followed immediately by thorough consolidation using vibrating screeds or spud vibrators. Vibrators may be external or internal type, depending on the thickness of the lean concrete layer. The surface vibrators may be attached to the spreader or they may be mounted on a separate carriage. They shall not come in contact with the joint, subgrade, or side forms. When spud vibrators are used, the lean concrete shall be thoroughly consolidated against and along the faces of all forms and previously placed lean concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 20 seconds in any one location, nor shall the vibrators be used to move the lean concrete.

Hand finishing will not be permitted except in areas where the mechanical finisher cannot operate.

306-5.8.2 SLIP-FORM CONSTRUCTION.

For slip-form construction, the Contractor shall verify the elevations of the guide wires controlling slip-form pavers such that the thickness and finished grade of the lean concrete will be in accordance with the requirements of the project plans and specifications. The slip-form paver should spread, consolidate, and shape the freshly placed lean concrete in one complete pass of the machine. The machine shall vibrate and finish the lean concrete for the full width and depth of the layer.

306-5.9 FINAL FINISHING.

Final finishing shall be accomplished while the lean concrete is still in the plastic state. Limited surface refinishing by hand is acceptable to meet the grade and surface tolerance established in paragraphs 306-6.2.3 and 306-6.2.4, after strike off and consolidation.

If the overlying layer is to be PCC pavement, the surface of the lean concrete shall not be textured. If the overlying layer is to be HMA pavement, and if the bond between the HMA layer and the lean concrete is considered important for pavement performance, tining or scarifying the surface to provide a coarse texture may be permitted.

306-5.10 JOINTS.

Joints shall be constructed as shown on the plans.

306-5.10.1 CONSTRUCTION JOINTS.

Locate all longitudinal and transverse construction joints as shown on the plans. If longitudinal joints are not shown, locate longitudinal joints within 6 inches (150 mm) from planned joints in the PCC to be placed over the lean concrete.

306-5.10.2 CONTRACTION JOINTS.

If required by paragraph 306-3.1.1 or if shown on the plans, transverse contraction joints shall be constructed by sawing the hardened lean concrete to a depth of at least one-third the thickness of the lean concrete base. These joints shall match within 3 inches (75 mm) the planned joints of the overlying concrete surface.

306-5.10.3 CONCRETE SAWS.

When sawing of joints are specified, the Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. The Contractor shall provide at least one standby saw in good working order. An ample supply of saw blades shall be maintained at the site of the work at all times during sawing operations. The Contractor shall provide adequate artificial lighting facilities for night sawing. All equipment shall be on the job at all times during lean concrete placement.

FAA-P-306-8
ver. 07-21-2014
306-5.11 CURING.

Immediately after the finishing operations are complete and within two (2) hours of placement of the lean concrete, the entire surface and edges of the newly placed lean concrete shall be sprayed uniformly with white pigmented, liquid membrane forming curing compound. The layer should be kept moist using a moisture-retaining cover or a light application of water until the curing material is applied. The curing compound shall not be applied during rainfall.

The curing material shall be applied at a maximum rate of 200 square feet per gallon (5.0 m²/l) using pressurized mechanical sprayers. The spraying equipment shall be a fully atomizing type equipped with a tank agitator. At the time of use, the curing compound in the tank shall be thoroughly and uniformly mixed with the pigment. During application the curing compound shall be continuously stirred by mechanical means.

Hand spraying of odd widths or shapes and lean concrete surfaces exposed by the removal of forms is permitted.

If the film of curing material becomes damaged from any cause, including sawing operations, within the required 7-day curing period or until the overlying course is constructed, the damaged portions shall be repaired immediately with additional compound or other approved means as quickly as practical.

Edges of the lean concrete layer shall be sprayed with curing compound immediately following placement with slip-form pavers or when side-forms are removed.

306-5.11.1 CURING IN COLD WEATHER.

The lean concrete shall be maintained at a temperature of at least 50°F (10°C) during curing. Cover lean concrete and provide with a source of heat sufficient to maintain 50°F (10°C) minimum while curing. The Contractor shall adhere to the practices recommended in ACI 306R. The Contractor shall be responsible for the quality and strength of the lean concrete placed during cold weather, and any lean concrete injured by frost action shall be removed and replaced at the Contractor’s expense.

306-5.11.2 CURING IN HOT WEATHER.

Lean concrete temperature from initial mixing through final cure shall not exceed 90°F (32°C). Shade the fresh lean concrete and start curing as soon as the surface is sufficiently hard to permit curing without damage. The Contractor shall adhere to the practices recommended in ACI305R.

306-5.12 PROTECTION.

The Contractor shall protect the lean concrete from injurious action by sun, rain, flowing water, frost, or mechanical injury. Protect lean concrete surfaces from foot and vehicular traffic and other sources of abrasion for a minimum of 72 hours. The Engineer shall decide when the pavement shall be opened to traffic. Traffic shall not be allowed on the pavement until test specimens made per ASTM C31 have attained a compressive strength of 350 psi (2,413 kPa) when tested per ASTM C39. The Contractor shall maintain continuity of applied curing method for the entire curing period.

306-5.13 BOND-BREAKER.

When the lean concrete is placed directly beneath PCC pavement, a bond-breaker shall be used. The entire surface of the lean concrete shall be coated with a de-bonding compound applied in a sufficient quantity to prevent bonding between the PCC pavement and the lean concrete. The Contractor shall be responsible for selecting the de-bonding compound and determining the appropriate application rate. This application shall be made at least eight (8) hours and not more than 24 hours before placement of the PCC pavement. If an impervious membrane is used as a bond breaker, a second application of curing materials is required and shall be placed no more than 24 hours prior to placement of the PCC pavement. After application of the bond-breaker coat, traffic will be limited to that required for placement of the PCC pavement.
AIRFIELD PAVEMENT REPAIRS
Project No. 460C_HOU

LEAN CONCRETE BASE COURSE

306-6.1 ACCEPTANCE SAMPLING AND TESTING.

All acceptance sampling and testing, with the exception of coring for thickness determination, necessary to determine conformance with the requirements specified in this section will be performed by the Engineer. The Contractor shall provide the required lean concrete samples during construction for acceptance testing purposes. The samples shall be taken in the presence of the Engineer.

The lean concrete layer shall be tested for air content, strength, thickness, grade, and surface tolerance. Sampling and testing for air shall be as specified in paragraph 306-6.1.1. Sampling and testing for strength, thickness, grade, and surface tolerance shall be on a lot basis, with a lot consisting of either: (1) one day’s production not to exceed 2,000 square yards (1700 sq m), or (2) a half day’s production, where a day’s production is expected to consist of between 2,000 and 4,000 square yards (1675 and 3350 m²).

Each lot will be divided into four equal sublots. In the event that only three sublots are produced, the three sublots shall constitute a complete lot. If only one or two sublots are produced, they shall be incorporated into the next lot, and the total number of sublots shall be used in the acceptance plan calculation.

End-of-production sublots (sublots associated with the final placement of lean concrete for the project which are less than a complete lot) shall be handled as (1) three sublots shall constitute a lot, or (2) one or sublots shall be incorporated into the previous lot.

306-6.1.1 AIR CONTENT TESTING.

Air content tests shall be performed on the first three truckloads of lean concrete produced at the start of operations each day and the first three truckloads produced after any scheduled or non-scheduled shutdown. Additional tests shall be performed each time a sample is taken for a strength test and when requested by the Engineer.

Air content tests shall be made in accordance with ASTM C231. Air content test results shall be between 4% and 8%.

If the first test on a truckload of lean concrete is not within the specification limits, a second test on the same truckload shall be made. If the second test is within the specification limits, the lean concrete will be accepted with respect to entrained air content. If the second test is not within the specification limits, the truckload shall be rejected.

306-6.1.2 COMPRESSION STRENGTH TESTING.

One sample of freshly delivered lean concrete shall be taken from each sublot for compressive strength testing. The lean concrete shall be sampled in accordance with ASTM C172. Sampling locations shall be determined per ASTM D3665.

At least two test cylinders shall be made from each sample per ASTM C31. The 7-day compressive strength of each cylinder shall be determined per ASTM C39.

The Contractor shall provide adequate facilities for the initial curing of cylinders. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60 to 80°F (16 to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather or in heavyweight closed plastic bags, or use other suitable methods, provided the temperature and moisture loss requirements are met.

The compressive strength for each sublot shall be computed by averaging the 7-day compressive strengths of the two test cylinders representing that sublot. The compressive strength of the lot shall be the average compressive strength of the individual sublots comprising the lot.

Specimens that are noticeably defective shall not be considered in the determination of the strength. If the test specimens fail to conform to the requirements for strength, the Engineer shall request changes in the lean concrete mixture to increase the strength to meet the requirements.

FAA- P-306-10
ver. 07-21-2014
If the maximum 7-day compressive strength values exceed the maximum strength requirements when evaluated in accordance with paragraph 306-6.2.1, the Contractor shall propose a jointing plan for approval by the Engineer.

306-6.1.3 THICKNESS TESTING.

After the lean concrete base has cured for three (3) days, one 4-inch (100 mm) diameter core per sublot shall be obtained per ASTM D3665. The thickness of each sampled core shall be determined using the caliper measurement procedures per ASTM C174. The average thickness for the lot shall be determined using the individual sublot core thicknesses. Acceptance criteria for lean concrete thickness are provided in paragraph 306-6.2.2.

When such measurement is deficient more than 1/2 inch (12 mm) and not more than 1 inch (25 mm) from the plan thickness, two additional cores shall be taken at random and used in determining the average thickness for that lot. The thickness of the cores shall be determined by average caliper measurement of cores tested in accordance with ASTM C174.

The Contractor shall survey the subgrade at all panel corners and at the center of the panel. After the lean concrete has cured for 24 hours, the Contractor shall survey the surface at the same locations of each panel for comparison against subgrade elevations for thickness determinations. Both subgrade elevations and lean concrete surface elevations shall be supplied to the Engineer. If the surface elevation is more than ½ inch higher than that required for the PCC pavement, the Contractor shall grind the lean concrete to the required grade. The lean concrete shall cure for 5 days prior to grinding. If the surface elevation is less than that required for the surface course pavement, the Contractor shall install additional Item P-501 PCC pavement thickness at no additional cost to the Owner.

At all locations where cores have been drilled, the resulting holes shall be filled with lean concrete or non-shrink grout material, as approved by the Engineer.

306-6.1.4 GRADE TESTING.

The elevations of the finished lean concrete shall be surveyed on both sides of the lean concrete lane, every 25 feet (7.5 m).

306-6.1.5 SURFACE TOLERANCE TESTING.

After the lean concrete has hardened sufficiently, it shall be tested for surface tolerance with a 12 feet (3.7 m) Straight edge provided by the Contractor.

306-6.2 ACCEPTANCE CRITERIA.

Acceptance of lean concrete will be based on compressive strength, thickness, grade, and surface tolerance, as described in the paragraphs below.

306-6.2.1 COMpressive STRENGTH REQUIREMENTS.

The lean concrete shall meet all of the following compressive strength requirements on a lot basis:

- The compressive strength of the lot, tested at seven (7) days, shall be greater than 500 pounds per square inch (3,445 kPa). When a given lot of lean concrete fails to meet the minimum compressive strength requirements, the entire lot shall be replaced at the Contractor’s expense.
- Not more than 20% of the individual cylinders in a given lot, tested at seven (7) days, shall have a compressive strength greater than 800 pounds per square inch (5,512 kPa). When greater than 20% of the individual cylinders in a given lot have 7-day compressive strengths in excess of 800 pounds per square inch (5,512 kPa), and transverse joints have not been constructed, a bond-breaker shall be used.

306-6.2.2 THICKNESS REQUIREMENTS.

The completed thickness shall be as shown on the plans. When the average lot thickness is not deficient by
more than 1/2 inch (12 mm) from the plan thickness, full payment shall be made. If the lot average thickness is deficient by more than one inch (25 mm), it shall be removed and replaced. The deficient thickness of lean concrete shall be compensated with additional Item P-501 concrete pavement at the time the surface course is constructed at the Contractor’s expense. When such measurement is deficient more than 1/2 inch (12 mm) and not more than one inch (25 mm) from the plan thickness, one additional core shall be taken at random from each subplot within the lot. The thickness of these additional cores shall be determined as indicated in paragraph 304-6.1.2. A new lot average thickness shall be recomputed based on these additional cores and the original cores taken from each subplot. When the recomputed average lot thickness is not deficient by more than 1/2 inch (12 mm) from the plan thickness, full payment shall be made. If the average lot thickness is deficient by more than 1/2 inch (12 mm) from the plan thickness, the entire lot shall be removed and replaced at the Contractor’s expense or shall be permitted to remain in place at an adjusted payment of 75% of the contract unit price.

When the measured thickness is more than that indicated on the plans, it will be considered as conforming to the requirements, provided the surface of the completed lean concrete layer is within the established grade and surface tolerance requirements.

306-6.2.3 GRADE REQUIREMENTS.

When the completed surface is more than 1/2 inch (12 mm) above the grade shown in the plans, the surface shall be trimmed at the Contractor’s expense using an approved grinding machine to an elevation that falls within a tolerance of 1/4 inch (6mm).

306-6.2.4 SURFACE TOLERANCE REQUIREMENTS.

Surface deviations shall not exceed 3/8 inch (9 mm) from a 12-foot (3.7-m) straightedge laid in any location parallel with or at right angles to the longitudinal axis of the centerline (includes along all edges of the paving lane). Any high spots of more than 3/8 inch (9 mm) in 12-foot (3.7-m) shall be marked and immediately trimmed with an approved grinding machine. If the overlying layer is PCC pavement, the ground surface shall be sprayed with a double application of the curing compound at the specified rate prior to paving.

**METHOD OF MEASUREMENT**

306-7.1 The quantity of lean concrete will be determined by the number of square yards of 12" lean concrete actually constructed and accepted by the Engineer as complying with the plans and specifications for full depth pavement repairs with subbase and subgrade repair. Lean concrete constructed to repair subgrade damage caused by the Contractor’s operations will not be measured for payment.

306-7.2 Lean concrete used to repair subgrade damaged during pavement removal shall not be measured for separate payment.

**BASIS OF PAYMENT**

306-8.1 The accepted quantities of lean concrete will be paid for at the contract unit price per square yard for 12" lean concrete base. The price and payment shall be full compensation for furnishing and placing all materials, including but not limited to jointing, curing, and bond-breaker materials, provided; however, for any pavement found deficient in thickness as specified in paragraph 306-6.2.2, the reduced unit price shall be paid.

Contractor’s election to substitute P-501 Portland Concrete Cement Pavement for P-306 shall be measured and paid for at the Item P-306-8.1 unit bid price as described below. Measurement and payment shall be in accordance per Item P-306, not P-501.

Payment will be made under:

FAA- P-306-12
ver. 07-21-2014
Item P-306-8.1 12” Lean Concrete Base Course - per square yard

TESTING REQUIREMENTS

ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C136 Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
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
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

MATERIAL REQUIREMENTS

ACI 305R Guide to Hot Weather Concreting
ACI 306R Guide to Cold Weather Concreting
ASTM C33 Standard Specification for Concrete Aggregates
ASTM C94 Standard Specification for Ready-Mixed Concrete
ASTM C150 Standard Specification for Portland Cement
ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete
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
END OF ITEM P-306
ITEM P-401 HOT MIX ASPHALT (HMA) PAVEMENTS

DESCRIPTION

401-1.1 This item shall consist of pavement courses composed of mineral aggregate and asphalt cement binder (asphalt binder) mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

MATERIALS

401-2.1 AGGREGATE.

Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. The aggregates should be free of ferrous sulfides, such as pyrite, that would cause “rust” staining that can bleed through pavement markings. The portion retained on the No. 4 (4.75 mm) sieve is coarse aggregate. The portion passing the No. 4 (4.75 mm) sieve and retained on the No. 200 (0.075 mm) sieve is fine aggregate, and the portion passing the No. 200 (0.075 mm) sieve is mineral filler.

a. Coarse aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from films of matter that would prevent thorough coating and bonding with the bituminous material and free from organic matter and other deleterious substances. The percentage of wear shall not be greater than 40% when tested in accordance with ASTM C131. The sodium sulfate soundness loss shall not exceed 12%, or the magnesium sulfate soundness loss shall not exceed 18%, after five cycles, when tested in accordance with ASTM C88. Clay lumps and friable particles shall not exceed 1.0% when tested in accordance with ASTM C142. Aggregate shall contain at least 75 percent by weight of individual pieces having two or more fractured faces and 85 percent by weight having at least one fractured face. The area of each face shall be equal to at least 75% of the smallest midsectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces. Fractured faces shall be achieved by crushing.

The aggregate shall not contain more than a total of 8%, by weight, of flat particles, elongated particles, and flat and elongated particles, when tested in accordance with ASTM D4791 with a value of 5:1.

Slag shall be air-cooled, blast furnace slag, and shall have a compacted weight of not less than 70 pounds per cubic foot (1.12 mg/cubic meter) when tested in accordance with ASTM C29.

b. Fine aggregate. Fine aggregate shall consist of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel that meets the requirements for wear and soundness specified for coarse aggregate. The aggregate particles shall be free from coatings of clay, silt, or other objectionable matter.

The fine aggregate, including any blended material for the fine aggregate, shall have a plasticity index of not more than six (6) and a liquid limit of not more than 25 when tested in accordance with ASTM D4318.

The soundness loss shall not exceed 10% when sodium sulfate is used or 15% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.
Clay lumps and friable particles shall not exceed 1.0%, by weight, when tested in accordance with ASTM C142.

Natural (non-manufactured) sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification. If used, the natural sand shall meet the requirements of ASTM D1073 and shall have a plasticity index of not more than six (6) and a liquid limit of not more than 25 when tested in accordance with ASTMD4318.

The aggregate shall have sand equivalent values of 45 or greater when tested in accordance with ASTM D2419.

c. **Sampling.** ASTM D75 shall be used in sampling coarse and fine aggregate, and ASTM C183 shall be used in sampling mineral filler.

### 401-2.2 MINERAL FILLER.

If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D242.

### 401-2.3 ASPHALT CEMENT BINDER.

Asphalt cement binder shall conform to ASTM D6373 Performance Grade (PG) 6476-22. A certificate of compliance from the manufacturer shall be included with the mix design submittal.

The supplier’s certified test report with test data indicating grade certification for the asphalt binder shall be provided to the Engineer for each load at the time of delivery to the mix plant. A certified test report with test data indicating grade certification for the asphalt binder shall also be provided to the Engineer for any modification of the asphalt binder after delivery to the mix plant and before use in the HMA.

### 401-2.4 PRELIMINARY MATERIAL ACCEPTANCE.

Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

a. **Coarse aggregate:**
   - (1) Percent of wear
   - (2) Soundness
   - (3) Clay lumps and friable particles
   - (4) Percent fractured faces
   - (5) Flat and elongated particles
   - (6) Unit weight of slag

b. **Fine aggregate:**
   - (1) Liquid limit and Plasticity index
   - (2) Soundness
   - (3) Clay lumps and friable particles
   - (4) Percent natural sand
   - (5) Sand equivalent

c. **Mineral filler.**

d. **Asphalt binder.** Test results for asphalt binder shall include temperature/viscosity charts for mixing and compaction temperatures.

The certifications shall show the appropriate ASTM tests for each material, the test results, and a statement that the material meets the specification requirement.
The Engineer may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

401-2.5 ANTI-STRIPPING AGENT.

Any anti-stripping agent or additive if required shall be heat stable, shall not change the asphalt cement viscosity beyond specifications, shall contain no harmful ingredients, shall be added in recommended proportion by approved method, and shall be a material approved by the Department of Transportation of the State in which the project is located.

COMPOSITION

401-3.1 COMPOSITION OF MIXTURE.

The HMA mix shall be composed of a mixture of well-graded aggregate, filler and anti-stripping agent if required, and asphalt binder. The several aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

401-3.2 JOB MIX FORMULA (JMF).

No hot-mixed asphalt (HMA) for payment shall be produced until a JMF has been approved in writing by the Engineer. The asphalt mix-design and JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 401-3.4. The HMA shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. ASTM D6926 shall be used for preparation of specimens using the manually held and operated hammer for the mix design procedure. ASTM D6927 shall be used for testing for Marshall stability and flow.

If material variability exceeds the standard deviations indicated, the JMF and subsequent production targets shall be based on a stability greater than shown in Table 1 and the flow shall be targeted close to the mid-range of the criteria in order to meet the acceptance requirements.

Tensile strength ratio (TSR) of the composite mixture, as determined by ASTM D4867, shall not be less than 75 when tested at a saturation of 70-80% or an anti-stripping agent shall be added to the HMA, as necessary, to produce a TSR of not less than 75 when tested at a saturation of 70-80%. If an anti-strip agent is required, it shall be provided by the Contractor at no additional cost to the Owner.

The JMF shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations. The JMF shall be developed within the same construction season using aggregates currently being produced.

The submitted JMF shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

a. Percent passing each sieve size for total combined gradation, individual gradation of all aggregate stockpiles and percent by weight of each stockpile used in the job mix formula.

b. Percent of asphalt cement.

c. Asphalt performance grade and type of modifier if used.

d. Number of blows per side of molded specimen.

e. Laboratory mixing temperature.

f. Laboratory compaction temperature.
g. Temperature-viscosity relationship of the PG asphalt cement binder showing acceptable range of mixing and compaction temperatures; and for modified binders include supplier recommended mixing and compaction temperatures.

h. Plot of the combined gradation on a 0.45 power gradation curve.

i. Graphical plots of stability, flow, air voids, voids in the mineral aggregate, and unit weight versus asphalt content.

j. Specific Gravity and absorption of each aggregate.

k. Percent natural sand.

l. Percent fractured faces.

m. Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).

n. Tensile Strength Ratio (TSR).

o. Anti-strip agent (if required).

p. Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season shall not be accepted.

q. Percentage and properties (asphalt content, binder properties, and aggregate properties) of reclaimed asphalt pavement (RAP) in accordance with paragraph “Reclaimed Hot-Mix Asphalt,” if RAP is used.

The Contractor shall submit to the Engineer the results of verification testing of three (3) asphalt samples prepared at the optimum asphalt content. The average of the results of this testing shall indicate conformance with the JMF requirements specified in Tables 1 and 3.

When the project requires asphalt mixtures of differing aggregate gradations, a separate JMF and the results of JMF verification testing shall be submitted for each mix.

The JMF for each mixture shall be in effect until a modification is approved in writing by the Engineer. Should a change in sources of materials be made, a new JMF must be submitted within 15 days and approved by the Engineer in writing before the new material is used. After the initial production JMF has been approved by the Engineer and a new or modified JMF, including a new test strip when required by the Engineer, will be borne by the Contractor. There will be no time extension given or considerations for extra costs associated with the stoppage of production paving or restart of production paving due to the time needed for the Engineer to approve the initial, new or modified JMF.

The Marshall Design Criteria applicable to the project shall meet the criteria specified in Table 1.

<table>
<thead>
<tr>
<th>Test Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of blows</td>
<td>75</td>
</tr>
<tr>
<td>Stability, pounds (Newtons) minimum</td>
<td>2150 (9560)</td>
</tr>
<tr>
<td>Flow, 0.01 in. (0.25 mm)</td>
<td>10-16</td>
</tr>
<tr>
<td>Air voids (%)</td>
<td>3.5</td>
</tr>
</tbody>
</table>
Table 2. Minimum Percent Voids In Mineral Aggregate (VMA)

<table>
<thead>
<tr>
<th>Aggregate (See Table 3)</th>
<th>Minimum VMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation 3</td>
<td>16%</td>
</tr>
<tr>
<td>Gradation 2</td>
<td>15%</td>
</tr>
<tr>
<td>Gradation 1</td>
<td>14%</td>
</tr>
</tbody>
</table>

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 3 when tested in accordance with ASTM C136 and ASTM C117.

The gradations in Table 3 represent the limits that shall determine the suitability of aggregate for use from the sources of supply; be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

Table 3. Aggregate - HMA Pavements

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage by Weight Passing Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch (25 mm)</td>
<td>--</td>
</tr>
<tr>
<td>3/4 inch (19 mm)</td>
<td>--</td>
</tr>
<tr>
<td>1/2 inch (12 mm)</td>
<td>100</td>
</tr>
<tr>
<td>3/8 inch (9 mm)</td>
<td>79-99</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>58-78</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>39-59</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>26-46</td>
</tr>
<tr>
<td>No. 30 (0.60 mm)</td>
<td>19-35</td>
</tr>
<tr>
<td>No. 50 (0.30 mm)</td>
<td>12-24</td>
</tr>
<tr>
<td>No. 100 (0.15 mm)</td>
<td>7-17</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
<td>3-6</td>
</tr>
</tbody>
</table>

Asphalt Percent:

| Stone or gravel | 5.5-8.0 |
| Slag            | 7.0-10.5 |

The aggregate gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves shall be corrected when aggregates of varying specific gravities are used, as indicated in the Asphalt Institute MS-2 Mix Design Manual, 7th Edition.

401-3.3 RECLAIMED ASPHALT PAVEMENT (RAP).

RAP shall not be used.

401-3.4 JOB MIX FORMULA (JMF) LABORATORY.

The Contractor’s laboratory used to develop the JMF shall be accredited in accordance with ASTM D3666. The laboratory accreditation must be current and listed on the accrediting authority’s website. All test
methods required for developing the JMF must be listed on the lab accreditation. A copy of the laboratory’s current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

401-3.5 TEST SECTION.

Prior to full production, the Contractor shall prepare and place a quantity of HMA according to the JMF. The amount of HMA shall be sufficient to construct a test section 200 long and 20 wide, placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. A cold joint for this test section is an exposed construction joint at least four (4) hours old or whose mat has cooled to less than 160°F (71°C). The cold joint must be cut-back using the same procedure that will be used during production in accordance with 401-4.13. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

The test section shall be evaluated for acceptance as a single lot in accordance with the acceptance criteria in paragraph 401-5.1 and 401-5.2. The test section shall be divided into equal sublots. As a minimum the test section shall consist of three (3) sublots.

The test section shall be considered acceptable if (1) stability, flow, mat density, air voids, and joint density are 90% or more within limits, (2) gradation and asphalt content are within the action limits specified in paragraphs 401-6.5a and 5b, and (3) the voids in the mineral aggregate are within the limits of Table 2.

If the initial test section should prove to be unacceptable, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor’s expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that are not acceptable shall be removed at the Contractor’s expense. Full production shall not begin until an acceptable test section has been constructed and accepted in writing by the Engineer. Once an acceptable test section has been placed, payment for the initial test section and the section that meets specification requirements shall be made in accordance with paragraph 401-8.1.

Job mix control testing shall be performed by the Contractor at the start of plant production and in conjunction with the calibration of the plant for the JMF. If aggregates produced by the plant do not satisfy the gradation requirements or produce a mix that meets the JMF, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens shall be prepared and the optimum asphalt content determined in the same manner as for the original JMF tests.

Contractor will not be allowed to place the test section until the Contractor Quality Control Program, showing conformance with the requirements of Paragraph 401-6.1, has been approved, in writing, by the Engineer.

A test section shall not be required.

CONSTRUCTION METHODS

401-4.1 WEATHER LIMITATIONS.

The HMA shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the Engineer, if requested; however, all other requirements including compaction shall be met.
Table 4. Surface Temperature Limitations of Underlying Course

<table>
<thead>
<tr>
<th>Mat Thickness</th>
<th>Base Temperature (Minimum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inches (7.5 cm) or greater</td>
<td>40°F, 4°C</td>
</tr>
<tr>
<td>Greater than 2 inches (50 mm)</td>
<td>but less than 3 inches (7.5 cm)</td>
</tr>
</tbody>
</table>

401-4.2 HMA PLANT.

Plants used for the preparation of HMA shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 with the following changes:

Requirements for all plants include:

a. **Truck scales.** The HMA shall be weighed on approved scales furnished by the Contractor, or on certified public scales at the Contractor’s expense. Scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy. Scales shall conform to the requirements of the General Provisions, subsection 90-01.

   In lieu of scales, and as approved by the Engineer, HMA weight may be determined by the use of an electronic weighing system equipped with an automatic printer that weighs the total HMA production and as often thereafter as requested by the Engineer.

b. **Testing facilities.** The Contractor shall ensure laboratory facilities are provided at the plant for the use of the Engineer. The lab shall have sufficient space and equipment so that both testing representatives (Engineer’s and Contractor’s) can operate efficiently. The lab shall meet the requirements of ASTM D3666 including all necessary equipment, materials, calibrations, current reference standards to comply with the specifications and a masonry saw with diamond blade for trimming pavement cores and samples.

   The plant testing laboratory shall have a floor space area of not less than 200 square feet (18.5 sq m), with a ceiling height of not less than 7-1/2 feet (2 m). The laboratory shall be weather tight, sufficiently heated in cold weather, air-conditioned in hot weather to maintain temperatures for testing purposes of 70°F ±5°F (21°C ±2.3°C). The plant testing laboratory shall be located on the plant site to provide an unobstructed view, from one of its windows, of the trucks being loaded with the plant mix materials. In addition, the facility shall include the minimum:

   (1) Adequate artificial lighting.
   (2) Electrical outlets sufficient in number and capacity for operating the required testing equipment and drying samples.
   (3) A minimum of two (2) Underwriter’s Laboratories approved fire extinguishers of the appropriate types and class.
   (4) Work benches for testing.
   (5) Desk with chairs and file cabinet.
   (6) Sanitary facilities convenient to testing laboratory.
   (7) Exhaust fan to outside air.
   (8) Sink with running water.
Failure to provide the specified facilities shall be sufficient cause for disapproving HMA plant operations.

Laboratory facilities shall be kept clean, and all equipment shall be maintained in proper working condition. The Engineer shall be permitted unrestricted access to inspect the Contractor’s laboratory facility and witness quality control activities. The Engineer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

c. **Inspection of plant.** The Engineer, or Engineer’s authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant: verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

d. **Storage bins and surge bins.** The HMA stored in storage and surge bins shall meet the same requirements as HMA loaded directly into trucks and may be permitted under the following conditions:

   1. Stored in non-insulated bins for a period of time not to exceed three (3) hours.
   2. Stored in insulated bins for a period of time not to exceed eight (8) hours.

   If the Engineer determines that there is an excessive amount of heat loss, segregation, or oxidation of the HMA due to temporary storage, no temporary storage will be allowed.

### 401-4.3 HAULING EQUIPMENT.

Trucks used for hauling HMA shall have tight, clean, and smooth metal beds. To prevent the HMA from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the Engineer. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

#### 401-4.3.1 MATERIAL TRANSFER VEHICLE (MTV).

Material transfer vehicles are not required.

#### 401-4.4 HMA PAVERS.

HMA pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of HMA that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the HMA uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging themixture.

If, during construction, it is found that the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued and satisfactory equipment shall be provided by the Contractor.
401-4.4.1 AUTOMATIC GRADE CONTROLS.

The HMA paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices that will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within ±0.1%.

The controls shall be capable of working in conjunction with any of the following attachments:

a. Ski-type device of not less than 30 feet (9 m) in length.

b. Taut string-line (wire) set to grade.

c. Short ski or shoe.

d. Laser control.

401-4.5 ROLLERS.

Rollers of the vibratory, steel wheel, and pneumatic-tired type shall be used. They shall be in good condition, capable of operating at slow speeds to avoid displacement of the HMA. The number, type, and weight of rollers shall be sufficient to compact the HMA to the required density while it is still in a workable condition. A vibrating roller will be required for compaction on cold joints, on hot joints, or on fresh joints. All rollers shall be specifically designed and suitable for compacting HMA concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used. Depressions in pavement surfaces caused by rollers shall be repaired by the Contractor at their own expense.

The use of equipment that causes crushing of the aggregate will not be permitted.

401-4.6. DENSITY DEVICE.

The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall also supply a qualified technician during all paving operations to calibrate the gauge and obtain accurate density readings for all new HMA. These densities shall be supplied to the Engineer upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

401-4.7 PREPARATION OF ASPHALT BINDER.

The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. The temperature of unmodified asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 325°F (160°C) when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F (175°C) when added to the aggregate.

401-4.8 PREPARATION OF MINERAL AGGREGATE.

The aggregate for the HMA shall be heated and dried. The maximum temperature and rate of heating shall be such that no damage occurs to the aggregates. The temperature of the aggregate and mineral filler shall not exceed 350°F (175°C) when the asphalt binder is added. Particular care shall be taken that aggregates high in calcium or magnesium content are not damaged by overheating. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability.
401-4.9 PREPARATION OF HMA.

The aggregates and the asphalt binder shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor, based on the procedure for determining the percentage of coated particles described in ASTM D2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95% of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all HMA upon discharge shall not exceed 0.5%.

401-4.10 PREPARATION OF THE UNDERLYING SURFACE.

Immediately before placing the HMA, the underlying course shall be cleaned of all dust and debris. A prime coat shall be applied in accordance with Item P-602, if shown on the plans.

401-4.11 LAYDOWN PLAN, TRANSPORTING, PLACING, AND FINISHING.

Prior to the placement of the HMA, the Contractor shall prepare a laydown plan for approval by the Engineer. This is to minimize the number of cold joints in the pavement. The laydown plan shall include the sequence of paving laydown by stations, width of lanes, temporary ramp locations, and laydown temperature. The laydown plan shall also include estimated time of completion for each portion of the work (that is, milling, paving, rolling, cooling, etc.). Modifications to the laydown plan shall be approved by the Engineer.

The HMA shall be transported from the mixing plant to the site in vehicles conforming to the requirements of paragraph 401-4.3. Deliveries shall be scheduled so that placing and compacting of HMA is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.

The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose for the first lift of all runway and taxiway pavements. Successive lifts of HMA surface course may be placed using a ski, or laser control per paragraph 401-4.1, provided grades of the first lift of HMA surface course meet the tolerances of paragraphs 401-5.2b(6) as verified by a survey. Contractor shall survey each lift of HMA surface course and certify to Engineer that every lot of each lift meets the grade tolerances of paragraph 401-5.2b(6) before the next lift can be placed.

The initial placement and compaction of the HMA shall occur at a temperature suitable for obtaining density, surface smoothness, and other specified requirements but not less than 250°F(121°C).

Edges of existing HMA pavement abutting the new work shall be saw cut and carefully removed as shown on the drawings and coated with asphalt tack coat before new material is placed against it.

Upon arrival, the HMA shall be placed to the full width by a HMA paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the HMA mat. Unless otherwise permitted, placement of the HMA shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The HMA shall be placed in consecutive adjacent strips having a minimum width of 10 feet (m) except where edge lanes require less width to complete the area at full paving lanes or to the widths prescribed in the plans at pavement repair areas. Additional screed sections shall not be attached to widen paver to meet the minimum lane width requirements specified above unless additional auger sections are added to match. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot (30 cm);
however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course.

Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m).

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the HMA may be spread and luted by hand tools.

Areas of segregation in the surface course, as determined by the Engineer, shall be removed and replaced at the Contractor’s expense. The area shall be removed by saw cutting and milling a minimum of 2 inches (50 mm) deep. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.

401-4.12 COMPACTION OF HMA.

After placing, the HMA shall be thoroughly and uniformly compacted by power rollers. The surface shall be compacted as soon as possible when the HMA has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the HMA to the roller, the wheels shall be equipped with a scraper and kept properly moistened but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power driven tampers. Tampers shall weigh not less than 275 pounds (125 kg), have a tamping plate width not less than 15 inches (38 cm), be rated at not less than 4,200 vibrations per minute, and be suitably equipped with a standard tamping plate wetting device.

Any HMA that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor’s expense. Skin patching shall not be allowed.

401-4.13 JOINTS.

The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid HMA except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. In both methods, all contact surfaces shall be coated with an asphalt tack coat before placing any fresh HMA against the joint.

Longitudinal joints which have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back 3 inches (75 mm) to 6 inches (150 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material shall be removed from the project. Asphalt tack coat or other product approved by the Engineer shall be applied to the clean, dry joint, prior to placing any additional fresh HMA against the joint. Any laitance produced from cutting joints shall be removed by vacuuming and washing. The cost of this work shall be considered incidental to the cost of the HMA. While the surface is being compacted and finished, the Contractor shall carefully trim the outside edges of the pavement to the
proper alignment. Edges so formed shall be beveled while still hot with the back of a rake or a smoothing iron and thoroughly compacted by tampers or by other satisfactory methods, providing a neat, smooth and straight edge.

401-4.14 SAW-CUT GROOVING.

If shown on the plans, saw cut grooves shall be provided as specified in Item P-621.

401-4.15 DIAMOND GRINDING.

When required, diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive. The saw blades shall be assembled in a cutting head mounted on a machine designed specifically for diamond grinding that will produce the required texture and smoothness level without damage to the pavement. The saw blades shall be 1/8-inch (3-mm) wide and there shall be a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; the actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Each machine shall be capable of cutting a path at least 3 feet (0.9 m) wide. Equipment that causes ravel, aggregate fractures, spalls or disturbance to the pavement will not be permitted. The depth of grinding shall not exceed 1/2 inch (13mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. Areas that have been ground will be sealed with a P-608 surface treatment as directed by the Engineer. It may be necessary to seal a larger area to avoid surface treatment creating any conflict with runway or taxiway markings.

401-4.16 NIGHTTIME PAVING REQUIREMENTS.

Paving during nighttime construction shall require the following:

a. All paving machines, rollers, distribution trucks and other vehicles required by the Contractor for his operations shall be equipped with artificial illumination sufficient to safely complete the work.

b. Minimum illumination level shall be twenty (20) horizontal foot-candles and maintained in the following areas:

   (1) An area of 30 feet (9 m) wide by 30 feet (9 m) long immediately behind the paving machines during the operations of the machines.

   (2) An area 15 feet (4.5 m) wide by 30 feet (9 m) long immediately in front and back of all rolling equipment, during operation of the equipment.

   (3) An area 15 feet (4.5 m) wide by 15 feet (4.5 m) long at any point where an area is being tack coated prior to the placement of pavement.

c. As partial fulfillment of the above requirements, the Contractor shall furnish and use, complete artificial lighting units with a minimum capacity of 3,000 watt electric beam lights, affixed to all equipment in such a way to direct illumination on the area underconstruction.

d. A lighting plan must be submitted by the Contractor and approved by the Engineer prior to the start of any nighttime work.

MATERIAL ACCEPTANCE

401-5.1 ACCEPTANCE SAMPLING AND TESTING.

Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the Contractor except that coring as required in this section shall be completed and paid for by the Contractor.

Testing organizations performing these tests shall be accredited in accordance with ASTM D3666. The
laboratory accreditation must be current and listed on the accrediting authority’s website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory’s current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction. All equipment in Contractor furnished laboratories shall be calibrated by an independent testing organization prior to the start of operations at the Contractor’s expense.

a. **Hot mixed asphalt.** Plant-produced HMA shall be tested for air voids and stability and flow on a lot basis. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. Samples shall be taken in accordance with ASTM D979.

A standard lot shall be equal to one day’s production or 2000 tons (1814 metric tons) whichever is smaller. If the day’s production is expected to exceed 2000 tons (1814 metric tons), but less than 4000 tons (3628 metric tons), the lot size shall be 1/2 day’s production. If the day’s production exceeds 4000 tons (3628 metric tons), the lot size shall be an equal sized fraction of the day’s production, but shall not exceed 2000 tons (1814 metric tons).

Where more than one plant is simultaneously producing HMA for the job, the lot sizes shall apply separately for each plant.

1. **Sampling.** Each lot will consist of four equal sublots. Sufficient HMA for preparation of test specimens for all testing will be sampled by the Engineer on a random basis, in accordance with the procedures contained in ASTM D3665. Samples will be taken in accordance with ASTM D979.

   The sample of HMA may be put in a covered metal tin and placed in an oven for not less than 30 minutes nor more than 60 minutes to stabilize to compaction temperature. The compaction temperature of the specimens shall be as specified in the JMF.

2. **Testing.** Sample specimens shall be tested for stability and flow in accordance with ASTM D6927. Air voids will be determined by the Engineer in accordance with ASTM D3203. One set of laboratory compacted specimens will be prepared for each sublot in accordance with ASTM D6926 at the number of blows required by paragraph 401-3.2, Table 1. Each set of laboratory compacted specimens will consist of three test specimens prepared from the same sample. The manual hammer in ASTM D6926 shall be used, however mechanical hammers may be used if they are approved by the engineer and calibrated to the same manual hammer density by varying the number of blows and for each specific mix. When calibrating the mechanical hammer, at least 5 samples should be compacted with the manual hammer (50 or 75 blows as specified) to establish an average density. Five samples should also be compacted at various blow counts with the mechanical hammer and plotted to give a curve that shows density vs blows. Where the average density of the manual hammer intersects the curve developed from the mechanical hammer, the number of blows required for the mechanical hammer is identified. The guide to control the vertical axis of the hammer shall not be used during compaction.

   Prior to testing, the bulk specific gravity of each test specimen shall be measured by the Engineer in accordance with ASTM D2726 using the procedure for laboratory-prepared thoroughly dry specimens for use in computing air voids and pavement density.

   For air voids determination, the theoretical maximum specific gravity of the mixture shall be measured one time for each sublot in accordance with ASTM D2041. The value used in the air voids computation for each sublot shall be based on theoretical maximum specific gravity measurement for the sublot.

   The stability and flow for each sublot shall be computed by averaging the results of all test specimens representing that sublot.
(3) **Acceptance.** Acceptance of plant produced HMA for stability, flow, and air voids shall be determined by the Engineer in accordance with the requirements of paragraph 401-5.2b.

b. **In-place HMA.** HMA placed in the field shall be tested for mat and joint density on a lot basis. A standard lot shall be equal to one day’s production or 2000 tons (1814 metric tons) whichever is smaller. If the day’s production is expected to exceed 2000 tons (1814 metric tons), but less than 4000 tons (3628 metric tons), the lot size shall be 1/2 day’s production. If the day’s production exceeds 4000 tons (3628 metric tons), the lot size shall be an equal sized fraction of the day’s production, but shall not exceed 2000 tons (1814 metric tons).

(1) **Mat density.** The lot size shall be the same as that indicated in paragraph 401-5.1a and shall be divided into four equal sublots. One core of finished, compacted HMA shall be taken by the Contractor from each sublot. Core locations will be determined by the Engineer on a random basis in accordance with procedures contained in ASTM D3665. Cores for mat density shall not be taken closer than one foot (30 cm) from a transverse or longitudinal joint.

(2) **Joint density.** The lot size shall be the total length of longitudinal joints constructed by a lot of HMA as defined in paragraph 401-5.1a. The lot shall be divided into four equal sublots. One core of finished, compacted HMA shall be taken by the Contractor from each sublot. Core locations will be determined by the Engineer on a random basis in accordance with procedures contained in ASTM D3665. All cores for joint density shall be taken centered on the joint. The minimum core diameter for joint density determination shall be 5 inches (125 mm).

(3) **Sampling.** Samples shall be neatly cut with a diamond core drill bit. Samples will be taken in accordance with ASTM D979. The minimum diameter of the sample shall be 5 inches (125 mm). Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. The Contractor shall furnish all tools, labor, and materials for cutting samples, cleaning, and filling the cored pavement. Cored pavement shall be cleaned and core holes shall be filled in a manner acceptable to the Engineer and within one day after sampling. Latrance produced by the coring operation shall be removed immediately.

The top most lift of HMA shall be completely bonded to the underlying layer. If any of the cores reveal that the surface is not bonded to the layer immediately below the surface then additional cores shall be taken as directed by the Engineer in accordance with paragraph 401-5.1b to determine the extent of any delamination. All delaminated areas shall be completely removed by milling to the limits and depth and replaced as directed by the Engineer at no additional cost.

(4) **Testing.** The bulk specific gravity of each cored sample will be measured by the Engineer in accordance with ASTM D2726. Samples will be taken in accordance with ASTM D979. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each sublot sample by the average bulk specific gravity of all laboratory prepared specimens for the lot, as determined in paragraph 401-5.1a(2). The bulk specific gravity used to determine the joint density at joints formed between different lots shall be the lowest of the bulk specific gravity values from the two different lots.

(5) **Acceptance.** Acceptance of field placed HMA for mat density will be determined by the Engineer in accordance with the requirements of paragraph 401-5.2b(1). Acceptance for joint density will be determined by the Engineer in accordance with the requirements of paragraph 401-5.2b(3).

c. **Partial lots.** When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, or when the Contractor and Engineer agree in writing to allow overages or other minor tonnage placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.
The last batch produced where production is halted will be sampled, and its properties shall be considered as representative of the particular sublot from which it was taken. In addition, an agreed to minor placement will be sampled, and its properties shall be considered as representative of the particular sublot from which it was taken. Where three sublots are produced, they shall constitute a lot. Where one or two sublots are produced, they shall be incorporated into the next lot, and the total number of sublots shall be used in the acceptance plan calculation, that is, \( n = 5 \) or \( n = 6 \), for example. Partial lots at the end of asphalt production on the project shall be included with the previous lot. The lot size for field placed material shall correspond to that of the plant material, except that, in no cases, shall less than three (3) cored samples be obtained, that is, \( n = 3 \).

**401-5.2 ACCEPTANCE CRITERIA.**

**a. General.** Acceptance will be based on the following characteristics of the HMA and completed pavement as well as the implementation of the Contractor Quality Control Program and test results:

1. Air voids
2. Mat density
3. Joint density
4. Thickness
5. Smoothness
6. Grade
7. Stability
8. Flow

Mat density and air voids will be evaluated for acceptance in accordance with paragraph 401-5.2b(1). Stability and flow will be evaluated for acceptance in accordance with paragraph 401-5.2b(2). Joint density will be evaluated for acceptance in accordance with paragraph 401-5.2b(3). Thickness will be evaluated by the Engineer for compliance in accordance with paragraph 401-5.2b(4). Acceptance for smoothness will be based on the criteria contained in paragraph 401-5.2b(5). Acceptance for grade will be based on the criteria contained in paragraph 401-5.2b(7).

The Engineer may at any time, reject and require the Contractor to dispose of any batch of HMA which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

**b. Acceptance criteria.**

1. **Mat density and air voids.** Acceptance of each lot of plant produced material for mat density and air voids shall be based on the percentage of material within specification limits (PWL). If the PWL of the lot equals or exceeds 90%, the lot shall be acceptable. Acceptance and payment shall be determined in accordance with paragraph 401-8.1.

2. **Stability and flow.** Acceptance of each lot of plant produced HMA for stability and flow shall be based on the PWL. If the PWL of the lot equals or exceeds 90%, the lot shall be acceptable. If the PWL is less than 90%, the Contractor shall determine the reason and take corrective action. If the PWL is below 80%, the Contractor must stop production until the reason for poor stability and/or flow has been determined and adjustments to the HMA are made.
(3) **Joint density.** Acceptance of each lot of plant produced HMA for joint density shall be based on the PWL. If the PWL of the lot is equal to or exceeds 90%, the lot shall be considered acceptable. If the PWL is less than 90%, the Contractor shall evaluate the reason and act accordingly. If the PWL is less than 80%, the Contractor shall cease operations and until the reason for poor compaction has been determined. If the PWL is less than 71%, the pay factor for the lot used to complete the joint shall be reduced by five (5) percentage points. This lot pay factor reduction shall be incorporated and evaluated in accordance with paragraph 401-8.1.

(4) **Thickness.** Thickness of each lift of surface course shall be evaluated by the Engineer for compliance to the requirements shown on the plans. Measurements of thickness shall be made by the Engineer using the cores extracted for each subplot for density measurement. The maximum allowable deficiency at any point shall not be more than 1/4 inch (6mm) less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, shall not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or subplot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the Engineer to circumscribe the deficient area.

(5) **Smoothness.** The final surface shall be free from roller marks. After the final rolling, but not later than 24 hours after placement, the surface of each lot shall be tested in both longitudinal and transverse directions for smoothness to reveal all surface irregularities exceeding the tolerances specified. The Contractor shall furnish paving equipment and employ methods that produce a surface for each pavement lot meeting the following smoothness criteria: the finished surface course of the pavement shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. When the surface course smoothness exceeds specification tolerances which cannot be corrected by diamond grinding of the surface course, full depth removal and replacement of surface course corrections shall be to the limit of the longitudinal placement. Corrections involving diamond grinding will be subject to the final pavement thickness tolerances specified. The Contractor shall apply an approved surface treatment per Item P-608 or P-609 to all areas that have been subject to grinding as directed by the Engineer.

(a) Transverse measurements. Transverse measurements will be taken for each lot placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet (15m) or more often as determined by Engineer.

(i) Testing shall be continuous across all joints, starting with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Smoothness readings will not be made across grade changes or cross slope transitions; at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. High spots on final surface course > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 401-4.15 or by removing and replacing full depth of surface course. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding...
should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) The joint between lots shall be tested separately to facilitate smoothness between lots. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface, with half the straightedge on one side of the joint and the other half of the straightedge on the other side of the joint. Measure the maximum gap between the straightedge and the pavement surface in the area between these two high points. One measurement shall be taken at the joint every 50 feet (15m) or more often if directed by the Engineer. Deviations on final surface course > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 401-4.15 or by removing and replacing full depth of surface course. Each measurement shall be recorded and a copy of the data shall be furnished to the Engineer at the end of each days testing.

(b) Longitudinal measurements. Longitudinal measurements will be taken from each lot placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6m) or greater.

(i) Longitudinal Short Sections. Longitudinal Short Sections are when the longitudinal lot length is less than 200 feet (60m) and areas not requiring a profilograph. When approved by the Engineer, the first and last 15 feet (4.5m) of the lot can also be considered as short sections for smoothness. The finished surface shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. Smoothness readings will not be made across grade changes or cross slope transitions; at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. Testing shall be continuous across all joints, starting with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final surface course > 1/4 inch (6mm) in longitudinal direction will be corrected with diamond grinding per paragraph 401-4.15 or by removing and replacing full depth of surface course. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) Profilograph Testing. Profilograph testing shall be performed by the contractor using approved equipment and procedures as described as ASTM E1274. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate “must grind” bumps and the Profile Index for the pavement using a 0.2 inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved operator. Profilograms shall
be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). A copy of the reduced tapes shall be furnished to the Engineer at the end of each days testing.

The pavement must have an average profile index meeting the requirements of paragraph 401-8.1d. High spots, or “must grind” spots, on final surface course in longitudinal direction shall be corrected with diamond grinding per paragraph 401-4.15 or by removing and replacing full depth of surface course. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

Where corrections are necessary, second profilograph runs shall be performed to verify that the corrections produced an average profile index of 15 inches (38 cm) per mile or less. If the initial average profile index was less than 15 inches (38 cm), only those areas representing greater than 0.4 inch (10 mm) deviation will be re-profiled for correction verification.

(iii) Final profilograph of [runway]. Final profilograph, full length of runway, shall be performed to facilitate testing of smoothness between lots. Profilograph testing shall be performed by the contractor using approved equipment and procedures as described as ASTM E1274. The pavement must have an average profile index meeting the requirements of paragraph 401-8.1d. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate “must grind” bumps and the Profile Index for the pavement using a 0.2 inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved, trained operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). A copy of the reduced tapes shall be furnished to the Engineer at the end of each days testing. Profilograph of final runway shall be performed one foot right and left of runway centerline and 15 feet (4.5 m) right and left of centerline. Any areas that indicate “must grind” will be corrected as directed by the Engineer.

Smoothness testing indicated in the above paragraphs except paragraph (iii) shall be performed within 24 hours of placement of material. Smoothness testing indicated in paragraph (iii) shall be performed within 48 hours of paving completion. The primary purpose of smoothness testing is to identify areas that may be prone to ponding of water which could lead to hydroplaning of aircraft. If the contractor’s machines and/or methods are producing significant areas that need corrective actions then production should be stopped until corrective measures can be implemented. If corrective measures are not implemented and when directed by the Engineer, production shall be stopped until corrective measures can be implemented.

(6) Grade. Grade shall be evaluated on the first day of placement and then as a minimum, every 2 days or less to allow adjustments to paving operations if measurements do not meet specification requirements. The Contractor must submit the survey data to the
Engineer by the following day after measurements have been taken. The finished surface of the pavement shall not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm). The finished grade of each lot will be determined by running levels at intervals of 50 feet (15 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet (15 m)) to determine the elevation of the completed pavement. The Contractor shall pay the cost of surveying of the level runs that shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer. The lot size shall be 2000 square yards. When more than 15% of all the measurements within a lot are outside the specified tolerance, or if any one shot within the lot deviates 3/4 inch (19 mm) or more from planned grade, the Contractor shall remove the deficient area to the depth of the final course plus 1/2 inch (12 mm) of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off provided the course thickness complies with the thickness specified on the plans. The surface of the ground pavement shall have a texture consisting of grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide. The peaks and ridges shall be approximately 1/32 inch (1 mm) higher than the bottom of the grooves. The pavement shall be left in a clean condition. The removal of all of the slurry resulting from the grinding operation shall be continuous. The grinding operation should be controlled so the residue from the operation does not flow across other lanes of pavement. High point grinding will be limited to 15 square yards (12.5 m²). Areas in excess of 15 square yards (12.5 m²) will require removal and replacement of the pavement in accordance with the limitations noted above. The Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

c. Percentage of material within specification limits (PWL). The PWL shall be determined in accordance with procedures specified in Section 110 of the General Provisions. The specification tolerance limits (L) for lower and (U) for upper are contained in Table 5.

Table 5. Marshall acceptance limits for stability, flow, air voids, density

<table>
<thead>
<tr>
<th>TEST PROPERTY</th>
<th>Number of Blows</th>
<th>75 blows</th>
<th>Specification Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stability, minimum (pounds)(N)</td>
<td>1800</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Flow, 0.01 inch (25 mm)</td>
<td>8</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Air Voids Total Mix (%)</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Mat Density (%)</td>
<td>96.3</td>
<td>101.3</td>
<td></td>
</tr>
<tr>
<td>Base Mat Density (%)</td>
<td>95.5</td>
<td>101.3</td>
<td></td>
</tr>
<tr>
<td>Joint Density (%)</td>
<td>93.3</td>
<td>101.3</td>
<td></td>
</tr>
</tbody>
</table>

d. Outliers. All individual tests for mat density and air voids shall be checked for outliers (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers shall be discarded, and the PWL shall be determined using the remaining test values. The criteria in Table 5 is based on production processes which have a variability with the following standard deviations: Surface Course Mat Density (%), 1.30; Base Course Mat Density (%), 1.55; Joint Density (%), 2.1.

The Contractor should note that (1) 90 PWL is achieved when consistently producing a surface course with an average mat density of at least 98% with 1.30% or less variability, (2) 90 PWL is
achieved when consistently producing a base course with an average mat density of at least 97.5% with 1.55% or less variability, and (3) 90 PWL is achieved when consistently producing joints with an average joint density of at least 96% with 2.1% or less variability.

401-5.3 RESAMPLING PAVEMENT FOR MAT DENSITY.

a. **General.** Resampling of a lot of pavement will only be allowed for mat density, and then, only if the Contractor requests same, in writing, within 48 hours after receiving the written test results from the Engineer. A retest will consist of all the sampling and testing procedures contained in paragraphs 401-5.1b and 401-5.2b(1). Only one resampling per lot will be permitted.
   
a. A redefined PWL shall be calculated for the resampled lot. The number of tests used to calculate the redefined PWL shall include the initial tests made for that lot plus the retests.

b. The cost for resampling and retesting shall be borne by the Contractor.

c. **Payment for resampled lots.** The redefined PWL for a resampled lot shall be used to calculate the payment for that lot in accordance with Table 6.

b. **Outliers.** Check for outliers in accordance with ASTM E178, at a significance level of 5%.

401-5.4 **Leveling course.** Any course used for trueing and leveling shall meet the aggregate gradation in Table 3, paragraph 401-3.2. The trueing and leveling course shall meet the requirements of paragraph 401-3.2, 401-5.2b(1) for air voids; and 401-5.2b(2) for stability and flow, but shall not be subject to the density requirements of paragraph 401-5.2b(1) for mat density and 401-5.2b(3) for joint density. The leveling course shall be compacted with the same effort used to achieve density of the test section. The trueing and leveling course shall not exceed the maximum lift thickness associated with each gradation in Table 3, paragraph 401-3.2. The leveling course is the first variable thickness lift of an overlay placed prior to subsequent courses.

**CONTRACTOR QUALITY CONTROL**

401-6.1 **GENERAL.**

The Contractor shall develop a Quality Control Program in accordance with Section 100 of the General Provisions. The program shall address all elements that affect the quality of the pavement including, but not limited to:

a. Mix design
b. Aggregate grading
c. Quality of materials
d. Stockpile management
e. Proportioning
f. Mixing and transportation
g. Placing and finishing
h. Joints
i. Compactions
j. Surface smoothness
k. Personnel
l. Laydown plan
The Contractor shall perform quality control sampling, testing, and inspection during all phases of the work and shall perform them at a rate sufficient to ensure that the work conforms to the contract requirements, and at minimum test frequencies required by paragraph 401-6.3 and Section 100 of the General Provisions. As a part of the process for approving the Contractor’s plan, the Engineer may require the Contractor’s technician to perform testing of samples to demonstrate an acceptable level of performance.

No partial payment will be made for materials that are subject to specific quality control requirements without an approved plan.

401-6.2 CONTRACTOR TESTING LABORATORY.

The lab shall meet the requirements of ASTM D3666 including all necessary equipment, materials, and current reference standards to comply with the specifications. All costs associated with the testing laboratory shall be included in the unit prices for P-401.

401-6.3 QUALITY CONTROL TESTING.

The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to these specifications and as set forth in the approved Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

a. **Asphalt content.** A minimum of two asphalt content tests shall be performed per lot in accordance with ASTM D6307 or ASTM D2172 if the correction factor in ASTM D6307 is greater than 1.0. The asphalt content for the lot will be determined by averaging the test results.

b. **Gradation.** Aggregate gradations shall be determined a minimum of twice per lot from mechanical analysis of extracted aggregate in accordance with ASTM D5444, ASTM C136, and ASTM C117.

c. **Moisture content of aggregate.** The moisture content of aggregate used for production shall be determined a minimum of once per lot in accordance with ASTM C566.

d. **Moisture content of HMA.** The moisture content shall be determined once per lot in accordance with ASTM D1461.

e. **Temperatures.** Temperatures shall be checked, at least four times per lot, at necessary locations to determine the temperatures of the dryer, the asphalt binder in the storage tank, the HMA at the plant, and the HMA at the job site.

f. **In-place density monitoring.** The Contractor shall conduct any necessary testing to ensure that the specified density is being achieved. A nuclear gauge may be used to monitor the pavement density in accordance with ASTM D2950.

g. **Additional testing.** Any additional testing that the Contractor deems necessary to control the process may be performed at the Contractor’s option.

h. **Monitoring.** The Engineer reserves the right to monitor any or all of the above testing.

401-6.4 SAMPLING

When directed by the Engineer, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.
401-6.5 CONTROL CHARTS.

The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each subplot will be calculated and monitored by the Quality Control laboratory.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept current. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and Suspension Limits applicable to each test parameter, and the Contractor’s test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor’s projected data during production indicates a problem and the Contractor is not taking satisfactory corrective action, the Engineer may suspend production or acceptance of the material.

a. **Individual measurements.** Control charts for individual measurements shall be established to maintain process control within tolerance for aggregate gradation, asphalt content, and VMA. The control charts shall use the job mix formula target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Action Limit</th>
<th>Suspension Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch (19 mm)</td>
<td>±6%</td>
<td>±9%</td>
</tr>
<tr>
<td>1/2 inch (12 mm)</td>
<td>±6%</td>
<td>±9%</td>
</tr>
<tr>
<td>3/8 inch (9 mm)</td>
<td>±6%</td>
<td>±9%</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>±6%</td>
<td>±9%</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>±5%</td>
<td>±7.5%</td>
</tr>
<tr>
<td>No. 50 (0.30 mm)</td>
<td>±3%</td>
<td>±4.5%</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
<td>±2%</td>
<td>±3%</td>
</tr>
<tr>
<td>Asphalt Content</td>
<td>±0.45%</td>
<td>±0.70%</td>
</tr>
<tr>
<td>VMA</td>
<td>-1.00%</td>
<td>-1.50%</td>
</tr>
</tbody>
</table>

b. **Range.** Control charts for range shall be established to control process variability for the test parameters and Suspension Limits listed below. The range shall be computed for each lot as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of n = 2. Should the Contractor elect to perform more than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.
Control Chart Limits Based On Range
(Based On n = 2)

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Suspension Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 inch (12 mm)</td>
<td>11%</td>
</tr>
<tr>
<td>3/8 inch (9 mm)</td>
<td>11%</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>11%</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>9%</td>
</tr>
<tr>
<td>No. 50 (0.30 mm)</td>
<td>6%</td>
</tr>
<tr>
<td>No. 200 (0.075 mm)</td>
<td>3.5%</td>
</tr>
<tr>
<td>Asphalt Content</td>
<td>0.8%</td>
</tr>
</tbody>
</table>

c. **Corrective Action.** The Contractor Quality Control Program shall indicate that appropriate action shall be taken when the process is believed to be out of tolerance. The Plan shall contain sets of rules to gauge when a process is out of control and detail what action will be taken to bring the process into control. As a minimum, a process shall be deemed out of control and production stopped and corrective action taken, if:

1. One point falls outside the Suspension Limit line for individual measurements or range; or
2. Two points in a row fall outside the Action Limit line for individual measurements.

### 401-6.6 QUALITY CONTROL REPORTS.

The Contractor shall maintain records and shall submit reports of quality control activities daily, in accordance with the Contractor Quality Control Program described in General Provisions, Section 100.

### METHOD OF MEASUREMENT

#### 401-7.1 MEASUREMENT.

HMA shall be measured by the number of tons of HMA used in the accepted work. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage.

Placement of HMAC pavements shall be as shown in the plans or as directed by the Engineer or his authorized representative in the field. Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage. Corresponding tickets shall be given to the Engineer’s project representative at the end of each day’s production. No payment will be made for HMAC pavements placed without the corresponding material receipts.

### BASIS OF PAYMENT

#### 401-8.1 PAYMENT.

Payment for a lot of HMA meeting all acceptance criteria as specified in paragraph 401-5.2 shall be made based on results of tests for mat density and air voids. Payment for acceptable lots shall be adjusted according to paragraph 401-8.1a for mat density and air voids and 401-8.1c for smoothness, subject to the limitation that:

a. The total project payment for plant mix bituminous concrete pavement shall not exceed 100 percent of the product of the contract unit price and the total number of tons (kg) of HMA used in the accepted work (See Note 1 under Table 6).
b. The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

c. **Basis of adjusted payment.** The pay factor for each individual lot shall be calculated in accordance with Table 6. A pay factor shall be calculated for both mat density and air voids. The lot pay factor shall be the higher of the two values when calculations for both mat density and air voids are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either mat density or air voids is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both mat density and air voids are less than 100%. If PWL for joint density is less than 71 percent then the lot pay factor shall be reduced by 5% but be no higher than 95%.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 401-8.1. Payment in excess of 100% for accepted lots of HMA shall be used to offset payment for accepted lots of bituminous concrete pavement that achieve a lot pay factor less than 100%.

**Table 6. Price adjustment schedule**

<table>
<thead>
<tr>
<th>Percentage of material within specification limits (PWL)</th>
<th>Lot pay factor (percent of contract unit price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 – 100</td>
<td>106</td>
</tr>
<tr>
<td>90 – 95</td>
<td>PWL + 10</td>
</tr>
<tr>
<td>75 – 89</td>
<td>0.5 PWL + 55</td>
</tr>
<tr>
<td>55 – 74</td>
<td>1.4 PWL – 12</td>
</tr>
<tr>
<td>Below 55</td>
<td>Reject 2</td>
</tr>
</tbody>
</table>

1 Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment above 100% shall be subject to the total project payment limitation specified in paragraph 401-8.1.

2 The lot shall be removed and replaced. However, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50% of the contract unit price and the total project payment shall be reduced by the amount withheld for the rejected lot.

d. **Profilograph smoothness.** When the final average profile index (subsequent to any required corrective action) does not exceed 7 inches per mile (18 cm per 1.6 km), payment will be made at the contract unit price for the completed pavement. If the final average profile index (subsequent to any required corrective action) exceeds 7 inches per mile (18 cm per 1.6 km), but does not exceed 15 inches per mile (38 cm per 1.6 m), the Contractor may elect to accept a contract unit price adjustment in lieu of reducing the profile index.

e. **Basis of adjusted payment for smoothness.** Price adjustment for pavement smoothness will be made in accordance with Table 7. The adjustment will apply to the total tonnage of HMA within a lot of pavement and shall be applied with the following equation:

\[
(Tons \text{ of asphalt concrete in lot}) \times (\text{lot pay factor}) \times (\text{unit price per ton}) \times (\text{smoothness pay factor}) = \text{payment for lot}
\]
Table 7. Profilograph Average Profile Index Smoothness Pay Factor

<table>
<thead>
<tr>
<th>Inches/miles per 1/10 mile</th>
<th>Short Sections</th>
<th>Pay Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 7</td>
<td>00.0 - 15.0</td>
<td>100%</td>
</tr>
<tr>
<td>7.1 - 9</td>
<td>15.1 - 16</td>
<td>98%</td>
</tr>
<tr>
<td>9.1 - 11</td>
<td>16.1 - 17</td>
<td>96%</td>
</tr>
<tr>
<td>11.1 - 13</td>
<td>17.1 - 18</td>
<td>94%</td>
</tr>
<tr>
<td>13.1 - 14</td>
<td>18.1 - 20</td>
<td>92%</td>
</tr>
<tr>
<td>14.1 - 15</td>
<td>20.1 - 22</td>
<td>90%</td>
</tr>
<tr>
<td>15.1 and up</td>
<td>22.1 and up</td>
<td>Corrective work required¹</td>
</tr>
</tbody>
</table>

¹ The Contractor shall correct pavement areas not meeting these tolerances by removing and replacing the defective work. If the Contractor elects to construct an overlay to correct deficiencies, the minimum thickness of the overlay should be at least three times the maximum aggregate size (approximately four (4) times the nominal maximum aggregate size). The corrective overlay shall not violate grade Criteria and butt joints shall be constructed by sawing and removing the original pavement in compliance with the thickness/maximum aggregate size ratio. Skin patching shall not be permitted.

f. Sawcut, Remove, and Replace Damaged Asphalt Pavement shall be measured by the square foot.

g. 4” HMA Surface Course shall be measured by the ton.

HMA placed above the specified grade shall not be included in the quantities for payment.

401-8.1.1. PAYMENT.

Payment for “Sawcut, Remove, and Replace Damaged Asphalt Pavement shall include the sawcutting, removal of existing pavement, removal of existing subgrade/subbase, and placement of new HMA materials in accordance with these specifications and plans, and shall include all materials, equipment, and labor required. Saw Cut Grooving, Bituminous Prime Coat, and Lean Concrete Base shall be measured and paid in accordance with P-621, P-602, and P-306 respectively.

Payment for 4” HMA Surface Course shall include the sawcutting, removal of existing pavement, and placement of new HMA surface course materials in accordance with these specifications and the plans, and shall include all materials, equipment, and labor required.

Payment will be made under:

Item P-401-8.1  Sawcut, Remove, and Replace Damaged Asphalt Pavement – Per SF

Item P-401-8.2  4” HMA Surface Course – per TON

TESTING REQUIREMENTS

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

Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates

Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement

Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying

Standard Practice for Sampling Aggregates

Standard Practice for Sampling Bituminous Paving Mixtures

Standard Specification for Fine Aggregate for Bituminous Paving Mixtures

Standard Test Method for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures

Standard Test Method for Moisture or Volatile Distillates in Bituminous Paving Mixtures

Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate

Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures

Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

Standard Practice for Random Sampling of Construction Materials

Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures

Standard Test Method for Mechanical Size Analysis of Extracted Aggregate


Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method


Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus
AIRFIELD PAVEMENT REPAIRS

HOT MIX ASPHALT

Project No. 460C_HOU

(MHA) PAVEMENT

**MATERIAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM E11</td>
<td>Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves</td>
</tr>
<tr>
<td>ASTM E178</td>
<td>Standard Practice for Dealing with Outlying Observations</td>
</tr>
<tr>
<td>ASTM E1274</td>
<td>Standard Test Method for Measuring Pavement Roughness Using a Profilograph</td>
</tr>
<tr>
<td>AASHTO T030</td>
<td>Standard Method of Test for Mechanical Analysis of Extracted Aggregate</td>
</tr>
<tr>
<td>AASHTO T110</td>
<td>Standard Method of Test for Moisture or Volatile Distillates in Hot Mix Asphalt (HMA)</td>
</tr>
<tr>
<td>AASHTO T275</td>
<td>Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Paraffin-Coated Specimens</td>
</tr>
<tr>
<td>AASHTO T329</td>
<td>Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method</td>
</tr>
</tbody>
</table>

Asphalt Institute Handbook MS-26, Asphalt Binder
Asphalt Institute MS-2 Mix Design Manual, 7th Edition

END OF ITEM P-401
ITEM P-501 PORTLAND CEMENT CONCRETE (PCC) PAVEMENT (FLEXURAL STRENGTH)

DESCRIPTION

501-1.1 This work shall consist of pavement composed of Portland Cement Concrete (PCC), with reinforcement and PCC without reinforcement constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross-sections shown on the plans.

MATERIALS

501-2.1 AGGREGATES.

a. Reactivity. Fine and Coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Aggregate and mix proportion reactivity tests shall be performed for each project.

(1) Coarse and fine aggregate shall be tested separately in accordance with ASTM C1260. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.10% at 28 days (30 days from casting).

(2) Combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) Concrete Research Division (CRD) C662. If lithium nitrate admixture is used, it shall be nominal 30% ±0.5% weight lithium nitrate in water.

(3) If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C1567, modified for combined aggregates, or COE CRD C662, does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion of the proposed combined materials test specimens is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

b. Fine aggregate. Fine aggregate shall conform to the requirements of ASTM C33. Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and shall have a fineness modulus of not less than 2.50 nor more than 3.40. The soundness loss shall not exceed 10% when sodium sulfate is used or 15% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the fine aggregate shall not exceed the following limits:
Limits for Deleterious Substances in Fine Aggregate for Concrete

<table>
<thead>
<tr>
<th>Deleterious material</th>
<th>ASTM</th>
<th>Percentage by Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay Lumps and friable particles</td>
<td>ASTM C142</td>
<td>1.0</td>
</tr>
<tr>
<td>Material finer than 0.075mm (No. 200 sieve)</td>
<td>ASTM C117</td>
<td>3.0</td>
</tr>
<tr>
<td>Lightweight particles</td>
<td>ASTM C123 using a medium with a density of Sp. Gr. of 2.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Total of all deleterious Material</td>
<td></td>
<td>3.0</td>
</tr>
</tbody>
</table>

c. **Coarse aggregate.** Gradation, within the separated size groups, shall meet the coarse aggregate grading requirements of ASTM C33 when tested in accordance with ASTM C136. When the nominal maximum size of the aggregate is greater than one inch (25 mm), the aggregates shall be furnished in two size groups.

Aggregates delivered to the mixer shall consist of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates should be free of ferrous sulfides, such as pyrite, that would cause “rust” staining that can bleed through pavement markings. Steel blast furnace slag shall not be permitted. The aggregate shall be composed of clean, hard, uncoated particles. Dust and other coating shall be removed from the aggregates by washing.

The percentage of wear shall be no more than 40% when tested in accordance with ASTM C131.

The quantity of flat, elongated, and flat and elongated particles in any size group coarser than 3/8 sieve (9 mm) shall not exceed 8% by weight when tested in accordance with ASTM D4791. A flat particle is defined as one having a ratio of width to thickness greater than 5. An elongated particle is one having a ratio of length to width greater than 5.

The soundness loss shall not exceed 12% when sodium sulfate is used or 18% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the coarse aggregate shall not exceed the following limits:

**Limits for Deleterious Substances in Coarse Aggregate for Concrete**

<table>
<thead>
<tr>
<th>Deleterious material</th>
<th>ASTM</th>
<th>Percentage by Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay Lumps and friable particles</td>
<td>ASTM C142</td>
<td>1.0</td>
</tr>
<tr>
<td>Material finer than No. 200 sieve (0.075mm)</td>
<td>ASTM C117</td>
<td>1.0</td>
</tr>
<tr>
<td>Lightweight particles</td>
<td>ASTM C123 using a medium with a density of Sp. Gr. of 2.0</td>
<td>0.5</td>
</tr>
<tr>
<td>Chert (less than 2.40 Sp Gr.)</td>
<td>ASTM C123 using a medium with a density of Sp. Gr. of 2.4)</td>
<td>1.0</td>
</tr>
<tr>
<td>Total of all deleterious Material</td>
<td></td>
<td>3.0</td>
</tr>
</tbody>
</table>
Table 1. Gradation For Coarse Aggregate

(ASTM C33)

<table>
<thead>
<tr>
<th>Sieve Designations (square openings)</th>
<th>Percentage by Weight Passing Sieves</th>
<th>From 1-1/2 inch to No. 4 (38 mm - 4.75 mm)</th>
<th>From 1 inch to No. 4 (25.0 mm - 4.75 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>inch</td>
<td>mm</td>
<td>From 1-1/2 inch - 3/4 inch</td>
<td>#67 3/4-inch - No. 4</td>
</tr>
<tr>
<td>2-1/2</td>
<td>60</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>1-1/2</td>
<td>38</td>
<td>90-100</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td>20-55</td>
<td>400</td>
</tr>
<tr>
<td>3/4</td>
<td>19</td>
<td>0-15</td>
<td>90-100</td>
</tr>
<tr>
<td>1/2</td>
<td>13</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3/8</td>
<td>9</td>
<td>0-5</td>
<td>20-55</td>
</tr>
<tr>
<td>No. 4</td>
<td>4.75</td>
<td>---</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 8</td>
<td>2.36</td>
<td>---</td>
<td>0-5</td>
</tr>
</tbody>
</table>

1. **Aggregate susceptibility to durability (D) cracking.** Coarse aggregate may be accepted from sources that have a 20 year service history for the same gradation to be supplied with no durability issues. Aggregates that do not have a record of 20 years of service without major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless it meets the following:

   (a) Material currently being produced shall have a durability factor ≥ 95 using ASTM C666 procedure B. Coarse aggregates that are crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test but must meet all other quality tests. Aggregates meeting State Highway Department material specifications may be acceptable.

   (b) The Contractor shall submit a current certification that the aggregate does not have a history of D-cracking and that the aggregate meets the state specifications for use in PCC pavement for use on interstate highways. Certifications, tests and any history reports must be for the same gradation as being proposed for use on the project. Certifications which are not dated or which are over one (1) year old or which are for different gradations will not be accepted. Test results will only be accepted when tests were performed by a State Department of Transportation (DOT) materials laboratory or an accredited laboratory.

2. **Combined aggregate gradation.** If substituted for the grading requirements specified for coarse aggregate and for fine aggregate and when approved by the Engineer, the combined aggregate grading shall meet the following requirements:

   (a) The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in d. below, the point thus determined shall fall within the parallelogram described therein.
(b) The CF shall be determined from the following equation: 
\[ CF = \frac{\text{(cumulative percent retained on the 3/8 in. sieve)}}{\text{(cumulative percent retained on the No. 8 sieve)}} \times 100 \]

(c) The Workability Factor WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic yard greater than 564 pounds per cubic yard (335 kg per cubic meter).

(d) A diagram shall be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary.

501-2.2 Cement. Cement shall conform to the requirements of ASTM C150 Type II.

If aggregates are deemed innocuous when tested in accordance with paragraph 501-2.1.a.1 and accepted in accordance with paragraph 501-2.1.a.2, higher equivalent alkali content in the cement may be allowed if approved by the Engineer and FAA. If cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

501-2.3 Cementitious materials.

a. Fly ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash for use in mitigating alkali-silica reactivity shall have a Calcium Oxide (CaO) content of less than 13% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the mix design, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the Engineer.

b. Slag cement (ground granulated blast furnace (GGBF)). Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

c. Raw or calcined natural pozzolan. Natural pozzolan shall be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity shall have a total available alkali content less than 3%.

d. Ultrafine fly ash and ultrafine pozzolan. UltraFine Fly Ash (UFFA) and UltraFine Pozzolan (UFP) shall conform to ASTM C618, Class F or N, and the following additional requirements:

1. The strength activity index at 28 days of age shall be at least 95% of the control specimens.
2. The average particle size shall not exceed 6 microns.
501-2.4 JOINT SEAL.

The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-605 and shall be of the type specified in the plans.

501-2.5 ISOLATION JOINT FILLER.

Premolded joint filler for isolation joints shall conform to the requirements of ASTM D1751 and shall be where shown on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Engineer.

501-2.6 STEEL REINFORCEMENT.

Reinforcing shall consist of carbon-steel bars conforming to the requirements of ASTM A615 and carbon-steel welded wire reinforcement conforming to the requirements of ASTM A1064 as shown in the plans.

501-2.7 DOWEL AND TIE BARS.

Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 shall be used for construction requiring bent bars.

501-2.8 WATER.

Water used in mixing or curing shall be potable, clean, free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product, except that non-potable water, or water from concrete production operations, may be used if it meets the requirements of ASTM C1602.

501-2.9 MATERIAL FOR CURING CONCRETE.

Curing materials shall conform to one of the following specifications:

a. Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class B, or Class A if wax base only.

b. White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.

c. White burlap polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.

d. Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

501-2.10 ADMIXTURES.

The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

a. **Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.
b. **Water-reducing admixtures.** Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

c. **Other admixtures.** The use of set retarding, and set-accelerating admixtures shall be approved by the Engineer. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

d. **Lithium Nitrate.** The lithium admixture shall be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Limit (Percent by Mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiNO₃ (Lithium Nitrate)</td>
<td>30 ±0.5</td>
</tr>
<tr>
<td>SO₄ (Sulfate Ion)</td>
<td>0.1 (max)</td>
</tr>
<tr>
<td>Cl (Chloride Ion)</td>
<td>0.2 (max)</td>
</tr>
<tr>
<td>Na (Sodium Ion)</td>
<td>0.1 (max)</td>
</tr>
<tr>
<td>K (Potassium Ion)</td>
<td>0.1 (max)</td>
</tr>
</tbody>
</table>

Provide a trained manufacturer’s representative to supervise the lithium nitrate admixture dispensing and mixing operations.

**501-2.11 EPOXY-RESIN.**

All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

b. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

c. Material for use for injecting cracks shall be Type IV, Grade 1.

d. Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

**501-2.12 MATERIAL ACCEPTANCE.**

Prior to use of materials, the Contractor shall submit certified test reports to the Engineer for those materials proposed for use during construction. The certification shall show the appropriate ASTM test for each material, the test results, and a statement that the material passed or failed.

The Engineer may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

**MIX DESIGN**

**501-3.1. GENERAL.**

No concrete shall be placed until the mix design has been submitted to the Engineer for review and the Engineer has taken appropriate action. The Engineer’s review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

**501-3.2 PROPORTIONS.**
The laboratory preparing the mix design shall be accredited in accordance with ASTM C1077. The mix design for all Portland cement concrete placed under P-501 shall be stamped or sealed by the responsible professional Engineer of the laboratory. Concrete shall be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 501-5.2 for a flexural strength of 650 psi per ASTM C78. The mix shall be developed using the procedures contained in the Portland Cement Association’s (PCA) publication, “Design and Control of Concrete Mixtures”.

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) shall be 470 pounds per cubic yard (280 kg per cubic meter). The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall not be more than 0.45 by weight.

Flexural strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. The mix determined shall be workable concrete having a maximum allowable slump between one and two inches (25 mm and 50 mm) as determined by ASTM C143. For slip-form concrete, the slump shall be between 1/2 inch (12 mm) and 1-1/2 inch (38 mm). At the start of the project, the Contractor shall determine a maximum allowable slump for slip-form pavement which will produce in-place pavement to control the edge slump. The selected slump shall be applicable to both pilot and fill-in lanes.

Before the start of paving operations and after approval of all material to be used in the concrete, the Contractor shall submit a mix design showing the proportions and flexural strength obtained from the concrete at seven (7) and 28 days. The mix design shall include copies of test reports, including test dates, and a complete list of materials including type, brand, source, and amount of cement, fly ash, ground slag, coarse aggregate, fine aggregate, water, and admixtures. The mix design shall be submitted to the Engineer at least 30 days prior to the start of operations. The submitted mix design shall not be more than 90 days old. Production shall not begin until the mix design is approved in writing by the Engineer.

If a change in sources is made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Engineer for approval. Previously approved mix designs for airfield paving older than 90 days shall not be used without re-submitting and re-approval.

The results of the mix design shall include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities shall be based on the mass in a saturated surface dry condition. The recommended mixture proportions shall be accompanied by test results demonstrating that the proportions selected will produce concrete of the qualities indicated. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in PCA’s publication, Design and Control of Concrete Mixtures, modified as necessary to accommodate flexural strength.

The submitted mix design shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

a. Coarse, fine, and combined aggregate gradations and plots including fineness modulus of the fine aggregate.

b. Reactivity Test Results.

c. Coarse aggregate quality test results, including deleterious materials.

d. Fine aggregate quality test results, including deleterious materials.

e. Mill certificates for cement and supplemental cementitious materials.

f. Certified test results for all admixtures, including Lithium Nitrate if applicable.

g. Specified flexural strength, slump, and air content.

h. Recommended proportions/volumes for proposed mixture and trial water-cementitious materials.
materials ratio, including actual slump and air content.

i. Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.

j. Correlation ratios for acceptance testing and Contractor Quality Control testing, when applicable.

k. Historical record of test results documenting production standard deviation, when applicable.

501-3.3 CEMENTITIOUS MATERIALS.

a. **Fly ash.** When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

b. **Slag cement (ground granulated blast furnace (GGBF)).** Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight. If the concrete is to be used for slipforming operations and the air temperature is expected to be lower than 55°F (13°C) the percent slag cement shall not exceed 30% by weight.

c. **Raw or calcined natural pozzolan.** Natural pozzolan may be used in the mix design. When pozzolan is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

d. **Ultrafine fly ash (UFFA) and ultrafine pozzolan (UFP).** UFFA and UFP may be used in the mix design with the Engineer’s approval. When UFFA and UFP is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between seven (7) and 16% by weight of the total cementitious material.

501-3.4 ADMIXTURES.

a. **Air-entraining admixtures.** Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be 3.0%. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

b. **Water-reducing admixtures.** Water-reducing admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted on trial mixes, with the materials to be used in the work, in accordance with ASTM C494.

c. **Other admixtures.** Set controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted on trial mixes, with the materials to be used in the work, in accordance with ASTM C 494.

d. **Lithium nitrate.** Lithium nitrate shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 501-2.10d.

501-3.5 CONCRETE MIX DESIGN LABORATORY.

The Contractor’s laboratory used to develop the concrete mix design shall be accredited in accordance with FAA-P-501-8

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FAA - P-501-9  
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501-3.6 Maturity Meters for early strength.

a. Calibration during mix design. As a part of the mix design procedure, sufficient beams shall be cast during the mix design process to adequately determine the strengths at 3 days, 5 days, 7 days, 14 days, and 28 days, to ensure compliance with the requirements of the contract documents. The use of maturity meters may be used to monitor and determine the concrete strength. The meters shall be IntelliRock Maturity Meters supplied by Engius of Stillwater, Oklahoma. Curves shall be developed during the mix design process and further proved during the concrete placement.

b. During construction. The Contractor shall take and make at least six (6) beams for each 200 cubic yards. Each individual three (3) day, five (5) day, and seven (7) day, flexural strength test, shall consist of the average of two (2) beam breaks. When the maturity meter curves have been developed to an acceptable level, then maturity meter readings may be used to determine strength for opening associated areas to paving traffic per 501-4.8 and 501-4.18. Acceptable being defined as 10 consecutive tests where the difference between the meter reading and actual beams results are within the single operator precision level of ASTM C78.

c. Monitoring and continued calibration. After an acceptable level of calibration has been achieved per P501-3.6b, then for every fifth (5) placement at least 6 beams will be made for each 200 cubic yards as detailed above to verify continued acceptability of the maturity meter readings. If the meter readings are found to be outside the single operator precision of ASTM C78, then the procedure per P 501-3.6b will be repeated.

CONSTRUCTION METHODS

501-4.1 EQUIPMENT.

Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer, but does not relieve the Contractor of the responsibility for the proper operation of equipment and maintaining the equipment in good working condition. The equipment shall be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.

a. Batch plant and equipment. The batch plant and equipment shall conform to the requirements of ASTM C94.

b. Mixers and transportation equipment.

(1) General. Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer’s nameplate showing
c. **Finishing equipment.** The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It shall weigh at least 2,200 lbs per foot (3274 kg/m) of paving lane width and powered by an engine having at least 6.0 horsepower per foot of lane width.

On projects requiring less than 500 square yard (418 sq m) of cement concrete pavement or requiring individual placement areas of less than 500 square yard (418 sq m), or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with approved placement and finishing equipment using stationary side forms. Hand screeding and float finishing may only be used on small irregular areas as allowed by the Engineer.

d. **Vibrators.** Vibrators shall be the internal type. Operating frequency for internal vibrators shall be between 8,000 and 12,000 vibrations per minute. Average amplitude for internal vibrators shall be 0.025-0.05 inch (0.06 - 0.13 cm).

The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The Contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the Engineer.

Hand held vibrators may be used in irregular areas only, but shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

e. **Concrete saws.** The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations. Early-entry saws may be used, subject to demonstration and
f. **Side forms.** Straight side forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall have a depth equal to the pavement thickness at the edge, and a base width equal to or greater than the depth. Flexible or curved forms of proper radius shall be used for curves of 100-foot (31 m) radius or less. Forms shall be provided 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. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the Engineer.

g. **Pavers.** The paver shall be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement, true to grade, tolerances, and cross-section. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown in the plans, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. The paver shall be equipped with electronic or hydraulic horizontal and vertical control devices.

**501-4.2 FORM SETTING.**

Forms shall be set sufficiently in advance of the concrete placement to ensure continuous paving operation. After the forms have been set to correct grade, the underlying surface shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place sufficiently to maintain the form in position for the method of placement.

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/8 inch (3 mm) at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the placing of concrete.

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete.

**501-4.3 CONDITIONING OF UNDERLYING SURFACE.**

The compacted underlying surface on which the pavement will be placed shall be widened approximately 3 feet (1 m) to extend beyond the paving machine track to support the paver without any noticeable displacement. After the underlying surface has been placed and compacted to the required density, the areas that will support the paving machine and the area to be paved shall be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the underlying surface shall be controlled by a positive grade control system using lasers, stringlines, or guide wires. If the density of the underlying surface is disturbed by the trimming operations, it shall be corrected by additional compaction and retested at the option of the Engineer before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it shall be corrected full depth by the Contractor. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. The underlying surface shall be protected so that it will be entirely free of frost when concrete displaced.

**501-4.4 CONDITIONING OF UNDERLYING SURFACE, SIDE-FORM AND FILL-IN LANE CONSTRUCTION.**

The prepared underlying surface shall be moistened with water, without saturating, immediately ahead of
Concrete placement to prevent rapid loss of moisture from the concrete. Damage caused by hauling or usage of other equipment shall be corrected and retested at the option of the Engineer. If damage occurs to a stabilized subbase, it shall be corrected full depth by the Contractor. A template shall be provided and operated on the forms immediately in advance of the placing of all concrete. The template shall be propelled only by hand and not attached to a tractor or other power unit. Templates shall be adjustable so that they may be set and maintained at the correct contour of the underlying surface. The adjustment and operation of the templates shall be such as will provide an accurate retest of the grade before placing the concrete thereon. All excess material shall be removed and wasted. Low areas shall be filled and compacted to a condition similar to that of the surrounding grade. The underlying surface shall be protected so that it will be entirely free from frost when the concrete is placed. The use of chemicals to eliminate frost in the underlying surface shall not be permitted.

The template shall be maintained in accurate adjustment, at all times by the Contractor, and shall be checked daily.

501-4.5 HANDLING, MEASURING, AND BATCHING MATERIAL.

The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit freecraining.

Batching plants shall be equipped to proportion aggregates and bulk cement, by weight, automatically using interlocked proportioning devices of an approved type. When bulk cement is used, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer, such as a chute, boot, or other approved device, to prevent loss of cement. The device shall be arranged to provide positive assurance that the cement content specified is present in each batch.

501-4.6 MIXING CONCRETE.

The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are emptied into the drum. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94.

Mixed concrete from the central mixing plant shall 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 deposited in place at the work site shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified in the approved mix design is not exceeded, and approved by the Engineer.

501-4.7 LIMITATIONS ON MIXING AND PLACING.

No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

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a. **Cold weather.** Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

b. **Hot weather.** During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions shall be taken.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The finished surfaces of the newly laid pavement shall be kept damp by applying a water-fog or mist with approved spraying equipment until the pavement is covered by the curing medium. When necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.2 psf (0.98 kg/m² per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. Such measures shall consist of wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

c. **Temperature management program.** Prior to the start of paving operation for each day of paving, the Contractor shall provide the Engineer with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. As a minimum the program shall 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 11-8, 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.

**501-4.8 PLACING CONCRETE.**

At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling
equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a flexural strength of 550 psi (7392 kPa), based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed or two specimens per full depth repair location as required to open the pavement to aircraft traffic. Also, subgrade and subbase planers, concrete pavers, and concrete finishing equipment may be permitted to ride upon the edges of previously constructed pavement when the concrete has attained a minimum flexural strength of 400 psi (2757 kPa).

The Contractor shall have available materials for the protection of the concrete during inclement weather. Such protective materials shall consist 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 shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

a. Slip-form construction. The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The plastic concrete shall be effectively consolidated 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 shall 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 shall be uniform and shall 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 shall be within 8000 to 12000 cycles per minute and the amplitude of vibration shall 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 shall vary proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall 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 breaking the pavement edge.

Not more than 15% of the total free edge of each 500 foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be 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 will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall 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, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor as directed by the Engineer.

b. **Side-form construction.** Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work. Metal side forms shall be used except at end closures and transverse construction joints where straight forms of other suitable material may be used.

Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such build-up is attached to the top of metal forms, the build-up shall also be metal.

Width of the base of all forms shall be equal to or greater than the specified pavement thickness.

Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the weight of subgrading and paving equipment or from the pressure of the concrete. The Contractor shall provide sufficient forms so that there will be no delay in placing concrete due to lack of forms.

Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the finished pavement. They shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall 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 shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

Concrete shall be spread, screeded, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery.

Concrete for the full paving width shall be effectively consolidated by internal vibrators without causing segregation. Internal type vibrators’ rate of vibration shall be not less than 7,000 cycles per minute. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than one foot (30 cm) from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

The provisions relating to the frequency and amplitude of internal vibration shall be considered
the minimum requirements and are intended to ensure adequate density in the hardened concrete.

c. Consolidation. Concrete shall 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 shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than inches (50 mm). Excessive vibration shall not be permitted. If the vibrators cause visible tracking in the paving lane, the paving operation shall be stopped and equipment and operations modified to prevent it. Concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment shall be vibrated with an approved hand-operated immersion vibrator operated from a bridge spanning the area. Vibrators shall not be used to transport or spread the concrete. Hand-operated vibrators shall not be operated in the concrete at one location for more than 20 seconds. Insertion locations for hand-operated vibrators shall be between 6 to 15 inches (150 to 400 mm) on centers. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the Engineer.

If a lack of consolidation of the concrete is suspected by the Engineer, referee testing may be required. Referee testing of hardened concrete will be performed by the Engineer by cutting cores from the finished pavement after a minimum of 24 hours curing. Density determinations will be made by the Engineer based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m³) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original mix design density, with no cores having a density of less than 96% of the original mix design density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete conforms to the above requirements.

The Contractor shall immediately cease paving operations, and provide a written plan for approval by the Engineer demonstrating how consolidation of the concrete will be achieved. No additional contract time or payment will be allowed for any delays related to any work to achieve proper consolidation.

Concrete not meeting consolidation, as defined above, may be required to be removed and replaced at the sole direction of the Engineer at the Contractor’s expense.

501-4.9 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT.

Following the placing of the concrete, it shall be struck 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 shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off 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. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced 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 afterspreading.

Reinforcing steel, at the time concrete is placed, shall 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 will be 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.

Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2 inch (12 mm) from their designated position and shall be true to line with not more than 1/4 inch (6 mm) variation in 10 feet (3 m). The surface across the joints shall be tested with a 12 feet (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

a. Construction. Longitudinal construction joints shall be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints shall be installed 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 shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

b. Contraction. Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer’s instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

c. Isolation (expansion). Isolation joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface. A cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off, the cap shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint.

d. Tie bars. Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab depth. 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 shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.
e. **Dowel bars.** Dowel bars or other load-transfer units of an approved type shall be placed across joints as shown on the plans. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place for all contraction joints or shall be drilled and epoxy set into place for all construction joints. Drilling shall not commence until a flexural strength of 450 psi is attained or a period of 36 hours has elapsed. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the Engineer. The portion of each dowel epoxy coated, as required under paragraph 501-2.7 and shown on the plans to receive a debonding lubricant, shall be thoroughly coated with asphalt MC-70, or an approved lubricant, to prevent the concrete from bonding to that portion of the dowel.

f. Dowel bars at longitudinal construction joints shall be bonded in drilled holes.

g. **Placing dowels and tie bars.** The method used in installing and holding dowels in position shall ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after the pavement has been completed will not be greater than 1/8 inch per feet (3 mm per 0.3 m). Except as otherwise specified below, horizontal spacing of dowels shall be within a tolerance of ±5/8 inch (16 mm). The vertical location on the face of the slab shall be within a tolerance of ±1/2 inch (12 mm). The vertical alignment of the dowels shall be measured parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The horizontal alignment shall be checked with a framing square. Dowels shall not be placed closer than 0.6 times the dowel bar length to the planned joint line. If the last regularly spaced longitudinal dowel is closer than that dimension, it shall be moved away from the joint to a location 0.6 times the dowel bar length, but not closer than 6 inches (150 mm) to its nearest neighbor. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the followingsubparagraphs.

1. **Contraction joints.** Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held 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, in lieu of the above, dowels and tie bars in contraction joints shall be installed near the front of the paver by insertion into the plastic concrete using approved equipment and procedures. Approval will be based on the results of a preconstruction demonstration, showing that the dowels and tie bars are installed within specified tolerances.

2. **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 will not be permitted. Dowels and tie bars shall be prepared and placed 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. The spacing of dowels and tie bars in construction joints shall be as indicated.

3. **Dowels installed in isolation joints and other hardened concrete.** Install dowels for isolation joints and in other hardened concrete by bonding the dowels into holes drilled into the hardened concrete. The concrete shall have cured for seven (7) days or reached a minimum flexural strength of 450 psi (3.1 MPa) before drilling commences. Holes 1/8 inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete.
using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur to the concrete joint face. Modification of the equipment and operation shall be required if, in the Engineer’s opinion, the equipment and/or operation is causing excessive damage. Depth of dowel hole shall be within a tolerance of ±1/2 inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel. Dowels required to be installed in any joints between new and existing concrete shall be grouted in holes drilled in the existing concrete, all as specified above.

h. Sawing of joints. Joints shall be cut as shown on the plans. Equipment shall be as described in paragraph 501-4.1. The circular cutter shall be capable of cutting a groove in a straight line and shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans. The top of the slot shall be widened by sawing to provide adequate space for joint sealers as shown on the plans. Sawing shall commence, without regard to day or night, 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 shall continue without interruption until all joints have been sawn. The joints shall be sawn at the required spacing. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial sawcut and maintained for the remaining cure period.

501-4.11 FINISHING.

Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Any operations which produce more than 1/8 inch (3 mm) of mortar-rich surface (defined as deficient in plus U.S. No. 4 (4.75 mm) sieve size aggregate) shall be halted immediately and the equipment, mixture, or procedures modified as necessary. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

a. Machine finishing with slipform pavers. The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. 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 shall be allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

b. **Machine finishing with fixed forms.** The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall 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, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

c. **Other types of finishing equipment.** Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the Engineer’s approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

d. **Hand finishing.** Hand finishing methods will not be 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. Use hand finishing operations only as specified below.

(1) **Equipment and screed.** In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping screed and a longitudinal float for hand finishing. The screed shall be at least one foot (30 cm) longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, and shall be constructed of metal or other suitable material shod with metal. The longitudinal float shall be at least 10 feet (3 m) long, of approved design, and rigid and substantially braced, and shall maintain a plane surface on the bottom. Grate tampers (jitterbugs) shall not be used.

(2) **Finishing and floating.** As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross-section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, the entire surface shall be tamped with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed, consolidated and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces.

e. **Straightedge testing and surface correction.** After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a Contractor furnished 12-foot (3.7-
m) straightedge swung from handles 3 feet (1 m) longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall bein successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements of paragraph 501-5.2e(3). Straightedge testing and surface corrections shall continue until the entire surface is found to be 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 shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment. This straight-edging is not a replacement for the straightedge testing of paragraph 501-5.2e(3). Smoothness.

501-4.12 SURFACE TEXTURE.

The surface of the pavement shall be finished with either a brush or broom, burlap drag, or artificial turf finish for all newly constructed concrete pavements to match that of the adjacent existing pavement. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the Engineer.

a. **Brush or broom finish.** If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 inch (2 mm) in depth.

b. **Burlap drag finish.** If a burlap drag is used to texture the pavement surface, it shall be at least 15 ounces per square yard (555 grams per square meter). To obtain a textured surface, the transverse threads of the burlap shall be removed 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. The corrugations shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth.

c. **Artificial turf finish.** If artificial turf is used to texture the surface, it shall be applied 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 shall be in contact with the concrete surface during dragging operations. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated by the Contractor to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85 inch long polyethylene turf blades per square foot. The corrugations shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth.

501-4.13 CURING.

Immediately after finishing operations are completed and marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

When a two-sawcut method is used to construct the contraction joint, the curing compound shall be applied
to the sawcut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

a. Impervious membrane method. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 sq ft (14 sq m). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the Engineer, a double application rate shall be used to ensure coverage. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface. Curing shall be applied immediately after the bleed water is gone from the surface.

b. White burlap-polyethylene sheets. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

c. Water method. The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

d. Concrete protection for cold weather. The concrete shall be maintained at an ambient 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 curing time. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor’s expense.

e. Concrete protection for hot weather. Concrete should be continuous moisture cured for the entire curing period and shall 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, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the Engineer.

501-4.14 REMOVING FORMS.

Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab shall be cured as per the methods indicated in paragraph 501-4.13. Major honeycombed areas shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-5.2(f). Major honeycombing to be defined as penetrating more than ½” into concrete from face or voids in the thickness cores greater than ½” in diameter.
501-4.15 SAW-CUT GROOVING.

If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.

501-4.16 SEALING JOINTS.

The joints in the pavement shall be sealed in accordance with Item P-605.

501-4.17 PROTECTION OF PAVEMENT.

The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor’s employees and agents until accepted by the Engineer. This shall include 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 shall install and maintain continuous barricades around the perimeter of all concrete pavement until such time that the pavement may be opened to aircraft traffic. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor’s expense.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic other than paving equipment, shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) three (3) days old, or for a longer period if directed by the Engineer.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days and the joints have been sealed or otherwise protected, and the concrete has attained a minimum field cured flexural strength of 550 psi (37928 kPa) and approved means are furnished to prevent damage to the slab edge and pavement joints.

All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean, and spillage of concrete or other materials shall be cleaned up immediately upon occurrence.

Damaged pavements shall be removed and replaced at the Contractor’s expense. Slabs shall be removed to the full depth, width, and length of the slab.

501-4.18 OPENING TO CONSTRUCTION TRAFFIC.

The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural strength of 550 lb / square inch (3.8 kPa) when tested in accordance with ASTM C78 or the results of maturity meters in accordance with P401-3.6. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Sufficient test beams shall be made so that three-day, five-day, seven-day, 14-day, and 28-day flexural tests can be performed. Prior to opening the pavement to construction traffic, all joints shall 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.

501-4.19 REPAIR, REMOVAL, OR REPLACEMENT OF SLABS.

a. General. New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable shall be removed and replaced or repaired, as directed by the Engineer and as specified hereinafter at no cost to the Owner. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The Engineer will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be 4 inch (100 mm) diameter, shall be drilled by the Contractor and shall be filled by
the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. All epoxy resin used in this work shall conform to ASTM C881, Type V. Repair of cracks as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

**b. Shrinkage cracks.** Shrinkage cracks, which do not exceed 4 inches (100 mm) in depth, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved by the Engineer. Care shall be taken to assure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the Engineer. Shrinkage cracks, which exceed 4 inches (100 mm) in depth, shall be treated as full depth cracks in accordance with paragraphs 4.19b and 4.19c.

c. **Slabs with cracks through interior areas.** Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than 4 inches (100 mm) in depth, that extend into the interior area.

d. **Cracks close to and parallel to joints.** All cracks essentially parallel to original joints, extending full depth of the slab, and lying wholly within 6 inches (150 mm) either side of the joint shall be treated as specified here. Any crack extending more than 6 inches (150 mm) from the joint shall be treated as specified above in subparagraph c.

1. **Full depth cracks present, original joint not opened.** When the original un-cracked joint has not opened, the crack shall be sawed and sealed, and the original joint filled with epoxy resin as specified below. The crack shall be sawed with equipment specially designed to follow random cracks. The reservoir for joint sealant in the crack shall be formed by sawing to a depth of 3/4 inches (19 mm), ±1/16 inch (2 mm), and to a width of 5/8 inch (16 mm), ±1/8 inch (3 mm). Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent such raveling or spalling. The joint sealant shall be a liquid sealant as specified. Installation of joint seal shall be as specified for sealing joints or as directed. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler type material has been used to form a weakened plane in the transverse joint, it shall be completely sawed out and the saw cut pressure injected 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, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

2. **Full depth cracks present, original joint also cracked.** At a joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced for the full lane width and length.

e. **Removal and replacement of full slabs.** Where it is necessary to remove full slabs, unless there are dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If dowels, or tie bars are present along any edges, these...
edges shall be sawed full depth just beyond the end of the dowels or tie bars. These joints shall then be carefully sawed on the joint line to within one inch (25 mm) of the depth of the dowel or tie bar.

The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along dowelled edges shall be carefully broken up and removed using light, hand-held jackhammers, 30 lb (14 kg) or less, or other approved similar equipment.

Care shall be taken to prevent damage to the dowels, tie bars, or to concrete to remain in place. The joint face below dowels shall be suitably trimmed so that there is not abrupt offset in any direction greater than 1/2 inch (12 mm) and no gradual offset greater than one inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4 inches (38 and 100 mm) deep occurs at any point along any edge, the area shall be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary.

If underbreak over 4 inches (100 mm) deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels or tie bars, or where they have been damaged, dowels or tie bars of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All four (4) edges of the new slab shall contain dowels or original tie bars.

Placement of concrete shall be as specified for original construction. Prior to placement of new concrete, the underlying material (unless it is stabilized) shall be re-compact and shaped as specified in the appropriate section of these specifications. The surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab shall be prepared and sealed as specified for original construction.

f. **Repairing spalls along joints.** Where directed, spalls along joints of new slabs, and along parallel cracks used as replacement joints, shall be repaired by first making a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inch (50 mm). Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete. The cavity thus formed shall be thoroughly cleaned with high-pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat of epoxy resin, Type III, Grade I, shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff bristle brush. Polishing of epoxy resin shall be avoided. The cavity shall be filled with low slump Portland cement concrete or mortar or with epoxy resin concrete or mortar. Concrete shall be used for larger spalls, generally those more than 1/2 cu. ft. (0.014 m³) in size, and mortar shall be used for the smaller ones. Any spall less than 0.1 cu. ft. (0.003 m³) shall be repaired only with epoxy resin mortar or a Grade III epoxy resin. Portland cement concrete and mortar mixtures shall be proportioned as directed and shall be mixed, placed, consolidated, and cured as directed. Epoxy resin mortars shall be made with Type III, Grade I, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved by the Engineer. The epoxy resin materials
shall be placed in the cavity in layers not over 2 inches (50 mm) thick. The time interval between placements of additional layers shall be such that the temperature of the epoxy resin material does not exceed 140°F (60°C) at any time during hardening. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or mortar. Spalls shall be repaired in accordance with G-117 Partial Depth Pavement Repair. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab shall be removed and replaced as previously specified. If any spall would require over 25% of the length of any single joint to be repaired, the entire slab shall be removed and replaced. Repair of spalls as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of spalls shall be allowed in any panel that demonstrates segregated aggregate with a significant absence of coarse aggregate in the upper one-eighth (1/8th) inch of the pavement surface.

g. Diamond grinding of PCC surfaces. Diamond grinding of the hardened concrete with an approved diamond grinding machine should not be performed until the concrete is 14 days or more old and concrete has reached full minimum strength. When required, diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive. The saw blades shall be assembled in a cutting head mounted on a machine designed specifically for diamond grinding that will produce the required texture and smoothness level without damage to the pavement. The saw blades shall be 1/8-inch (3-mm) wide and there shall be a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; the actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Each machine shall be capable of cutting a path at least 3 feet (0.9 m) wide. Equipment that causes raveling, aggregate fractures, spalls or disturbance to the joints will not be permitted. The area corrected by diamond grinding shall be 10% of the total area of any sublot. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. All pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above, may require removing and replacing to conform with paragraph 501-4.19.

501-4.20 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR.

All operations shall be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts shall be made perpendicular to the slab surface.

a. Removal of existing pavement slab.

When it is necessary to remove existing concrete pavement and leave adjacent concrete in place, unless there are dowels present, the joint between the removal area and adjoining pavement to stay in place, shall first be cut full depth with a standard diamond-type concrete saw. If dowels are present at this joint, the saw cut shall be made full depth just beyond the end of dowels. The edge shall then be carefully sawed on the joint line to within one inch (25 mm) of the top of the dowel. Next, a full depth saw cut shall be made parallel to the joint at least 24 inches (600 mm) from the joint and at least 12 inches (300 mm) from the end of any dowels. All pavement between this last saw cut and the joint line shall be carefully broken up and removed using hand-held jackhammers, 30 lb (14 kg) or less, or the approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place.
When the underlying asphalt bond breaker course is damaged during the removal of the concrete pavement, the Contractor shall remove the asphalt bond breaker to a uniform depth, equivalent to the maximum extent of asphalt damage, over the entire full depth repair area. If a concrete pavement, econcrete pavement, or cement treated subgrade is exposed by the removal of the bond breaker, the contractor shall apply a de-bonding compound. The asphalt bond breaker thickness shall then be replaced with concrete pavement by increasing to total thickness of the pavement surface course. A separate pour is not required.

b. Edge repair.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas that are damaged during construction shall be repaired at no cost to the Owner.

(1) Spall repair. Spalls shall be repaired where indicated and where directed by the Engineer. Repair materials and procedures shall be as previously specified in subparagraph 501-4.19f, specified in G-117 Partial Depth Pavement Repair.

(2) Underbreak repair. All underbreak shall be repaired. First, all delaminated and loose material shall be carefully removed. Next, the underlying material shall be recompacted, without addition of any new material. Finally, the void shall be completely filled with paving concrete, thoroughly consolidated. Care shall be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material shall be thoroughly moistened. After placement, the exposed surface shall be heavily coated with curing compound.

(3) Underlying material. The underlying material adjacent to the edge and under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete, and shall be shaped as shown on the drawings or as directed. Sufficient material shall be kept in place outside the joint line to prevent disturbance (or sloughing) of material under the pavement that is to remain in place. Any material under the portion of the concrete pavement to remain in place, which is disturbed or loses its compaction shall be carefully removed and replaced with concrete as specified in paragraph 501-4.20b(2). The underlying material outside the joint line shall be thoroughly compacted and moist when new concrete is placed.

MATERIAL

ACCEPTANCE 501-5.1 ACCEPTANCE SAMPLING AND TESTING.

All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the Engineer at no cost to the Contractor. The Contractor shall bear the cost of providing curing facilities for the strength specimens, per paragraph 501-5.1a(3), and coring and filling operations, per paragraph 501-5.1b(1). Testing organizations performing these tests shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority’s website. All test methods required
for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory’s current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

Concrete shall be accepted for strength and thickness on a lot basis.

A lot shall consist of a day’s production not to exceed 3,500 square yards.

a. Flexural strength.

(1) Sampling. Each lot shall be divided into four equal sublots. One sample shall be taken for each sublot from the plastic concrete delivered to the job site. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D3665. The concrete shall be sampled in accordance with ASTM C172.

(2) Testing. Two (2) specimens shall be made from each sample. Specimens shall be made in accordance with ASTM C31 and the flexural strength of each specimen shall be determined in accordance with ASTM C78. The flexural strength for each sublot shall be computed by averaging the results of the two test specimens representing that sublot.

Immediately prior to testing for flexural strength, the beam shall be weighed and measured for determination of a sample unit weight. Measurements shall be made for each dimension; height, depth, and length, at the mid-point of the specimen and reported to the nearest 1/10 inch (3 mm). The weight of the specimen shall be reported to the nearest 0.1 pound (45 gm). The sample unit weight shall be calculated by dividing the sample weight by the calculated volume of the sample. This information shall be reported as companion information to the measured flexural strength for each specimen.

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method. Slump, air content, and temperature tests will also be conducted by the quality assurance laboratory for each set of strength test samples, per ASTM C31.

(3) Curing. The Contractor shall provide adequate facilities for the initial curing of beams. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

(4) Acceptance. Acceptance of pavement for flexural strength will be determined by the Engineer in accordance with paragraph 501-5.2b.

b. Pavement thickness.

(1) Sampling. Each lot shall be divided into four equal sublots and one core shall be taken by the Contractor for each sublot. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, shall be excluded from sample locations. Cores shall be neatly cut with a core drill. The Contractor shall furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes shall be filled by the Contractor with a non-shrink grout approved by the Engineer within one day after sampling.

(2) Testing. The thickness of the cores shall be determined by the Engineer by the average caliper measurement in accordance with ASTM C174.

(3) Acceptance. Acceptance of pavement for thickness shall be determined by the Engineer in
accordance with paragraph 501-5.2c.

c. **Partial lots.** When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, or when the Contractor and Engineer agree in writing to allow overages or minor placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

Where three sublots have been produced, they shall constitute a lot. Where one or two sublots have been produced, they shall be incorporated into the next lot or the previous lot and the total number of sublots shall be used in the acceptance criteria calculation, that is, n=5 or n=6.

d. **Outliers.** All individual flexural strength tests within a lot shall be checked for an outlier (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers shall be discarded, and the percentage of material within specification limits (PWL) shall be determined using the remaining test values.

### 501-5.2 ACCEPTANCE CRITERIA.

a. **General.** Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-5.2e:

1. Flexural strength
2. Thickness
3. Smoothness
4. Grade
5. Edge slump

Flexural strength and thickness shall be evaluated for acceptance on a lot basis using the method of estimating PWL. Acceptance using PWL considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (L).

Acceptance for flexural strength will be based on the criteria contained in accordance with paragraph 501-5.2e(1). Acceptance for thickness will be based on the criteria contained in paragraph 501-5.2e(2). Acceptance for smoothness will be based on the criteria contained in paragraph 501-5.2e(3). Acceptance for grade will be based on the criteria contained in paragraph 501-5.2e(4).

The Engineer may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

b. **Flexural strength.** Acceptance of each lot of in-place pavement for flexural strength shall be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

c. **Pavement thickness.** Acceptance of each lot of in-place pavement shall be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

d. **Percentage of material within limits (PWL).** The PWL shall be determined in accordance with procedures specified in Section 110 of the General Provisions.

The lower specification tolerance limit (L) for flexural strength and thickness shall be:
e. Acceptance criteria.

(1) **Flexural Strength.** If the PWL of the lot equals or exceeds 90%, the lot shall be acceptable. Acceptance and payment for the lot shall be determined in accordance with paragraph 501-8.1.

(2) **Thickness.** If the PWL of the lot equals or exceeds 90%, the lot shall be acceptable. Acceptance and payment for the lot shall be determined in accordance with paragraph 501-8.1.

(3) **Smoothness.** As soon as the concrete has hardened sufficiently, but not later than 48 hours after placement, the surface of each lot shall be tested in both longitudinal and transverse directions for smoothness to reveal all surface irregularities exceeding the tolerances specified. The Contractor shall furnish paving equipment and employ methods that produce a surface for each section of pavement having an average profile index meeting the requirements of paragraph 501-8.1c when evaluated with a profilograph; and the finished surface of the pavement shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. When the surface smoothness exceeds specification tolerances which cannot be corrected by diamond grinding of the pavement, full depth removal and replacement of pavement shall be to the limit of the longitudinal placement. Corrections involving diamond grinding will be subject to the final pavement thickness tolerances specified.

(a) **Transverse measurements.** Transverse measurements will be taken for each lot placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet (15m) or more often as determined by the Engineer.

(i) Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. Smoothness readings will not be made across grade changes or cross slope transitions; at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of pavement. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) The joint between lots shall be tested separately to facilitate smoothness between lots. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface, with half the straightedge on one side of the joint and the other half of the straightedge on the other side of the joint. Measure the maximum gap between the straightedge and the pavement surface in the area between these two high points. One measurement...
shall be taken at the joint every 50 feet (15m) or more often if directed by the Engineer. Maximum gap on final pavement surface > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Each measurement shall be recorded and a copy of the data shall be furnished to the Engineer at the end of each days testing.

(b) Longitudinal measurements. Longitudinal measurements will be taken for each lot placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6m); and at the one third points of paving lanes when widths of paving lanes are 20 ft (6m) or greater.

(i) Longitudinal Short Sections. Longitudinal Short Sections are when the longitudinal lot length is less than 200 feet (60m) and areas not requiring a profilograph. When approved by the Engineer, the first and last 15 feet (4.5m) of the lot can also be considered as short sections for smoothness. The finished surface shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. Smoothness readings will not be made across grade changes or cross slope transitions, at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement surface > 1/4 inch (6mm) in longitudinal direction will be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) Profilograph Testing. Profilograph testing shall be performed by the contractor using approved equipment and procedures as described as ASTM E1274. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate “must grind” bumps and the Profile Index for the pavement using a 0.2 inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). A copy of the reduced tapes shall be furnished to the Engineer at the end of each days testing. The pavement must have an average profile index meeting the requirements of paragraph 501-8.1c. Deviations on final surface in longitudinal direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of pavement. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

Where corrections are necessary, second profilograph runs shall be performed to
verify that the corrections produced an average profile index of 15 inches (38 cm) per mile or less. If the initial average profile index was less than 15 inches (38 cm), only those areas representing greater than 0.4 inch (10 mm) deviation will be re-profiled for correction verification.

(iii) Final profilograph of [runway]. Final profilograph, full length of runway, shall be performed to facilitate testing of smoothness between lots. Profilograph testing shall be performed by the contractor using approved equipment and procedures as described in ASTM E1274. The pavement must have an average profile index meeting the requirements of paragraph 501-8.1c. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate “must grind” bumps and the Profile Index for the pavement using a 0.2 inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved, trained operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). A copy of the reduced tapes shall be furnished to the Engineer at the end of each day’s testing. Profilograph of final runway shall be performed one foot right and left of runway centerline and 15 feet right and left of centerline. Any areas that indicate “must grind” will be corrected as directed by the Engineer.

Smoothness testing indicated in the above paragraphs except paragraph (iii) shall be performed within 48 hours of placement of material. Smoothness testing indicated in paragraph (iii) shall be performed within 48 hours final paving completion. The primary purpose of smoothness testing is to identify areas that may be prone to ponding of water which could lead to hydroplaning of aircraft. If the contractor’s machines and/or methods are producing significant areas that need corrective actions then production should be stopped until corrective measures can be implemented. If corrective measures are not implemented and when directed by the Engineer, production shall be stopped until corrective measures can be implemented.

(4) Grade. An evaluation of the surface grade shall be made by the Engineer for compliance to the tolerances contained below. The finish grade will be determined by running levels at intervals of 50 feet (15 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet (15 m)) to determine the elevation of the completed pavement. The Contractor shall pay the costs of surveying the level runs, and this work shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer.

(a) Lateral deviation. Lateral deviation from established alignment of the pavement edge shall not exceed ±0.10 feet (3 mm) in any lane.

(b) Vertical deviation. Vertical deviation from established grade shall not exceed ±0.04 feet (12 mm) at any point.

(5) Edge slump. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor as directed by the Engineer in accordance with paragraph 501-4.8a.

f. Removal and replacement of concrete. Any area or section of concrete that is removed and replaced shall be removed and replaced back to planned joints. The Contractor shall replace damaged dowels and the requirements for doweled longitudinal construction joints in paragraph 501-4.10 shall apply to all contraction joints exposed by concrete removal. Removal and replacement shall be in accordance with paragraph 501-4.20.
CONTRACTOR QUALITY

CONTROL 501-6.1 QUALITY CONTROL PROGRAM.

The Contractor shall develop a Quality Control Program in accordance with Section 100 of the General Provisions. The program shall address all elements that affect the quality of the pavement including but not limited to:

a. Mix Design
b. Aggregate Gradation
c. Quality of Materials
d. Stockpile Management
e. Proportioning
f. Mixing and Transportation
g. Placing and Consolidation
h. Joints
i. Dowel Placement and Alignment
j. Flexural or Compressive Strength
k. Finishing and Curing
l. Surface Smoothness

501-6.2 QUALITY CONTROL TESTING.

The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

a. Fine aggregate.

   (1) **Gradation.** A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

   (2) **Moisture content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

   (3) **Deleterious Materials.** The Contractor will sample and check the aggregates a minimum of once per week for deleterious materials in accordance with ASTM C33 and the requirements of P-501-2.1

b. Coarse Aggregate.

   (1) **Gradation.** A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

   (2) **Moisture content.** If an electric moisture meter is used, at least two direct measurements...
of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

(3) **Deleterious Materials.** The Contractor will sample and check the aggregates a minimum of once per week for deleterious materials in accordance with ASTM C33 and the requirements of P-501-2.1

c. **Slump.** Four slump tests shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each sublot. Slump tests shall be performed in accordance with ASTM C143 from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

d. **Air content.** Four air content tests, shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each sublot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

e. **Eight** Eight unit weight and yield tests shall be made in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

**501-6.3 CONTROL CHARTS.**

The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, moisture content and air content.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension limits, or Specification limits, applicable to each test parameter, and the Contractor’s test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor’s projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the Engineer may halt production or acceptance of the material.

a. **Fine and coarse aggregate gradation.** The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits contained in the Lower Specification Tolerance Limit (L) table above and the Control Chart Limits table below shall be superimposed on the Control Chart for job control.

b. **Slump and air content.** The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

<table>
<thead>
<tr>
<th>Control Parameter</th>
<th>Individual Measurements</th>
<th>Range Suspension Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Action Limit</td>
<td>Suspension Limit</td>
</tr>
<tr>
<td>Slump</td>
<td>+0 to -1 inch (0-25 mm)</td>
<td>+0.5 to -1.5 inch (13-38 mm)</td>
</tr>
</tbody>
</table>
The individual measurement control charts shall use the mix design target values as indicators of central tendency.

**501-6.4 CORRECTIVE ACTION.**

The Contractor Quality Control Program shall indicate that appropriate action shall be taken when the process is believed to be out of control. The Contractor Quality Control Program shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

a. **Fine and coarse aggregate gradation.** When two consecutive averages of five tests are outside of the specification limits in paragraph 501-2.1, immediate steps, including a halt to production, shall be taken to correct the grading.

b. **Combined Gradation.** When the plot of the WF and CF from the combined gradation is outside of the parallelogram limits in paragraph 501-2.1, immediate steps, including a halt to production, shall be taken to correct the grading.

c. **Deleterious Materials.** When aggregates are found to contain deleterious in excess of the requirements in 501-2.1 production will be halted and the unacceptable aggregates removed from the site.

d. **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 shall be adjusted.

e. **Slump.** The Contractor shall halt production and make appropriate adjustments whenever:
   
   (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.

f. **Air content.** The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

   (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.

Whenever a point falls outside the Action Limits line, the air-entraining admixture dispenser shall be calibrated to ensure that it is operating correctly and with good reproducibility.

**METHOD OF MEASUREMENT**

**501-7.1** Portland cement concrete pavement shall be measured by the number of square yards of either plain or reinforced pavement as specified in-place, completed and accepted. The Contractor shall exercise extreme caution during all panel removal operations. Any damage to adjacent pavements or underlying base courses scheduled to remain in place shall be repaired at no additional cost to the Owner.
Measurement for sawcutting, removing, and replacing full or partial cracked or damaged panels in existing PCC pavements or in HMA pavement shall be measured by the square yard of material placed. The Engineer shall specify areas of replacement. The Contractor shall use the coordinates provided in the plans to locate and mark the full and partial panels to be replaced in existing PCC pavements in the field. This Measurement shall include all material, labor, and equipment, and incidentals used in the removal of existing concrete, preparation for placement, and placement of all materials, completed, and accepted by the Engineer.

Measurement for additional pavement required to replace damaged asphalt bond breaker shall be measured for separate payment only when the total depth of the repair exceeds twenty (20) inches. In such case, measurement shall include only the depth in excess of twenty (20) inches and shall be measured by the cubic foot.

**BASIS OF PAYMENT**

501-8.1 PAYMENT.

Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 501-5.2 Acceptance Criteria shall be based on results of strength and thickness tests. Payment for acceptable lots of concrete pavement shall be adjusted in accordance with paragraph 501-8.1a for strength and thickness and 501-8.1c for smoothness, subject to the limitation that:

The total project payment for concrete pavement shall not exceed 100 percent of the product of the contract unit price and the total number of square yards of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment shall be full compensation for all labor, materials, tools, equipment, existing pavement removal, dowels, joint and joint sealant, etc., and incidentals required to complete the work as specified herein and on the drawings. All saw-cutting associated with new pavement shall be incidental to pavement installation. The Contractor shall exercise extreme caution during all panel removal operations. Any damage to adjacent pavements or underlying base courses scheduled to remain in place shall be repaired at no additional cost to the Owner.

a. Basis of adjusted payment. The pay factor for each individual lot shall be calculated in accordance with the Price Adjustment Schedule table below. A pay factor shall be calculated for both flexural strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both flexural strength and thickness are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either flexural strength or thickness is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both flexural strength and thickness are less than 100%.

<table>
<thead>
<tr>
<th>Percentage of Materials Within Specification Limits (PWL)</th>
<th>Lot Pay Factor (Percent of Contract Unit Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>96 – 100</td>
<td>106</td>
</tr>
<tr>
<td>90 – 95</td>
<td>PWL + 10</td>
</tr>
<tr>
<td>75 – 90</td>
<td>0.5 PWL + 55</td>
</tr>
<tr>
<td>55 – 74</td>
<td>1.4 PWL – 12</td>
</tr>
<tr>
<td>Below 55</td>
<td>Reject²</td>
</tr>
</tbody>
</table>

1 Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment in excess of 100% shall be subject to the total project payment limitation specified in paragraph 501-8.1.
For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 501-8.1. Payment in excess of 100% for accepted lots of concrete pavement shall be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100%.

b. Payment. Payment shall be made under:

Item P-501-8.1 Sawcut, Remove, and Replace Cracked or Damaged Panels in Existing 16”-20” PCC Pavement – per square yard

Item P-501-8.2 Sawcut, Remove, and Replace HMA Pavement with New 16.5” PCC Pavement – per square yard

c. Basis of adjusted payment for smoothness. Price adjustment for pavement smoothness will apply to the total area of concrete within a section of pavement and shall be applied in accordance the following equation and schedule:

\[(\text{Square yard in section}) \times (\text{original unit price per square yard}) \times PFm = \text{reduction in payment for area within section}\]

<table>
<thead>
<tr>
<th>Average Profile Index (Inches Per Mile)</th>
<th>Contract Unit Price Adjustment (PFm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 30,000 lb</td>
<td></td>
</tr>
<tr>
<td>0 - 7</td>
<td>0.00</td>
</tr>
<tr>
<td>7.1 - 9</td>
<td>0.02</td>
</tr>
<tr>
<td>9.1 - 11</td>
<td>0.04</td>
</tr>
<tr>
<td>11.1 - 13</td>
<td>0.06</td>
</tr>
<tr>
<td>13.1 - 14</td>
<td>0.08</td>
</tr>
<tr>
<td>14.1 - 15</td>
<td>0.10</td>
</tr>
<tr>
<td>15.1 and up</td>
<td>Corrective work required</td>
</tr>
<tr>
<td>30,000 lb or Less</td>
<td></td>
</tr>
<tr>
<td>0 - 10</td>
<td></td>
</tr>
<tr>
<td>10.1 - 11</td>
<td></td>
</tr>
<tr>
<td>11.1 - 12</td>
<td></td>
</tr>
<tr>
<td>12.1 - 13</td>
<td></td>
</tr>
<tr>
<td>13.1 - 14</td>
<td></td>
</tr>
<tr>
<td>14.1 - 15</td>
<td></td>
</tr>
<tr>
<td>15.1 and up</td>
<td></td>
</tr>
<tr>
<td>Short Sections</td>
<td></td>
</tr>
<tr>
<td>0 - 15</td>
<td></td>
</tr>
<tr>
<td>15.1 - 16</td>
<td></td>
</tr>
<tr>
<td>16.1 - 17</td>
<td></td>
</tr>
<tr>
<td>17.1 - 18</td>
<td></td>
</tr>
<tr>
<td>18.1 - 20</td>
<td></td>
</tr>
<tr>
<td>20.1 - 22</td>
<td></td>
</tr>
<tr>
<td>22.1 and up</td>
<td></td>
</tr>
</tbody>
</table>

**TESTING REQUIREMENTS**

ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field

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
<table>
<thead>
<tr>
<th>Standard Test Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM C136</td>
<td>Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates</td>
</tr>
<tr>
<td>ASTM C138</td>
<td>Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete</td>
</tr>
<tr>
<td>ASTM C142</td>
<td>Standard Test Method for Clay Lumps and Friable Particles in Aggregates</td>
</tr>
<tr>
<td>ASTM C143</td>
<td>Standard Test Method for Slump of Hydraulic-Cement Concrete</td>
</tr>
<tr>
<td>ASTM C172</td>
<td>Standard Practice for Sampling Freshly Mixed Concrete</td>
</tr>
<tr>
<td>ASTM C173</td>
<td>Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method</td>
</tr>
<tr>
<td>ASTM C174</td>
<td>Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores</td>
</tr>
<tr>
<td>ASTM C231</td>
<td>Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method</td>
</tr>
<tr>
<td>ASTM C289</td>
<td>Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)</td>
</tr>
<tr>
<td>ASTM C295</td>
<td>Standard Guide for Petrographic Examination of Aggregates for Concrete</td>
</tr>
<tr>
<td>ASTM C114</td>
<td>Standard Test Methods for Chemical Analysis of Hydraulic Cement</td>
</tr>
<tr>
<td>ASTM C311</td>
<td>Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland cement Concrete</td>
</tr>
<tr>
<td>ASTM C566</td>
<td>Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying</td>
</tr>
<tr>
<td>ASTM C642</td>
<td>Standard Test Method for Density, Absorption, and Voids in Hardened Concrete</td>
</tr>
<tr>
<td>ASTM C666</td>
<td>Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing</td>
</tr>
<tr>
<td>ASTM C1077</td>
<td>Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation</td>
</tr>
<tr>
<td>ASTM C1602</td>
<td>Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete</td>
</tr>
<tr>
<td>ASTM D3665</td>
<td>Standard Practice for Random Sampling of Construction Materials</td>
</tr>
</tbody>
</table>
| 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

U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD) C662 Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

MATERIAL REQUIREMENTS

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 A714  Standard Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe
ASTM A775  Standard Specification for Epoxy-Coated Steel Reinforcing Bars
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 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 C33  Standard Specification for Concrete Aggregates
ASTM C94  Standard Specification for Ready-Mixed Concrete
ASTM C150  Standard Specification for Portland cement
ASTM C171  Standard Specification for Sheet Materials for Curing Concrete
ASTM C260  Standard Specification for Air-Entraining Admixtures for Concrete
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  Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
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 D1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving
and Structural Construction (No extruding 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

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

ACI 305R Guide to Hot Weather Concreting

ACI 306R Guide to Cold Weather Concreting

ACI 309R Guide for Consolidation of Concrete

AC 150/5320-6 Airport Pavement Design and Evaluation

PCA Design and Control of Concrete

END ITEM P-501
ITEM P-602 BITUMINOUS PRIME COAT

DESCRIPTION

602-1.1 This item shall consist of an application of bituminous material on the prepared base course in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

MATERIALS

602-2.1 BITUMINOUS MATERIAL.

The bituminous material shall be an emulsified asphalt indicated in ASTM D3628 as a bituminous application for prime coat appropriate to local conditions or as designated by the Engineer.

CONSTRUCTION

METHODS 602-3.1 WEATHER LIMITATIONS.

The prime coat shall be applied only when the existing surface is dry; the atmospheric temperature is 50°F (10°C) or above, and the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the Engineer.

602-3.2 EQUIPMENT.

The equipment shall include a self-powered pressure bituminous material distributor and equipment for heating bituminous material.

Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 65.0 psi (4.5 kg/sq cm) of tire width to prevent rutting, shoving or otherwise damaging the base, surface or other layers in the pavement structure. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard (0.23 to 9.05 L/square meter), with a pressure range of 25 to 75 psi (172.4 to 517.1 kPa) and with an allowable variation from the specified rate of not more than ±5%, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper. The Contractor shall remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Owner.

A power broom and power blower suitable for cleaning the surfaces to which the bituminous coat is to be applied shall be provided.

602-3.3 APPLICATION FOR BITUMINOUS MATERIAL.

Immediately before applying the prime coat, the full width of the surface to be primed shall be swept with a power broom to remove all loose dirt and other objectionable material. Contractor shall mask in-pavement
The bituminous material shall be uniformly applied with a bituminous distributor at the rate of 0.15 to 0.30 gallons per square yard (0.68 to 1.36 liters per square meter) depending on the base course surface texture. The type of bituminous material and application rate shall be approved by the Engineer prior to application.

Following application of the bituminous material and prior to application of the succeeding layer of pavement, allow the bituminous coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread enough sand to effectively blot up and cure excess bituminous material. Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

602-3.4 TRIAL APPLICATIONS.

Before providing the complete bituminous coat, the Contractor shall apply three lengths of at least 100 feet (30 m) for the full width of the distributor bar to evaluate the amount of bituminous material that can be satisfactorily applied with the equipment. Apply three different trial application rates of bituminous materials within the application range specified in paragraph 602-3.3. Other trial applications will be made using various amounts of material as deemed necessary by the Engineer.

602-3.5 BITUMINOUS MATERIAL CONTRACTOR’S RESPONSIBILITY.

The Contractor shall provide a statement of source and character of the proposed bituminous material which must be submitted to and approved by the Engineer before any shipment of bituminous materials to the project. The Contractor shall furnish vendor’s certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The test reports shall be provided to and approved by the Engineer before the bituminous material is applied. If the bituminous material does not meet the specifications, it shall be replaced at the Contractor’s expense. Furnishing the vendor’s certified test report for the bituminous material shall not be interpreted as basis for final acceptance.

602-3.6 FREIGHT AND WEIGH BILLS.

The Contractor shall submit waybills and delivery tickets during the progress of the work. Before the final estimate is allowed, file with the Engineer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the contract. Do not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

METHOD OF MEASUREMENT

602-4.1 The bituminous material for prime coat shall be measured by the gallon. Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D1250. The bituminous material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of bituminous material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the bituminous material is necessary. Water added to emulsified asphalt will not be measured for payment.

BASIS OF PAYMENT

602-5.1 Payment shall be made at the contract unit price per gallon for bituminous prime coat. This price
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BITUMINOUS PRIME COAT

shall be full compensation for furnishing all materials and for all preparation, delivering, and applying the materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item P-602-5.1 Bituminous Prime Coat - per gallon

TESTING REQUIREMENTS


MATERIAL REQUIREMENTS

ASTM D977 Standard Specification for Emulsified Asphalt
ASTM D2028 Standard Specification for Cutback Asphalt (Rapid-Curing Type)
ASTM D2397 Standard Specification for Cationic Emulsified Asphalt
ASTM D3628 Standard Practice for Selection and Use of Emulsified Asphalts

END OF ITEM P-602
ITEM P-605 JOINT SEALANTS FOR CONCRETE PAVEMENTS

DESCRIPTION

605-1.1 This item shall consist of providing and installing a resilient and adhesive joint sealing material capable of effectively sealing joints and cracks in rigid pavements.

605-1.2 This item shall also consist of a resilient and adhesive joint sealing filler capable of effectively sealing joints between Portland Cement Concrete pavements and structures. The item shall consist of Type B low modulus silicone sealant in accordance with this section for all concrete pavement. Type B sealant shall be used for all sealing of joints specifically shown on the plans and in all joints on concrete structures receiving cork. Type C joint sealant shall be used for sealing of all joints interfacing Portland Cement Concrete and bituminous concrete.

MATERIALS

605-2.1 JOINT SEALANTS.
Joint sealant materials shall meet the requirements of ASTM D5893 Standard Specifications for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer’s original sealed container. Each container shall be marked with the manufacturer’s name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer’s certification stating that the sealant meets the requirements of this specification.

605-2.2 BACKER ROD.
The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant. The material shall have a water absorption of not more than 5% when tested in accordance with ASTM C509. The backer-rod material shall be 25% ± 5% larger in diameter than the nominal width of the joint crack.

605-2.3 BACKUP MATERIALS.
Provide backup material that is a compressible, nonshrinking, nonstaining, nonabsorbing material, nonreactive with the joint sealant. The material shall have a melting point at least 5°F (3°C) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The material shall have a water absorption of not more than 5% of the sample weight when tested in accordance with ASTM C509. The backup material shall be 25 ±5% larger in diameter than the nominal width of the joint crack.

605-2.4 BOND BREAKING TAPES.
Provide a bond breaking tape or separating material that is a flexible, nonshrinkable, nonabsorbing, nonstaining, and nonreacting adhesive-backed tape. The material shall have a melting point at least 5°F (3°C) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.
CONSTRUCTION METHODS

605-3.1 TIME OF APPLICATION.

Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall 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 installing sealant, all joint faces must be dry and the weather shall not be rainy or foggy.**

605-3.2 EQUIPMENT.

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 10 days prior to use on the project.

- **Routinist-mounted routing tool.** Provide a routing tool, used for removing old sealant from the joints, of such shape and dimensions and so mounted on the tractor that it will not damage the sides of the joint. The tool shall be designed so that 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 will not be permitted. **Hand-operated spindle routing devices may be used to clean and enlarge random cracks.**

- **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 or for refacing joints or cleaning sawed joints where sandblasting does not provide a clean joint.

- **Sandblasting equipment.** Include with the sandblasting equipment an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening should not exceed 1/4 inch (6 mm). The air compressor shall be portable and capable of furnishing not less than 150 cfm (71 L/s) and maintaining a line pressure of not less than 90 psi (621 kPa) at the nozzle while in use. Demonstrate compressor capability, under job conditions, before approval. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately one inch (25 mm) above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle as necessary to secure satisfactory results.

- **Waterblasting equipment.** Include with the waterblasting equipment a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. Provide water tank and auxiliary resupply equipment of sufficient capacity to permit continuous operations. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately one inch above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle as necessary to obtain satisfactory results. A pressure gauge mounted at the pump shall show at all times the pressure in psi at which the equipment is operating.

- **Hand tools.** Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces.

- **Hot-poured sealing equipment.** The unit applicators used for heating and installing ASTM D6690 joint sealant materials shall be mobile and shall be 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 shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.
g. **Two-component, cold-applied, machine mix sealing equipment.** Provide equipment used for proportioning, mixing, and installing Federal Specification SS-S-200 Type M joint sealants designed to deliver two semifluid components through hoses to a portable mixer at a preset ratio of one (1) to one (1) by volume using pumps with an accuracy of ±5% for the quantity of each component. The reservoir for each component shall be equipped with mechanical agitation devices that will maintain the components in a uniform condition without entrapping air. Incorporate provisions to permit thermostatically controlled indirect heating of the components, when required. However, immediately prior to proportioning and mixing, the temperature of either component shall not exceed 90°F. Provide screens near the top of each reservoir to remove any foreign particles or partially polymerized material that could clog fluid lines or otherwise cause misproportioning or improper mixing of the two components. Provide equipment capable of thoroughly mixing the two components through a range of application rates of 10 to 60 gallons per hour and through a range of application pressures from 50 to 1500 psi as required by material, climatic, or operating conditions. Design the mixer for the easy removal of the supply lines for cleaning and proportioning of the components. The mixing head shall accommodate nozzles of different types and sizes as may be required by various operations. The dimensions of the nozzle shall be such that the nozzle tip will extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier’s instructions, and unaltered in any way without obtaining prior approval.

h. **Two-component, cold-applied, hand-mix sealing equipment.** Mixing equipment for Federal Specification SS-S-200 Type H sealants shall consist of a slow-speed electric drill or air-driven mixer with a stirrer in accordance with the manufacturer’s recommendations. Submit printed copies of manufacturer’s recommendations 10 days prior to use on the project where installation procedures, or any part thereof, are required to be in accordance with those recommendations. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

i. **Cold-applied, single-component sealing equipment.** The equipment for installing ASTM D5893 single component joint sealants shall 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 shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. Sealant shall maintain a constant level as shown on details, applying a second sealant over the top of initial sealant installed to correct low areas will not be approved. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier’s instructions, and unaltered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

### 605-3.3 PREPARATION OF JOINTS.

a. **Sawing.** All joints shall be sawed in accordance with specifications and plan details. Immediately after sawing the joint, the resulting slurry shall be completely removed from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.

b. **Sealing.** Immediately before sealing, the joints shall be thoroughly cleaned 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. Cleaning shall be accomplished by sandblasting or tractor-mounted routing equipment as specified in paragraph 605-3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch (12 mm) from the joint edge shall be sandblasted clean. Sandblasting shall be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an
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JOINT SEALANTS FOR CONCRETE PAVEMENTS

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 compressed air and leave them completely free of debris and water. The joint faces shall be surface dry when the seal is applied.

c. **Back-up material.** 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 back-up material to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backup material is placed at the specified depth and is not stretched or twisted during installation.

d. **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-breaker separating tape 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.

Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the Engineer before sealing is allowed. Sealants shall be installed in accordance with 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 1/4 inch ±1/16 inch below the pavement surface. 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. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Contracting Officer. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with 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.

605-3.5 INSPECTION.

The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

605-3.6 CLEAN-UP.

Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

**METHOD OF MEASUREMENT**

605-4.1 Joint repairs in existing PCC pavements shall be made at the contract unit price per linear foot. This shall include all material, labor, and equipment used in the preparation and repair of the joint, regardless of joint type. This shall include all cleaning operations as described herein, for furnishing all materials, for all preparation, delivering, and placing of the material, and for all labor, equipment tools, and incidentials necessary to complete the item.

605-4.2 Crack repairs in existing PCC pavements shall be measured and paid in accordance with item 02555.

605-4.3 No separate measurement shall be made for sealing of joints in new pavement, including full depth repairs. This work shall be considered subsidiary to the various pavement bid items of the specifications. This shall include all material, labor, and equipment used in the preparation and sealing of the joints.

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ver. 07-21-2014
605-4.4 No separate measurement shall be made for sealing of joints damaged during construction of other items of work, including but not limited to partial depth repairs, sawcutting, and pavement marking obliteration.

BASIS OF PAYMENT

605-5.1 Payment for joint repairs in existing PCC pavements shall be made at the contract unit price per linear foot. This shall include all material, labor, and equipment used in the preparation and repair of the joint. This shall include all cleaning operations as described herein, for furnishing all materials, for all joint. This shall include all cleaning operations as described herein, for furnishing all materials, for all preparation, delivering, and placing of the material, and for all labor, equipment tools, and incidentals necessary to complete the item.

605-5.2 Payment for crack repairs in existing PCC pavements shall be made in accordance with item 02535.

605-5.3 No separate payment shall be made for sealing of joints in new pavement, including full depth repairs. This work shall be considered subsidiary to the various pavement bid items of the specifications. This shall include all cleaning operations as described herein, for furnishing all materials, for all preparation, delivering, and placing of the material, and for all labor, equipment tools, and incidentals necessary to complete the item.

605-5.4 No separate payment shall be made for sealing of joints damaged by the Contractors performance of other items of work.

Payment will be made under:

Item P-605-5.1 Joint Repair in Existing Concrete Pavement, per linear foot

TESTING REQUIREMENTS

ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
ASTM D1644 Standard Test Methods for Nonvolatile Content of Varnishes

MATERIAL REQUIREMENTS

AC 150/5340-30 Design and Installation Details for Airport Visual Aids
ASTM D789 Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)
ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ITEM P-610 STRUCTURAL PORTLAND CEMENT CONCRETE

DESCRIPTION

610-1.1 This item shall consist of plain and reinforced structural Portland Cement Concrete (PCC), prepared and constructed in accordance with these specifications, at the locations and of the form and dimensions shown on the plans. This specification shall be used for all structural and miscellaneous concrete including signage bases.

MATERIALS

610-2.1 GENERAL.

Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the Engineer before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

a. Reactivity. Fine and Coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and C1567. Aggregate and mix proportion reactivity tests shall be performed for each project.

(1) Coarse and fine aggregate shall be tested separately in accordance with ASTM C1260. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.10% at 28 days (30 days from casting).

(2) Combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) CRD C662. If lithium nitrate admixture is used, it shall be nominal 30% ±0.5% weight lithium nitrate in water.

(3) If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C1567, modified for combined aggregates, or COE CRD C662, does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion of the proposed combined materials test specimens is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.
610-2.2 COARSE AGGREGATE.

The coarse aggregate for concrete shall meet the requirements of ASTM C33. The Engineer may consider and reserve final approval of other State classification procedures addressing aggregate durability.

Coarse aggregate shall be well graded from coarse to fine and shall meet the following gradation shown in the table below when tested per ASTM C136.

<table>
<thead>
<tr>
<th>Sieve Designation (square openings)</th>
<th>Percentage by Weight Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4 to 1 in. (4.75-25 mm)</td>
<td>100 90-100 25-60 0-10</td>
</tr>
</tbody>
</table>

610-2.2.1 AGGREGATE SUSCEPTIBILITY TO DURABILITY (D) CRACKING.

Coarse aggregate may be accepted from sources that have a 20 year service history for the same gradation to be supplied with no durability issues.

a. Material currently being produced shall have a durability factor \( \geq 95 \) using ASTM C666. Coarse aggregates that are crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test but must meet all other quality tests. Aggregates meeting State Highway Department material specifications may be acceptable with concurrence of the FAA.

b. The Contractor shall submit a current certification that the aggregate does not have a history of D-cracking and that the aggregate meets the state specifications for use in PCC pavement for use on interstate highways. Certifications, tests and any history reports must be for the same gradation as being proposed for use on the project. Certifications which are not dated or which are over one (1) year old or which are for different gradations will not be accepted. Test results will only be accepted when tests were performed by a State Department of Transportation (DOT) materials laboratory or an accredited laboratory.

610-2.3 FINE AGGREGATE.

The fine aggregate for concrete shall meet the requirements of ASTM C33.

The fine aggregate shall be well graded from fine to coarse and shall meet the requirements of the table below when tested in accordance with ASTM C136:

<table>
<thead>
<tr>
<th>Sieve Designation (square openings)</th>
<th>Percentage by Weight Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch (9 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>45-80</td>
</tr>
<tr>
<td>No. 30 (0.60 mm)</td>
<td>25-55</td>
</tr>
<tr>
<td>No. 50 (0.30 mm)</td>
<td>10-30</td>
</tr>
<tr>
<td>No. 100 (0.15 mm)</td>
<td>2-10</td>
</tr>
</tbody>
</table>

Blending will be permitted, if necessary, to meet the gradation requirements for fine aggregate. Fine aggregate deficient in the percentage of material passing the No. 50 mesh sieve may be accepted, if the
deficiency does not exceed 5% and is remedied by the addition of pozzolanic or cementitious materials other than Portland cement, as specified in paragraph 610-2.6, Admixtures, in sufficient quantity to produce the required workability as approved by the Engineer.

610-2.4 CEMENT.
Cement shall conform to the requirements of ASTM C150 Type I or II.

If aggregates are deemed innocuous when tested in accordance with paragraph 610-2.1.a.1 and accepted in accordance with paragraph 610-2.1.a.3, higher equivalent alkali content in the cement may be allowed if approved by the Engineer and FAA. If cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

The Contractor shall furnish vendors’ certified test reports for each carload, or equivalent, of cement shipped to the project. The report shall be delivered to the Engineer before use of the cement is granted. All test reports shall be subject to verification by testing sample materials received for use on the project.

610-2.5 WATER.
The water used in concrete shall be fresh, clean and potable; free from injurious amounts of oils, acids, alkalies, salts, organic materials or other substances deleterious to concrete.

610-2.6 ADMIXTURES AND SUPPLMENTARY CEMENTITIOUS MATERIAL.
The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

a. **Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

b. **Water-reducing admixtures.** Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

c. **Other chemical admixtures.** The use of set retarding, and set-accelerating admixtures shall be approved by the Engineer. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

d. **Lithium nitrate.** The lithium admixture shall be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Limit (Percent by Mass)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LiNO₃ (Lithium Nitrate)</td>
<td>30±0.5</td>
</tr>
<tr>
<td>SO₄ (Sulfate Ion)</td>
<td>0.1 (max)</td>
</tr>
<tr>
<td>Cl (Chloride Ion)</td>
<td>0.2 (max)</td>
</tr>
<tr>
<td>Na (Sodium Ion)</td>
<td>0.1 (max)</td>
</tr>
<tr>
<td>K (Potassium Ion)</td>
<td>0.1 (max)</td>
</tr>
</tbody>
</table>

Provide a trained representative to supervise the lithium nitrate admixture dispensing and mixing operations.
AIRFIELD PAVEMENT REPAIRS

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STRUCTURAL PORTLAND CEMENT CONCRETE

610-2.7 PREMOLDED JOINT MATERIAL.

Premolded joint material for expansion joints shall meet the requirements of ASTM D1752.

610-2.8 JOINT FILLER.

The filler for joints shall meet the requirements of Item P-605, unless otherwise specified.

610-2.9 STEEL REINFORCEMENT.

Reinforcing shall consist of reinforcing steel or Welded Steel Wire Fabric conforming to the requirements of ASTM A615, ASTM A706, ASTM A775, A1064, and ASTM A934.

610-2.10 MATERIALS FOR CURING CONCRETE.

Curing materials shall conform to ASTM C309 White-Pigmented Liquid Membrane-Forming Compound, Type 2, Class B.

CONSTRUCTION METHODS

610-3.1 GENERAL.

The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the Engineer.

610-3.2 CONCRETE COMPOSITION.

The concrete shall develop a compressive strength of 3,500 psi in 7 days, and 4,400 psi in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39. The concrete shall contain not less than 470 pounds of cement per cubic yard (280 kg per cubic meter). The concrete shall contain 5% of entrained air, ±1%, as determined by ASTM C231 and shall have a slump of not more than 4 inches (100 mm) as determined by ASTM C143.

610-3.3 ACCEPTANCE SAMPLING AND TESTING.

Concrete for each structure will be accepted on the basis of the compressive strength specified in paragraph 610-3.2. The concrete shall be sampled in accordance with ASTM C172. Concrete cylindrical compressive strength specimens shall be made in accordance with ASTM C31 and tested in accordance with ASTM C39. The Contractor shall cure and store the test specimens under such conditions as directed by the Engineer. The Engineer will make the actual tests on the specimens at no expense to the Contractor.

The surrounding pavement at the trench drain shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a compressive strength of 3,500 psi when tested in accordance with ASTM C39. Sufficient cylinders shall be made so that three-day, five-day, seven-day, and 28 day compressive tests can be performed. Prior to opening the area to traffic, all joints shall be sealed.

Structural Concrete required for Trench Drain repair shall require additional acceptance testing. Such acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Engineer at no cost to the Contractor. The Contractor shall bear the cost of providing curing facilities for the strength specimens, per paragraph 501-5.1a(3). Testing organizations performing these tests shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority’s website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory’s
current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

Concrete shall be accepted for strength on a lot basis. A lot shall consist of a day’s production.

**610-3.4 QUALIFICATIONS FOR CONCRETE TESTING SERVICE.**

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM C1077 or ASTM E329.

**610-3.5 PROPORTIONING AND MEASURING DEVICES.**

When package cement is used, the quantity for each batch shall be equal to one or more whole sacks of cement. The aggregates shall be measured separately by weight. If aggregates are delivered to the mixer in batch trucks, the exact amount for each mixer charge shall be contained in each batch compartment. Weighing boxes or hoppers shall be approved by the Engineer and shall provide means of regulating the flow of aggregates into the batch box so the required, exact weight of aggregates is obtained.

**610-3.6 CONSISTENCY.**

The consistency of the concrete shall be determined by the slump test specified in ASTM C143.

**610-3.7 MIXING.**

Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94.

**610-3.8 MIXING CONDITIONS.**

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without permission of the Engineer. If permission is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material shall not be permitted.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

**610-3.9 FORMS.**

Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the Engineer. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.

The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface. The forms shall not be removed until at least 30 hours after concrete placement for vertical faces, walls, slender columns, and similar structures. Forms supported by falsework under slabs, beams, girders, arches, and similar construction shall not be removed until tests indicate the concrete has developed at least 60% of the design strength.
610-3.10 PLACING REINFORCEMENT.

All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

610-3.11 EMBEDDED ITEMS.

Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

610-3.12 PLACING CONCRETE.

All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the Engineer. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

610-3.13 VIBRATION.

Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309, Guide for Consolidation of Concrete. Where bars meeting ASTM A775 or A934 are used, the vibrators shall be equipped with rubber or non-metallic vibrator heads. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches (100 mm) in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches (100 mm) or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 cycles per minute when submerged. Do not use vibrators to transport the concrete in the forms. Penetrate the previously placed lift with the vibrator when more than one lift is required. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete. Vibrators shall be manipulated to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. The vibration at any point shall be of sufficient duration to accomplish compaction but shall not be prolonged to where segregation occurs. Concrete deposited under water shall be carefully placed in a compact mass in its final position by means of a tremie or other approved method and shall not be disturbed after placement.

610-3.14 CONSTRUCTION JOINTS.

If the placement of concrete is suspended, necessary provisions shall be made for joining future work before the placed concrete takes its initial set. For the proper bonding of old and new concrete, provisions shall be made for grooves, steps, reinforcing bars or other devices as specified. The work shall be arranged so that a section begun on any day shall be finished during daylight of the same day. Before depositing new concrete on or against concrete that has hardened, the surface of the hardened concrete shall be cleaned by a heavy steel broom, roughened slightly, wetted, and covered with a neat coating of cement paste or grout.

610-3.15 EXPANSION JOINTS.

Expansion joints shall be constructed at such points and dimensions as indicated on the drawings. The
premolded filler shall be cut to the same shape as the surfaces being joined. The filler shall be fixed firmly against the surface of the concrete already in place so that it will not be displaced when concrete is deposited against it.

610-3.16 DEFECTIVE WORK.

Any defective work discovered after the forms have been removed, which in the opinion of the Engineer cannot be repaired satisfactorily, shall be immediately removed and replaced at the expense of the Contractor. Defective work shall include deficient dimensions, or bulged, uneven, or honeycomb on the surface of the concrete.

610-3.17 SURFACE FINISH.

All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated. Mortar finishing shall not be permitted, nor shall dry cement or sand-cement mortar be spread over the concrete during the finishing of horizontal plane surfaces. The surface finish of exposed concrete shall be a rubbed finish. If forms can be removed while the concrete is still green, the surface shall be wetted and then rubbed with a wooden float until all irregularities are removed. If the concrete has hardened before being rubbed, a carborundum stone shall be used to finish the surface. When approved, the finishing can be done with a finishing machine.

610-3.18 CURING AND PROTECTION.

All concrete shall be properly cured and protected by the Contractor. The concrete shall be protected from the weather, flowing water, and from defacement of any nature during the project. The concrete shall be cured by covering with an approved material as soon as it has sufficiently hardened. Water-absorptive coverings shall be thoroughly saturated when placed and kept saturated for at least three (3) days following concrete placement. All curing mats or blankets shall be sufficiently weighted or tied down to keep the concrete surface covered and to prevent the surface from being exposed to air currents. Wooden forms shall be kept wet at all times until removed to prevent opening of joints and drying out of the concrete. Traffic shall not be allowed on concrete surfaces for seven (7) days after the concrete has been placed.

610-3.19 DRAINS OR DUCTS.

Drainage pipes, conduits, and ducts that are to be encased in concrete shall be installed by the Contractor before the concrete is placed. The pipe shall be held rigidly so that it will not be displaced or moved during the placing of the concrete.

610-3.20 COLD-WEATHER PLACING.

When concrete is placed at temperatures below 40°F (4°C), the Contractor shall provide satisfactory methods and means to protect the mix from injury by freezing. The aggregates, or water, or both, shall be heated to place the concrete at temperatures between 50°F and 100°F (10°C and 38°C).

Calcium chloride may be incorporated in the mixing water when directed by the Engineer. Not more than pounds (908 grams) of Type 1 nor more than 1.6 pounds (726 grams) of Type 2 shall be added per bag of cement. After the concrete has been placed, the Contractor shall provide sufficient protection such as cover, canvas, framework, heating apparatus, etc., to enclose and protect the structure and maintain the temperature of the mix at not less than 50°F (10°C) until at least 60% of the designed strength has been attained.

610-3.21 HOT WEATHER PLACING.

Concrete shall be properly placed and finished with procedures previously submitted. The concrete-placing temperature shall not exceed 90°F (32°C) when measured in accordance with ASTM C1064. Cooling of the mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph 610-2.6 may be used to facilitate placing and finishing. Steel
forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120°F (50°C). Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature. Submit the proposed materials and methods for review and approval by the Engineer, if concrete is to be placed under hot weather conditions.

610-3.22 FILLING JOINTS.

All joints that require filling shall be thoroughly cleaned, and any excess mortar or concrete shall be cut out with proper tools. Joint filling shall not start until after final curing and shall be done only when the concrete is completely dry. The cleaning and filling shall be done with proper equipment to obtain a neat looking joint free from excess filler.

610-3.23 EPOXY BONDING AGENT

Prior to placing new concrete on top of existing concrete, the contractor shall clean existing concrete designated to remain. All loose materials and dust shall be removed. The contractor shall then apply a moisture-insensitive epoxy bonding agent to assist in the adhesion of existing concrete to new concrete. Epoxy bonding agent shall conform to the requirements of ASTM C-188 Type I, II, IV, and V, Grade Z, Class B and C. Apply epoxy bonding agent by broom, brush, or spray gun to all exposed existing surfaces. Work into surfaces with stiff bristle brushes. If bonding agent loses its tack prior to concrete placement, reapply a second coat of epoxy. If epoxy becomes hard prior to concrete placement, the first coat must be roughened and a second coat of epoxy applied.

When vibrating concrete, take care to keep the head of the vibrator sufficiently away from the bond line to avoid wiping the epoxy from the existing surface.

After a minimum of 5 days cure of fresh concrete, apply epoxy bonding agent to adhere to existing fiberglass liner to the concrete trench wall. Take care to protect fiberglass liner during demolition and construction of concrete.

METHOD OF MEASUREMENT

610-4.1 Portland cement concrete for structures shall not be measured for separate payment, but the price shall be considered subsidiary to the unit price for the structure in which it is placed.

610-4.2 No separate payment will be made for reinforcing steel, but the price shall be considered subsidiary to the unit price for the structure in which it is placed.

610-4.3 Remove and Replace Trench Drain shall be measured per linear foot as specified in place, completed and accepted. Measurement shall be taken along the centerline of the trench, beginning and ending at the joint where the concrete is removed and replaced.

610-4.4 Remove and Replace Inlet Grate shall be measured by the unit, completed in place and accepted.

BASIS OF PAYMENT

610-5.1 Payment for Remove and Replace Trench Drain meeting all acceptance criteria shall be based on strength tests. Payment shall be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings. Such payment shall include but not be limited to sawcutting, removing, and replacing existing concrete surrounding existing trench grate; removal of existing frame; furnishing and installation of new grate frame; salvaging and reinstalling existing grate; furnishing and installation of all dowels, epoxy, stirrups, rebar, anchors, and bolts; protection, removal and/or repair to fiberglass liner; epoxy bonding agent; and construction of joints.

610-5.2 Payment for Remove and Replace Inlet Grate meeting all acceptance criteria shall be based on
strength tests. Payment shall be full compensation for all labor, materials, tools, equipment, and
incidentals required to complete the work as specified herein and on the drawings. Such payment shall
include but not be limited to sawcutting, removing, and replacing existing concrete surrounding the
existing inlet grate; removal of existing assembly frame; furnishing and installation of new grate assembly
frame; salvaging and reinstalling existing grate; furnishing and installation of all stirrups, rebar, anchors,
and bolts; and construction of joints.

Payment will be made under:

Item P-610-5.1 Remove and Replace Trench Drain – per linear foot
Item P-610-5.2 Remove and Replace Inlet Grate – per each

TESTING REQUIREMENTS

<table>
<thead>
<tr>
<th>ASTM</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASTM C31</td>
<td>Standard Practice for Making and Curing Concrete Test Specimens in the Field</td>
</tr>
<tr>
<td>ASTM C39</td>
<td>Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens</td>
</tr>
<tr>
<td>ASTM C136</td>
<td>Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates</td>
</tr>
<tr>
<td>ASTM C138</td>
<td>Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete</td>
</tr>
<tr>
<td>ASTM C143</td>
<td>Standard Test Method for Slump of Hydraulic-Cement Concrete</td>
</tr>
<tr>
<td>ASTM C231</td>
<td>Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method</td>
</tr>
<tr>
<td>ASTM C666</td>
<td>Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing</td>
</tr>
<tr>
<td>ASTM C1017</td>
<td>Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete</td>
</tr>
<tr>
<td>ASTM C1064</td>
<td>Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete</td>
</tr>
<tr>
<td>ASTM C1077</td>
<td>Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation</td>
</tr>
<tr>
<td>ASTM E329</td>
<td>Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection</td>
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<tr>
<td>U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD) C662</td>
<td>Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)</td>
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MATERIAL REQUIREMENTS

<table>
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<tr>
<th>ASTM</th>
<th>Description</th>
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<tr>
<td>ASTM A184</td>
<td>Standard Specification for Welded Deformed Steel Bar Mats for Concrete</td>
</tr>
</tbody>
</table>
Reinforcement

- ASTM A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
- 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 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 C33: Standard Specification for Concrete Aggregates
- ASTM C94: Standard Specification for Ready-Mixed Concrete
- ASTM C171: Standard Specification for Sheet Materials for Curing Concrete
- ASTM C172: Standard Practice for Sampling Freshly Mixed Concrete
- 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: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in 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
- ACI 305R: Hot Weather Concreting
- ACI 306R: Cold Weather Concreting
- ACI 309R: Guide for Consolidation of Concrete

**END OF ITEM P-610**
ITEM P-620 RUNWAY AND TAXIWAY MARKING

DESCRIPTION

620-1.1 This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the Engineer. The terms “paint” and “marking material” as well as “painting” and “application of markings” are interchangeable throughout this specification.

MATERIALS

620-2.1 MATERIALS ACCEPTANCE. The Contractor shall furnish manufacturer’s certified test reports for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. The reports can be used for material acceptance or the Engineer may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the Engineer upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers 55 gallons or smaller for inspection by the Engineer. Material shall not be loaded into the equipment until inspected by the Engineer.

620-2.2 MARKING MATERIALS.

Paint shall be waterborne in accordance with the requirements of paragraph 620-2.2. Paint shall be furnished in White-37925, Red-31136, Yellow-33538, and Black-37038 in accordance with Federal Standard No. 595.

   a. Waterborne. Paint shall meet the requirements of Federal Specification TT-P-1952E, Type II. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis.

   b. Preformed Thermoplastic Airport Pavement Markings. Markings must be composed of ester modified resins in conjunction with aggregates, pigments, and binders that have been factory produced 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) The markings must be supplied 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 shall conform to Federal Specification TT-B-1325D, Type I, gradation A & Federal Specification TT-B-1325D, Type IV. Federal Specification TT-B-1325D, Type III.

         (b) The material must have factory applied coated surface beads in addition to the intermixed beads at a rate of one (1) lb (0.45 kg) (±10%) per 10 square feet (1 sq m). These factory applied coated surface beads shall have a minimum of 90% true spheres, minimum refractive index of 1.50, and meet the following gradation.
Table: Size-Gradation

<table>
<thead>
<tr>
<th>U.S. Mesh</th>
<th>μm</th>
<th>Retained, %</th>
<th>Passing, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1700</td>
<td>0–2</td>
<td>98–100</td>
</tr>
<tr>
<td>14</td>
<td>1400</td>
<td>0–3.5</td>
<td>96.5–100</td>
</tr>
<tr>
<td>16</td>
<td>1180</td>
<td>2–25</td>
<td>75–98</td>
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<td>18</td>
<td>1000</td>
<td>28–63</td>
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<td>850</td>
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</tr>
<tr>
<td>50</td>
<td>300</td>
<td>89–95</td>
<td>5–14</td>
</tr>
<tr>
<td>80</td>
<td>200</td>
<td>97–100</td>
<td>0–3</td>
</tr>
</tbody>
</table>

(3) **Heating indicators.** The material manufacturer shall 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:
      Titanium Dioxide, ASTM D476, type II shall be 10% minimum.
   (b) Yellow and Colors:
      Titanium Dioxide, ASTM D476, type II shall be 1% minimum.
      Organic yellow, other colors, and tinting as required to meet color standard.

(5) **Prohibited materials.** The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor 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: The daylight directional reflectance of the white paint shall not be less than 75% (relative to magnesium oxide), when tested in accordance with ASTM E2302.
   (b) Yellow: The daylight directional reflectance of the yellow paint shall not be less than 45% (relative to magnesium oxide), when tested in accordance with ASTM E2302.
      The x and y values shall be consistent with the Federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:
      \[ \begin{align*}
      x &\quad 0.462 & \quad 0.470 & \quad 0.479 & \quad 0.501 \\
      y &\quad 0.438 & \quad 0.455 & \quad 0.428 & \quad 0.452
      \end{align*} \]

(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 in accordance with manufacturer’s guidelines, must demonstrate a uniform level of nighttime retroreflection when tested in accordance to ASTM E1710.
(11) Packaging. Packaging shall 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 capable of being affixed to asphalt and/or Portland cement concrete pavements by the use of a large radiant heater. Colors shall be available as required.

(b) The markings must be capable of conforming to pavement contours, breaks, and faults through the action of airport traffic at normal pavement temperatures. The markings must be capable of fully conforming to grooved pavements, including pavement grooving per advisory circular (AC) 150/5320-12, current version. The markings shall 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 shall have an integral color throughout the thickness of the marking material.

620-2.3 REFLECTIVE MEDIA.

Glass beads shall meet the requirements for TT-B-1325D, Type III, Gradation A, for yellow and white paint, and TT-B-1325D, Type I, Gradation A for red paint. Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment. At installation, markings shall have minimum retroreflective values of [600] mcd/m2/lux on white markings, and [300] mcd/m2/lux on yellow markings. The Contractor shall verify minimum retroreflectivity of installed markings. Retroreflectivity shall be measured by a portable retroreflectometer according to ASTM E1710 and the practices in ASTM D7585 shall be followed for taking retroreflectivity readings with a portable retroreflectometer and computing measurement averages. A van-mounted retroreflectometer may also be used.

CONSTRUCTION METHODS

620-3.1 WEATHER LIMITATIONS.

The painting shall be performed only when the surface is dry and when the surface temperature is at least 45°F (7°C) and rising and the pavement surface temperature is at least 5°F (2.7°C) above the dew point or meets the manufacturer’s recommendations. Painting operations shall be discontinued when the surface temperature exceeds 130°F (55°C). Markings shall not be applied when the pavement temperature is greater than 130°F (55°F). Markings shall not be applied when the wind speed exceeds...
AIRFIELD PAVEMENT REPAIRS
Project No. 460C_HOU
RUNWAY AND TAXIWAY MARKING

10 mph unless windscreens are used to shroud the material guns.

620-3.2 EQUIPMENT.

Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless-type marking machine suitable for application of traffic paint. It shall produce an even and uniform film thickness at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray.

620-3.3 PREPARATION OF SURFACE.

Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other foreign material that would reduce the bond between the paint and the pavement. The area to be painted shall be cleaned by waterblasting or by other methods as required to remove all contaminants minimizing damage to the pavement surface. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the Engineer. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

Paint shall not be applied to Portland cement concrete pavement until the areas to be painted are clean of curing material. Sandblasting or high-pressure water shall be used to remove curing materials. During the cure removal process, contractor shall employ methods to protect joint sealant from damage (i.e., placement of rebar over the newly sealed joints).

At least 24 hours prior to remarking existing markings, existing markings must be removed such that 90% of the existing markings are removed. After removal, the surface shall be cleaned of all residue or debris either with sweeping or blowing with compressed air or both.

Prior to the initial application of markings, the Contractor shall certify in writing that the surface has been prepared in accordance with the paint manufacturer’s requirements, that the application equipment is appropriate for the type of marking paint and that environmental conditions are appropriate for the material being applied. This certification along with a copy of the paint manufacturer’s surface preparation and application requirements must be submitted and approved by the Engineer prior to the initial application of markings.

620-3.4 LAYOUT OF MARKINGS.

The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans. Markings to be repainted shall be verified for proper location and alignment in accordance with the tolerances shown under 620-3.5 below. All markings shall receive glass beads unless otherwise noted on the plans.

620-3.5 APPLICATION.

Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the Engineer. The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacings shall be within the following tolerances:

<table>
<thead>
<tr>
<th>Dimension and Spacing</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>36 inch (910 mm) or less</td>
<td>±1/2 inch (12 mm)</td>
</tr>
<tr>
<td>greater than 36 inch to 6 feet (910 mm to 1.85 m)</td>
<td>±1 inch (25 mm)</td>
</tr>
<tr>
<td>greater than 6 feet to 60 feet (1.85 m to 18.3 m)</td>
<td>±2 inch (50 mm)</td>
</tr>
</tbody>
</table>
The paint shall be mixed in accordance with the manufacturer’s instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted. A period of 30 days shall elapse between placement of a bituminous surface course or seal coat and application of the paint. If the airport operations require pavement marking prior to the waiting period stated above, the paint may be applied in a temporary light coat application of 30% to 50% application rate for temporary markings. TT-P-1952E, Type II or A-A-2886B, Type III may be used for temporary markings when reflectorized temporary markings are required. Glass beads will not adhere well at the low application rates for temporary markings and require immediate sweeping and cleanup before aircraft are allowed to use the pavement. The final full-strength paint application shall occur after the waiting period has passed.

Prior to the initial application of markings, the Contractor shall certify in writing that the surface has been prepared in accordance with the paint manufacturer’s requirements, that the application equipment is appropriate for the marking paint and that environmental conditions are appropriate for the material being applied. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the Engineer prior to the initial application of markings.

620-3.6 TEST STRIP.

Prior to the full application of airfield markings, the Contractor shall produce a test strip in the presence of the Engineer. The test strip shall include the application of a minimum of 5 gallons (4 liters) of paint and application of 35 lbs (15.9 kg) of Type I/50 lbs (22.7 kg) of Type III glass beads. The test strip shall be used to establish thickness/darkness standard for all markings. The test strip shall be used in addition, and 100% with glass beads in the other direction.

An initial paint coat at 50% of the permanent coverage rates shall be applied for white markings to reduce the discoloration that occurs.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads as the paint is applied. Bead dispensers shall be calibrated in accordance with the manufacturer’s recommendations Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made.

Table 1. Application Rates For Paint And Glass Beads
(See Note regarding Red and Pink Paint)

<table>
<thead>
<tr>
<th>Paint Type</th>
<th>Paint Square feet per gallon, ft²/gal (Sq m per liter, m²/l)</th>
<th>Glass Beads, Type I, Gradation A Pounds per gallon of paint-lb/gal (Km per liter of paint-kg/l)</th>
<th>Glass Beads, Type III Pounds per gallon of paint-lb/gal (Km per liter of paint-kg/l)</th>
<th>Glass Beads, Type IV Pounds per gallon of paint-lb/gal (Km per liter of paint-kg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterborne Type I or II</td>
<td>115 ft²/gal max (2.8 m²/l)</td>
<td>7 lb/gal min (0.85 kg/l)</td>
<td>10 lb/gal min (1.2 kg/l)</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: The glass bead application rate for Red and Pink paint shall be reduced by 2 lb/gal (0.24 kg/l) for Type I and Type IV beads. Type III beads shall not be applied to Red or Pink Paint.
Different bead types shall not be mixed. Regular monitoring of glass bead embedment should be performed.

All emptied containers shall be returned to the paint storage area for checking by the Engineer. The containers shall not be removed from the airport or destroyed until authorized by the Engineer.

**620-3.7 APPLICATION—PREFORMED THEROPLASTIC AIRPORT PAVEMENT MARKINGS.**

a. **Asphalt and Portland cement.** To ensure minimum single-pass application time and optimum bond in the marking/substrate interface, the materials must be applied using a variable-speed self-propelled mobile heater with an effective heating width of no less than 16 feet (5 m) and a free span between supporting wheels of no less than 18 feet (5.5 m). The heater must emit thermal radiation to the marking material in such a manner 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 shall 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.

**620-3.8 PROTECTION AND CLEANUP.**

After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose or unadhered reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the Engineer. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and Federal environmental statutes and regulations.

**METHOD OF MEASUREMENT**

**620-4.1** The quantity of runway and taxiway markings to be paid for shall be the number of square feet of painting or the number of square feet of preformed markings performed in accordance with the specifications and accepted by the Engineer.

No separate measurement will be made for reflective media (glass beads).

**BASIS OF PAYMENT**

**620-5.1** Payment shall be made at the respective contract price per square foot for runway and taxiway painting and at the respective contract price per square foot for preformed markings. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

No separate payment will be made for reflective media (glass beads).

Payment will be made under:

- **Item P-620-5.1** Waterborne Reflectorized Pavement Marking (White) - square foot
- **Item P-620-5.2** Waterborne Reflectorized Pavement Marking (Yellow) - square foot
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P-620-5.3</td>
<td>Waterborne Non-Reflectorized Pavement Marking (Black) – square foot</td>
</tr>
<tr>
<td>P-620-5.4</td>
<td>Waterborne Reflectorized Pavement Marking (Red) – square foot</td>
</tr>
<tr>
<td>P-620-5.5</td>
<td>Temporary Marking - square foot</td>
</tr>
<tr>
<td>P-620-5.6</td>
<td>Preformed Thermoplastic Apron Entrance Point Marking – “19” (2 Color) - each</td>
</tr>
<tr>
<td>P-620-5.7</td>
<td>Preformed Thermoplastic Apron Entrance Point Marking – “20” (2 Color) - each</td>
</tr>
<tr>
<td>P-620-5.8</td>
<td>Preformed Thermoplastic Surface Painted Gate Sign – “D12” (2 Color) - each</td>
</tr>
<tr>
<td>P-620-5.9</td>
<td>Preformed Thermoplastic Surface Painted Gate Sign – “D12A” (2 Color) - each</td>
</tr>
<tr>
<td>P-620-5.10</td>
<td>Preformed Thermoplastic Gate Lead In Line (2 Color) - linear foot</td>
</tr>
<tr>
<td>P-620-5.11</td>
<td>Preformed Thermoplastic Alternate Gate Lead In Line (2 Color) - linear foot</td>
</tr>
</tbody>
</table>

**TESTING REQUIREMENTS**

- ASTM D92: Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- ASTM D2240: Standard Test Method for Rubber Property - Durometer Hardness
- ASTM G154: Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

**MATERIAL REQUIREMENTS**

- ASTM D476: Standard Classification for Dry Pigmentary Titanium Dioxide Products
- 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
AIRFIELD PAVEMENT REPAIRS
Project No. 460C_HOU


FED SPEC TT-B-1325D
  Beads (Glass Spheres) Retro-Reflective

American Association of State Highway and Transportation Officials (AASHTO) M247
  Standard Specification for Glass Beads Used in Pavement Markings

FED SPEC TT-P-1952E
  Paint, Traffic and Airfield Marking, Waterborne

Commercial Item Description A-A-2886B
  Paint, Traffic, Solvent Based

FED STD 595  Colors used in Government Procurement
AC 150/5340-1  Standards for Airport Markings

END OF ITEM P-620
ITEM P-621 SAW-CUT GROOVES

DESCRIPTION

621-1.1 This item consists of providing a skid resistant surface that prevents hydroplaning during wet weather in accordance with these specifications and at the locations shown on the plans, or as directed by the Engineer.

CONSTRUCTION METHODS

621-2.1 Procedures. The Contractor shall submit to the Engineer the grooving sequence and method of placing guide lines to control grooving operation. Transverse grooves saw-cut in the pavement must form a 1/4 inch (+1/16 inch, -0 inch) wide by 1/4 inch (±1/16 inch) deep by 1-1/2 inch (-1/8 inch, +0 inch) center-to-center configuration. 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 from the runway 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. The Contractor shall routinely spot check for compliance each time the equipment aligns for a grooving pass.

a. Alignment tolerance. The grooves shall not vary more than ±1-1/2 inch in alignment from the adjacent pavement grooves.

b. Groove tolerance. Depth. The standard depth is 1/4 inch. At least 90% of the grooves must be at least 3/16 inch, at least 60% of the grooves must be at least 1/4 inch, and not more than 10% of the grooves may exceed 5/16 inch.

c. Width. The standard width is 1/4 inch. At least 90% of the grooves must be at least 3/16 inch, at least 60% of the grooves must be at least 1/4 inch, and not more than 10% of the grooves may exceed 5/16 inch.


Saw-cut grooves must not be closer than 3 inches or more than 9 inches from transverse joints in concrete pavements. Grooves must not be closer than 6 inches and no more than 18 inches from in-pavement light fixtures or saw kerfs for lighting cables. Grooves may be continued through longitudinal construction joints. 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 or more than 5 inches from the longitudinal joints. Where lighting cables are installed, grooving through longitudinal or diagonal saw kerfs shall not be allowed.

621-2.2 Environmental requirements. Grooving operations will not be 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 shall be the Contractor’s responsibility.
621-2.3 Test section. Groove a test section in an area of the pavement outside of the trafficked area, as approved by the Engineer. The area shall be 250 feet long by two lanes wide. Demonstrate the setup and alignment process, the grooving operation, and the waste slurry disposal.

621-2.4 Existing pavements. Bumps, depressed areas, bad or faulted joints, and badly cracked and/or spalled areas in the pavement shall not be grooved until such areas are adequately repaired or replaced.

621-2.5 New pavements. New asphalt concrete pavements shall be allowed to cure for a minimum of 30 days before grooving, to allow the material to become stable enough to prevent closing of the grooves under normal use. Permit new Portland cement concrete pavements to cure for a minimum of 28 days before grooving. Spalling along or tearing or raveling of the groove edges shall not be allowed.

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 shall be equipped with diamond-saw cutting blades, and capable of making at least 18 inches in width of multiple parallel grooves in one pass of the machine. Thickness of the cutting blades shall be capable of making the required width and depth of grooves in one pass of the machine. The cutting head shall 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 existing airfield pavement. The wheels on the grooving machine shall be of a design that will not scar or spall the pavement. Provide the machine with devices to control depth of groove and alignment.

621-2.7 Water supply. Water for the grooving operation shall be provided by the Contractor and the cost thereof shall be included in the price of the grooving.

621-2.8 Wet saw cutting. Wet saw cutting shall be utilized in proximity to hangars and aprons to avoid excessive concrete dust.

621-2.9 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 satisfaction of the Engineer. 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. The dust coating remaining shall be picked up or flushed to the edge of the area if the resultant accumulation is not detrimental to the vegetation or storm drainage system. Accomplish all flushing operations in a manner to prevent erosion on the shoulders or damage to vegetation. Waste material must be disposed of in an approved manner. Waste material must not be allowed 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.

621-2.10 Repair of damaged pavement. Grooving must be stopped and damaged pavement repaired at the Contractor’s expense when, in the opinion of the Engineer, the result of the grooving operation will be detrimental to aircraft tires.

ACCEPTANCE

621-3.1 Acceptance testing. Grooves will be accepted based on results of zone testing. All acceptance testing necessary to determine conformance with the groove tolerances specified will be performed by the Engineer.

Instruments for measuring groove width and depth must have a range of at least 0.5 inch and a resolution of at least 0.005 inch. Gauge blocks or gauges machined to standard grooves width, depth, and spacing may be used.

Instruments for measuring center-to-center spacing must have a range of at least 3 inches and a resolution of at least 0.02 inch.
The Engineer will measure grooves in five zones across the pavement width. Measurements will be made at least three times during each day’s production. Measurements in all zones will be made for each cutting head on each piece of grooving equipment used for each day’s production.

The five zones are as follows:

- **Zone 1**: Centerline to 5 feet left or right of the centerline.
- **Zone 2**: 5 feet to 25 feet left of the centerline.
- **Zone 3**: 5 feet 25 feet right of the centerline.
- **Zone 4**: 25 feet to edge of grooving left of the centerline.
- **Zone 5**: 25 feet to edge of grooving right of the centerline.

At a random location within each zone, five consecutive grooves sawed by each cutting head on each piece of grooving equipment will be measured for width, depth, and spacing. The five consecutive measurements must be located about the middle blade of each cutting head ±4 inches. Measurements will be made along a line perpendicular to the grooves.

Width or depth measurements less than 0.170 inch shall be considered less than 3/16 inch.

Width or depth measurements more than 0.330 inch shall be considered more than 5/16 inch.

Width or depth measurements more than 0.235 inch shall be considered more than 1/4 inch.

Production must be adjusted when more than one groove on a cutting head fails to meet the standard depth, width, or spacing in more than one zone.

**METHOD OF MEASUREMENT**

**621-4.1** The quantity of grooving to be paid for shall be the number of square yards of grooving performed in accordance with the specifications and accepted by the Engineer per paragraph 621-3.1.

**BASIS OF PAYMENT**

**621-5.1 Payment for saw-cut grooving.** Payment for saw-cut grooving will be made at the contract unit price per square yard for saw-cut grooving. This price shall be 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 will be made under:

- **Item P-621-5.1**: Pavement Grooving - per square yard

**END OF ITEM P-621**
ITEM P-629 THERMOPLASTIC COAL TAR EMULSION SURFACE TREATMENTS

DESCRIPTION

629-1.1. This item shall consist of an application of a thermoplastic resin coal tar emulsion Micro-Surface applied to an existing, previously prepared asphalt surface. Thermoplastic resin coal tar emulsion products provide a fuel-resistant surface where pavements are subjected to fuel spills. Thermoplastic resin coal tar emulsion products assist in pavement preservation through reducing the rate of pavement oxidation. The application of the surface treatment shall be in accordance with these specifications and shall conform to the dimensions shown on the plans or as directed by the Engineer.

MATERIALS

629-2.1 THERMOPLASTIC COAL TAR EMULSION.

The emulsion material shall be a thermoplastic coal tar emulsion made up of plastic resin and emulsified coal tar pitch. The thermoplastic coal tar emulsion shall be manufactured as a complete product and tested at the manufacturing plant for material certification. The water content of the emulsion shall not exceed 48% ±1% when tested in accordance with ASTM D244, paragraph 3.

A dried film shall contain a minimum of 89% of a combination of plastic resin and coal tar with the remaining percentage being inorganic filler. The dried emulsion shall have a softening point greater than 212°F (100°C) when tested in accordance with ASTM D36. A film of the dried emulsion material, 8 mils thick, shall stretch to five (5) times its original length at 70°F (21°C) without breaking, and recover 35% of this length in one minute.

629-2.2 MATERIAL CERTIFICATION.

The Contractor shall furnish the manufacturer’s certification that each consignment of thermoplastic coal tar emulsion shipped to the project meets the requirements indicated in 629-2.1 and elsewhere in this specification. The Certification shall include actual results of each test and date of when test was performed. The Contractor shall submit a certification that the material proposed has been in field use for a minimum of two (2) years.

629-2.3 FUEL RESISTANCE TESTING.

The cured thermoplastic coal tar emulsion sample must pass the fuel-resistance test outlined in Appendix A.

629-2.4 WATER.

The water used in mixing shall be potable and free from harmful soluble salts. The temperature of the water added during mixing shall be at least 50°F (10°C). The pH of the water added during mixing shall conform to the requirements of the thermoplastic coal tar emulsion manufacturer.

629-2.5 HANDLING AND STORAGE.

The mixture shall be continuously agitated from the time it had been mixed until its application on the pavement surface. The distributor or applicator, pumps and all tools shall be maintained in satisfactory working condition. Spray bar nozzles, pumps, or other equipment can be cleaned mechanically or with clean water.
629-2.6 HEALTH, SAFETY, AND ENVIRONMENT.

The Contractor must provide a complete Material Safety Data Sheet (MSDS) in accordance with 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 MSDS for hazardous materials. The MSDS, Section II, shall 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 shall 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.

COMPOSITION AND APPLICATION

629–3.0 THERMOPLASTIC COAL TAR EMULSION MICRO-SURFACE, MICRO-SURFACE TYPE B

629-3.1 QUANTITIES OF MATERIALS PER SQUARE YARD.

Based on the data in this specification, the Contractor shall submit the proportions of water, thermoplastic coal tar emulsion, and aggregate proposed for use to the Engineer for approval prior to the start of operations. A copy of the mix design and test data required by this specification shall be submitted to the Engineer for approval along with the above information. No thermoplastic coal tar emulsion micro-surface shall be produced for payment until a job mix formula has been approved in writing by the Engineer.

The approximate amounts of materials per square yard (square meter) for the micro-surface treatment shall be as provided in the Application Rate table.

<table>
<thead>
<tr>
<th>Aggregate Type</th>
<th>Composition i lbs/gal (kg/l)</th>
<th>Application Rate ii lb/yd² (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>19-21 (2.28-2.52)</td>
<td>6.5</td>
</tr>
</tbody>
</table>

i. Aggregate (lbs) shall be mixed homogeneously with the thermoplastic coal tar emulsion (gals).

ii. Minimum application rate of uncured thermoplastic coal tar emulsion micro-surface.

629-3.2 AGGREGATE.

The aggregate shall consist of sound, durable crushed igneous type stone (crushed basalt, granite, trap rock, etc.), be free from films of matter that would prevent thorough coating and bonding with the bituminous material and free from coatings of clay, organic matter, and other deleterious materials. The percentage of wear shall not be greater than 35% when tested in accordance with ASTM C131. The aggregate shall meet the gradation in the table below for Type A and for Type B when tested in accordance with ASTM C136.

The Contractor shall provide a certification showing particle size analysis and properties of the material delivered for use on the project.
629-3.3 APPLICATION

a. **Application of tack coat.** After preparation of the pavement and acceptance by the Engineer, the tack coat shall be applied to the pavement surface only where micro-surface will be applied. Apply a tack coat of thermoplastic coal tar emulsion diluted with 50% water at the rate of 0.10 gallons of mix per square yard (0.45 l/m²).

b. **Application of micro-surface.** The surface shall be pre-wet by fogging ahead of the spreader box. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the spreader box. If temperatures are in the colder acceptable range the rate of fogging may be decreased. The mixture shall be of the desired consistency when deposited on the surface, and no additional elements shall be added. A sufficient amount of mixture shall be carried in the spreader box at all times so that even distribution is obtained. No clumped or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate will be permitted.

Upon completion of the work, the thermoplastic coal tar emulsion micro-surface shall have no bare spots or cracks through which liquids or foreign matter could penetrate to the underlying pavement. The finished surface shall present a uniform texture.

In areas where the spreader box cannot be used, the thermoplastic coal tar emulsion micro-surface shall be applied by a means of a hand squeegee.

629-3.4 FRICTION CHARACTERISTICS.

For projects where thermoplastic coal tar emulsion spray seal coat is applied on runway and taxiway surfaces, the Contractor shall submit to the Engineer friction tests, from previous airport projects which used the thermoplastic coal tar emulsion spray seal coat in a similar environment, in accordance with AC 150/5320-12, at 40 or 60 mph (65 or 95 km/h) wet, showing, as a minimum; friction value of pavement surface prior to thermoplastic coal tar emulsion spray seal coat 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 thermoplastic coal tar emulsion spray seal coat application. The results of the two tests between 24 and 96 hours shall indicate friction is increasing at a rate to obtain similar friction value of the pavement surface prior to application, and the long term test shall indicate no apparent adverse effect with time relative to friction values and existing pavement surface. The Contractor shall submit to the Engineer a list of airports which meet the above requirements, as well as technical details on application rates, aggregate rates, and point of contact at these airports to confirm use and success of thermoplastic coal tar emulsion spray seal coat with aggregate. Friction tests shall be submitted from no less than one of the airports on the list and each set of tests described above, must be from one project.

The thermoplastic coal tar emulsion spray seal coat submittal without the required friction performance will...
CONSTRUCTION METHODS

629-4.1 WORKER SAFETY.

The thermoplastic coal tar emulsion surface treatment product shall be handled with caution. The Contractor shall obtain a MSDS for both the thermoplastic coal tar emulsion product and sand and require workmen to follow the manufacturer’s recommended safety precautions.

629-4.2 WEATHER LIMITATIONS.

The material shall not be applied when the humidity or impending weather conditions will not allow proper drying or when the atmospheric or pavement temperature is below 50°F (10°C), unless otherwise directed by the Engineer.

During application of thermoplastic coal tar emulsion surface treatment, account for wind drift. Cover existing buildings, structures, 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. Should thermoplastic coal tar emulsion surface treatment get on any light or marker fixture, promptly clean the fixture. If cleaning is not satisfactory to the Engineer, the Contractor shall replace any light, sign or marker with equivalent equipment at no cost to the Owner.

629-4.3 APPLICATION EQUIPMENT

a. Mobile mixing machine. The mobile mixing machine shall be a truck-mounted mobile mixing plant with a towed-type spreader box. It shall have a water tank and water pump capable of delivering a constant volume of water.

The mobile mixing machine shall have an agitated storage tank for the thermoplastic coal tar emulsion and a non-shearing peristaltic pump with variable rate of flow for the delivery of this material. The mobile mixing machine shall have a hopper for holding aggregate, supplying this material to the mixing chamber by a conveyor belt. The rate of aggregate delivery shall be volumetrically controlled by an adjustable gate opening. The speed of the conveyor shall be mechanically dependent upon the speed of the peristaltic pump.

The mobile mixing machine shall be 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 shall deliver the materials to the mixing chamber in a constant proportion in a manner not dependent on power plant or vehicle speed. The machine shall be equipped with a water spray bar capable of fogging the pavement surface to aid in the application process.

Attached to the mixing machine shall be a mechanical-type squeegee distributor, equipped with flexible material in contact with the surface to prevent loss of material from the distributor. It shall be maintained to prevent loss of micro-surfacing on varying grades and adjusted to assure uniform spread. The spreader box may have an adjustable width.

Batch mixing machine. The batch-mixing machine shall be either a truck-mounted 500 to 3,000 gallon (1893 to 11356 liter) tank or a self-propelled batch mixing machine 300 to 1000 gallons (1136 to 3785 liters) containing suitably driven mixing blades to combine predetermined quantities of thermoplastic emulsion, aggregate if specified and if necessary, water into a homogeneous mixture. It shall be equipped with a water tank and diaphragm style pump capable of delivering a constant volume of material to a spray wand or spray bar. The device shall have a bottom ball valve of 3 inches (75 mm) diameter capable of delivering material to a squeegee spreader or a drag box.

b. Auxiliary equipment. Other tools or equipment such as power brooms, power blowers, air compressors, hand brooms, hand squeegees, etc., shall be provided as required.
629-4.4 TEST AREAS AND TEST SECTIONS.

A qualified manufacturer’s representative shall be present in the field to assist the Contractor in applying test areas and/or test sections to determine the optimum application rate. A test area and/or section shall be applied for each differing hot mix asphalt (HMA) pavement surface identified in the project. The test area(s) and/or test section(s) shall be used to determine the material application rate(s) prior to full production. The same equipment and method of operation shall be utilized on the test area(s) and/or test section(s) as will be utilized on the remainder of the work.

a. For Taxiway, taxilane and apron surfaces. Prior to full application, the Contractor shall place test areas at varying application rates as specified by the manufacturer’s representative and Engineer to determine application rate(s). The test areas will be located on representative section(s) of the pavement to receive the Thermoplastic coal tar emulsion spray seal coat designated by the Engineer.

b. For spray seal coat on runway and taxiway surfaces. Prior to full application, the Contractor shall place a series of test sections a minimum of 300 feet (90 m) long by 12 feet (3.6 m) wide, or width of anticipated application, whichever is greater, at varying application rates as stipulated by the manufacturer’s representative and Engineer to determine application rate(s). The area to be tested will be located on a representative section of the pavement to receive the Thermoplastic coal tar emulsion spray seal coat designated by the Engineer. Before beginning the test section(s), the skid resistance of the existing pavement shall be determined for each test section with a continuous friction measuring equipment (CFME). The skid resistance test after application shall be at approximately the same location as the test done on the existing pavement. The Contractor may begin testing the skid resistance of runway and taxiway test sections after application of the Thermoplastic coal tar emulsion spray seal has fully cured. Aircraft shall not be permitted on the runway or taxiway test sections for a minimum of 24 hours and until such time as the Contractor validates that its surface friction meets AC 150/5320-12. The results of the friction evaluation meet or exceed the Maintenance Planning levels provided in Table 3-2, “Friction Level Classification for Runway Pavement Surfaces,” 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 95 km/h) wet with approved CFME.

If the test section should prove to be unsatisfactory, necessary adjustments to the application rate, placement operations, and equipment shall be made. Additional test sections shall be placed and additional skid resistance tests performed and evaluated. Full production shall not begin without the Engineer’s approval of an appropriate application rate(s). Acceptable test sections shall be paid for in accordance with paragraph 629-8.1.

629-4.5 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, shall be in accordance with paragraph 101-3.6.

629-4.6 APPLICATION.

Application shall be in accordance with paragraph 629-3.3.

629-4.7 CURING.

The mixture shall be permitted to dry for a minimum of 24 hours after the application, before opening to traffic or painting, and shall be sufficiently cured to drive over without damage to the installation. Any damage to the uncured mixture will be the responsibility of the Contractor to repair.
QUALITY CONTROL

629-5.1 MANUFACTURER’S REPRESENTATION.

The manufacturer’s representative shall have knowledge of the material, procedures, and equipment described in the specification and shall be responsible for determining the application rates and shall oversee the preparation and application of the thermoplastic coal tar emulsion surface treatment. Documentation of the manufacturer representative’s experience and knowledge for applying the thermoplastic coal tar emulsion surface treatment shall be furnished to the Engineer a minimum of 10 work days prior to placement of the test sections. The cost of the manufacturer’s representative shall be included in the bid price.

629-5.2 CONTRACTOR QUALIFICATIONS.

The Contractor shall provide the Engineer contractor qualifications for applicators, personnel and equipment. The Contractor shall also provide, from the thermoplastic coal tar emulsion Manufacturer, documentation that the Contractor is certified to apply the thermoplastic coal tar emulsion surface treatment. Contractor shall provide documentation for at least three (3) applications similar to this project completed in the past two (2) years.

MATERIAL ACCEPTANCE

629-6.1 FRICTION TESTS.

Friction Test in accordance with AC 150/5320-12, Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces, shall be accomplished on all runway and taxiways that have received a seal coat. The Contractor shall coordinate testing with the Engineer. Each test includes performing friction tests at 40 mph and 60 mph (65 and 95 km/h) both wet, 15 feet (4.5 m) to each side of runway centerline. Friction test shall be run within 30 days prior to application of the seal coat to runway and/or high-speed taxiways and after application of the seal coat. The Engineer shall be present for testing. The Contractor shall provide a written report of friction test results.

METHOD OF MEASUREMENT

629-7.1 MEASUREMENT.

The Thermoplastic Coal Tar Emulsion Micro-Surface Type B shall be measured by the actual square yardage of the area indicated on the contract drawings or designated by the Engineer.

BASIS OF PAYMENT

629-8.1 PAYMENT.

Payment shall be made at the contract unit price per square yard for the Thermoplastic Coal Tar Emulsion Micro-Surface Type B. This price shall fully compensate 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.

Payments will be made under:

Item P-629-8.1 Thermoplastic Coal Tar Emulsion - Micro-Surface Type B – per square yard

TESTING REQUIREMENTS

The publications listed below form a part of this specification to the extent referenced. The publications

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are referred to in this text by basic designation only.


ASTM C136    Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM D3699   Standard Specification for Kerosene
ASTM D36     Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D244    Standard Test Methods and Practices for Emulsified Asphalts
ASTM D5340   Standard Test Method for Airport Pavement Condition Index Surveys
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
1. **Scope**
   This method determines the resistance of the thermoplastic coal tar emulsion surface treatment to kerosene.

2. **Apparatus**
   2.1 Two 6" × 6" (150 mm × 150 mm) square 16 gauge sheet metal masks with a 4" × 4" (100 mm × 100 mm) square center removed.
   2.2 6" × 6" (150 mm × 150 mm) unglazed white ceramic tile with an absorption rate of 10-18% (determined in accordance with ASTM C67).
   2.3 Brass ring, 2" (50 mm) diameter and 2" (50 mm) high.
   2.4 Kerosene meeting requirements of ASTM D3699.
   2.5 Silicone rubber sealant.

3. **Procedure**
   3.1 Immerse the ceramic tile in distilled water for a minimum of ten minutes.
   3.2 Remove excess water from the tile to produce a damp surface before applying the thermoplastic coal tar emulsion surface treatment.
   3.3 Using the mask described in 2.1 apply thermoplastic coal tar emulsion surface treatment as specified to the tile. Spread even with the top of the mask using a spatula or other straightedge.
   3.4 Allow the sample to cure for 96 hours at 77 ±2°F. and 50 ±10% relative humidity.
   3.5 After curing, affix the brass ring to the thermoplastic coal tar emulsion surface treatment on the tile with silicone rubber sealant.
   3.6 Fill the brass ring with kerosene.
   3.7 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.
   3.8 Evaluate for penetration of kerosene through the thermoplastic coal tar emulsion surface treatment and loss of adhesion.

4. **Report**
   4.1 Report the results as pass or fail. Visible evidence of leakage or discoloration shall constitute failure of the fuel resistance test.

5. **Criterion:** A “pass” rating in the fuel resistance test is required prior to full production.

END OF ITEM P-629
ITEM D-705 PIPE UNDERDRAINS FOR AIRPORTS

DESCRIPTION

705-1.1 This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

705-2.1 GENERAL.
Materials shall meet the requirements shown on the plans and specified below.

705-2.2 PIPE.
The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

- 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
- 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 F794 Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
- ASTM F2562 Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

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705-2.3 JOINT MORTAR.
Pipe joint mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

705-2.4 ELASTOMERIC SEALS.
Elastomeric seals shall conform to the requirements of ASTM F477.

705-2.5 POROUS BACKFILL.
Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

Table 1. Gradation of Porous Backfill

<table>
<thead>
<tr>
<th>Sieve Designation (square openings)</th>
<th>Percentage by Weight Passing Sieves</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Porous Material No. 1</td>
</tr>
<tr>
<td>1-1/2 inch (38 mm)</td>
<td>100</td>
</tr>
<tr>
<td>1 inch (25 mm)</td>
<td></td>
</tr>
<tr>
<td>3/8 inch (9 mm)</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>95 – 100</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td></td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
<td>45 – 80</td>
</tr>
<tr>
<td>No. 50 (0.30 mm)</td>
<td>10 – 30</td>
</tr>
<tr>
<td>No. 100 (0.15 mm)</td>
<td>0 – 10</td>
</tr>
</tbody>
</table>

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

705-2.6. GRANULAR MATERIAL.
Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials, or shall meet the requirements of AASHTO Standard Specification for Highway Bridges Section 30.

705-2.7. FILTER FABRIC.
The filter fabric shall conform to the requirements of AASHTO M288 Class 2.

Table 2

<table>
<thead>
<tr>
<th>Fabric Property</th>
<th>Test Method</th>
<th>Test Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grab Tensile Strength, lbs</td>
<td>ASTM D4632</td>
<td>125 min</td>
</tr>
<tr>
<td>Grab Tensile Elongation %</td>
<td>ASTM D4632</td>
<td>50 min</td>
</tr>
<tr>
<td>Burst Strength, psi</td>
<td>ASTM D3785</td>
<td>125 min</td>
</tr>
<tr>
<td>Trapezoid Tear Strength, lbs</td>
<td>ASTM D4533</td>
<td>55 min</td>
</tr>
<tr>
<td>Puncture Strength, lbs</td>
<td>ASTM D4833</td>
<td>40 min</td>
</tr>
<tr>
<td>Abrasion, lbs</td>
<td>ASTM D4886</td>
<td>15 max loss</td>
</tr>
</tbody>
</table>
Fabric Property | Test Method | Test Requirement
--- | --- | ---
Equivalent Opening Size | ASTM D4751 | 70-100
Permittivity sec^{-1} | ASTM D4491 | 0.80
Accelerated Weathering (UV Stability) (Strength Retained - \%) | ASTM D4355 *(500 hrs exposure) | 70

705-2.8. CONTROLLED LOW-STRENGTH MATERIAL (CLSM).
CLSM is not allowed. Structural concrete material shall conform to the requirements of Item P-610. When Structural Concrete is used, all joints shall have elastomeric seals.

705-2.9. STRUCTURAL CONCRETE. Structural concrete material shall conform to the requirements of Item P-610. When structural concrete is used, all joints shall have elastomeric seals.

CONSTRUCTION METHODS

705-3.1 EQUIPMENT.
All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the Engineer before construction is permitted to start.

705-3.2 EXCAVATION.
The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The Engineer shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the Engineer. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor’s expense with material approved by the Engineer and compacted to the density of the surrounding material.

The pipe bed shall be shaped so at least the lower quarter of the pipe shall be in continuous contact with the bottom of the trench. Spaces for the pipe bell shall be excavated to allow the pipe barrel to support the entire weight of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to Federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.
705-3.3 LAYING AND INSTALLING PIPE.

a. **Concrete pipe.** The laying of the pipe in the finished trench shall be started at the lowest point and proceed upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground. Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and relaid by the Contractor at no additional expense.

b. **Metal pipe.** The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands that is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint. During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

c. **PVC or polyethylene pipe.** PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321 or AASHTO Standard Specification for Highway Bridges Section 30. Perforations shall meet the requirements of AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans.

d. **All types of pipe.** The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the Engineer.

Unless otherwise shown on the plans, a 4 inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

e. **Filter fabric.** The filter fabric shall be installed in accordance with the manufacturer’s recommendations, or in accordance with AASHTO M288 Appendix, unless otherwise shown on the plans.

705-3.4 MORTAR.

The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

705-3.5 JOINTS IN CONCRETE PIPE.

When open or partly open joints are required or specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, mortar shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 in Table 1 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches (75 mm) nor more than 6 inches (150 mm), unless otherwise shown on the plans.
When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2 (Table 1), as shown on the plans or as directed by the Engineer.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the Engineer.

705-3.6 BACKFILLING.

a. Earth. All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The backfill material shall be select material from excavation or borrow and shall be approved by the Engineer. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and one foot (30 cm) over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the Engineer. The material shall be moistened or dried, as required to aid compaction. Placement of the backfill shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe, and not exceeding 8 inches (200 mm) over the pipe. Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the Engineer, until the trench is completely filled and brought to the planned elevation. Backfilling shall be done to avoid damaging top or side pressures on the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

b. Granular backfill. When granular backfill is required, placement in the trench and about the pipe shall be as shown on the plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the granular backfill. When required by the Engineer, a template shall be used to properly place and separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressures on the pipe. The granular backfill shall extend to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor’s expense.

If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains...
shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

c. **Controlled low-strength material (CLSM).** CLSM is not allowed.

d. **Structural Concrete.** Structural concrete for encasing underdrain pipe for pavement crossings shall conform to the requirements of P-610.

e. **Deflection testing.** The Engineer may at any time, notwithstanding previous material acceptance, reject or require re-installation of pipe that exceeds 5% deflection when measured in accordance with ASTM D2321, including Appendices.

### 705-3.7 CONNECTIONS.

When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

### 705-3.8 CLEANING AND RESTORATION OF SITE.

After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the Engineer. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

### METHOD OF MEASUREMENT

#### 705-4.1

The length of pipe shall be the number of linear feet of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

#### 705-4.2

The quantity of porous backfill shall not be paid for directly but shall be considered subsidiary to installation of the underdrain pipe.

#### 705-4.3

The quantity of filter fabric shall not be paid for directly but shall be considered subsidiary to installation of the underdrain pipe.

### BASIS OF PAYMENT

#### 705-5.1

Payment will be made at the contract price as shown below. These prices shall fully compensate the Contractor for furnishing all materials; for all preparation, excavation, and installation for all labor, equipment, tools, and incidentals necessary to complete the item.

These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

- **Item D-705-5.1**  Perforated Underdrain (8") (Schedule 40 PVC) – per linear foot
- **Item D-705-5.2**  Single Underdrain Cleanout – per Each
Item D-705-5.3  Non-Perforated Underdrain (8") (Schedule 40 PVC) – per linear foot

Item D-705-5.4  Connect Underdrain Pipe to Structure – per Each

**MATERIAL REQUIREMENTS**

- **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 D3034**  Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- **ASTM F477**  Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- **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
- **AASHTO M190**  Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches
- **AASHTO M196**  Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
- **AASHTO M252**  Standard Specification for Corrugated Polyethylene Drainage Pipe
- **AASHTO M288**  Standard Specification for Geotextile Specification for Highway Applications
- **AASHTO M294**  Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
- **AASHTO M304**  Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
- **AASHTO MP20**  Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter
AASHTO Standard Specifications for Highway Bridges

END OF ITEM D-705
Item D-751

MANHOLES, CATCH BASINS, INLETS AND INSPECTION HOLES

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the Engineer.

751-1.2 Submittals. Shop drawings of each component shall be submitted to the Engineer for review and approval prior to fabrication. The submittal shall include the proposed method of installation for all components. The submittal shall include data on all component parts of this item. The data shall be sufficient, in the opinion of the Engineer, to determine compliance with the contract documents. The complete submittal shall be signed and sealed by a Professional Engineer licensed to practice in the state of Texas.

MATERIALS

751-2.1 Brick. The brick shall conform to the requirements of ASTM C32, Grade MS.

751-2.2 Mortar. Mortar shall consist of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

751-2.3 Concrete. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610, Structural Portland Cement Concrete. Concrete produced by a reputable local supplier of ready-mix or transit-mix concrete designed for a minimum compressive strength of 4,000 psi at 28 days, unless otherwise specified, may be used when approved by the Engineer. The Contractor shall submit the ready-mix or transit-mix design to the Engineer at least 15 days prior to startup of construction.

751-2.4 Precast concrete pipe manhole rings. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole.

Precast concrete pipe manhole rings shall be designed to withstand a 250 psi tire pressure and shall meet the FAA loading conditions for heavy aircrafts.

751-2.5 Corrugated metal. Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

751-2.6 Frames, covers, and grates. The castings shall conform to one of the following requirements:

a. ASTM A48, Class 35B: Gray iron castings
b. ASTM A47: Malleable iron castings
c. ASTM A27: Steel castings
d. ASTM A283, Grade D: Structural steel for grates and frames
e. ASTM A536, Grade 65-45-12: Ductile iron castings
f. ASTM A897:Austempered ductile iron castings
All castings or structural steel units shall conform to the dimensions shown on the plans and shall be
designed to support the loadings, aircraft gear configuration and/or direct loading, specified. All castings
shall be designed to withstand a 250 psi tire pressure and loading conditions for heavy aircraft (FAA AC
150/5320-6E).

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being
dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet
the requirements of ASTM A123.

**751-2.7 Steps.** The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps
shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given
a coat of bituminous paint, when directed.

**751-2.8 Precast inlet structures.** Manufactured in accordance with and conforming to ASTM C1433.
Precast concrete structures shall be constructed on prepared or previously placed slab foundations and shall
conform to the dimensions and locations shown on the contract drawings. All precast concrete sections
necessary to build a completed structure shall be furnished. The different sections shall fit together readily
and all joints shall be sealed with a butyl rubber gasket type sealant. The top of the upper precast concrete
member shall be suitably formed and dimensioned to receive the metal frame and cover or grate as required.

**751-2.9 Reinforcing steel.** All reinforcing steel shall be deformed bars of new billet steel meeting the
requirements of ASTM A 615, Grade 60.

**751-2.10 Sealants.** Joints between precast concrete sections shall be sealed with a butyl rubber gasket type
sealant that meets all of the requirements of Federal Specification SS-S-210A, Sealing Compound,
Preformed Plastic, for Expansion Joints and Pipe Joints.

**751-2.11 Submittals.** Shop drawings, catalogue data and certifications shall be submitted in accordance
with appropriate sections of the specifications. Submittals required are as follows:

a. Certifications and concrete mix design submittals in accordance with Item P-610, Structural Portland
   Cement Concrete;

b. Catalogue data and certifications that castings meet the requirements specified.

c. Catalogue data and certification that ladders meet the requirements specified.

d. Certification that reinforcing steel meets the requirements specified.

e. Submittal of strength design calculations, shop drawings and certifications for precast units.

**CONSTRUCTION METHODS**

**751-3.1 Unclassified excavation.**

a. The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown
on the plans, or as staked by the Engineer. The excavation shall be of sufficient size to permit the
placing of the full width and length of the structure or structure footings shown. The elevations of the
bottoms of footings, as shown on the plans, shall be considered as approximately only; and the Engineer
may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory
foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All
rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface
either level, stepped, or serrated, as directed by the Engineer. All seams or crevices shall be cleaned out
and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest
on a surface other than rock, the bottom of the excavation shall not be disturb and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. All bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After excavation is completed for each structure, the Contractor shall notify the Engineer. No concrete or reinforcing steel shall be placed until the Engineer has approved the depth of the excavation and the character of the foundation material.

751-3.2 Brick structures. (Temporary Structures Only)

a. Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item P-610.

b. Laying brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it that can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretcher and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and relaid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

c. Joints. All joints shall be filled with mortar at every course Exterior faces shall be laid up in advance of backing. Exterior faces shall be plastered or parged with a coat of mortar not less than 3/8 inch (9 mm) thick before the backing is laid up. Prior to parging, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than 1/4 inch (6 mm) nor more than 1/2 inch (12 mm) wide and the selected joint width shall be maintained uniform throughout the work.

d. Pointing. Face joints shall be neatly struck, using the weather-struck joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

e. Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing with water. If necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of water.

f. Curing and cold weather protection. The brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost on the brick or when the air temperature is below 50°F (10°C) unless the Contractor has, on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60°F (16°C) for the duration of the curing period.

Brick structures are only allowed for temporary structures.
751-3.3 **Concrete structures.** Concrete structures shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the Engineer before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

751-3.4 **Precast concrete structures.** Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal steps that are embedded or built into the side walls shall be aligned and placed at vertical intervals of 12 inches (300 mm). When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 **Corrugated metal structures.** Corrugated metal structures shall be prefabricated. All standard or special fittings shall be furnished to provide pipe connections or branches with the correct dimensions and of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to allow the fastening of a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, the structures shall be placed on a reinforced concrete base. Corrugated metal structures shall not be allowed.

751-3.6 **Inlet and outlet pipes.** Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

751-3.7 **Placement and treatment of castings, frames, and fittings.** All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the Engineer, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the Engineer. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

751-3.8 **Installation of steps.** The steps shall be installed as indicated on the plans or as directed by the Engineer. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least
seven (7) days. After seven (7) days, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete structures, they shall be cast into the side of the sections at the time the sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches.

Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the Engineer.

**751-3.9 Backfilling.**

a. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the Engineer.

b. Backfill shall not be placed against any structure until approved by the Engineer. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

c. Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

**751-3.10 Cleaning and restoration of site.** After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the Engineer. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

**751-3.11 Manhole / Inlet Frame Adjustment.** Combine the aircraft rated precast concrete adjustment rings so elevation of installed casting cover matches the finish grade or pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces joined with non-shrink grout. Set the frame to match the finish grade. The inlet opening and type shall match the existing opening and type unless otherwise stated.

**751-3.12 Manhole / Inlet Frame Adjustment/Aircraft Rating Modifications.** Raise existing manhole and provide a bridging slab to accommodate.

**METHOD OF MEASUREMENT**

**751-4.1** Manholes, catch basins, inlets, clean outs, and inspection holes shall be measured by the unit, completed in place and accepted. All required excavation, sheeting and bracing, all required backfilling, restoration of all surfaces, all required connections and dewatering shall be included as part of the unit completed.

**751-4.2** Temporary Maintenance of Storm Pipes and Structures shall be measured on a per month basis for a period of up to 18 months. Measurement of time for this item shall not begin before the substantial
completion of the Base Bid (Bid Schedule A) work unless by mutual agreement of the owner and contractor. A month shall be measured from any given calendar day of one month to the same calendar day of the following month. If the owner determines that this work is no longer necessary before the full 18 month period has elapsed then the contractor shall be paid a prorated amount for the days they were responsible for maintenance in the incomplete month.

Inlet or Manhole Adjustment shall be measured by the unit, completed in place and accepted. All required excavation, sheeting, and bracing, all required backfilling, and removal and restoration of adjacent surfaces shall be included as part of the unit completed.

**BASIS OF PAYMENT**

**751-5.1** The accepted quantities of manholes, catch basins, inlets, cleanouts, and inspection holes will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling, dewatering, trench bracing 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.

**751-5.2** Temporary Maintenance of Storm Pipes and Structures shall be paid on a per month basis for a period of up to 18 months at the contract unit price for each month of maintenance provided. If less than a full month is completed then the contractor shall be paid a prorated amount based on the number of days they were responsible for maintenance. This price shall be full compensation for furnishing all materials, equipment, and labor; and for all preparation, excavation, backfilling, dewatering, trench bracing, or other work that may be required to ensure proper drainage in the constructed system.

Inlet or Manhole Adjustment will be paid for at the contract unit price bid per each. This price shall be full compensation for all furnishing all materials, and for preparation, excavation, backfilling, and placing of materials; furnishing and installation of such specials as may be required to complete the item; and for all labor, equipment, tools, and incidentals necessary to make elevation adjustments to the structure.

Payment will be made under:

- **Item D-751-5.1** 3’ x 3’ Grate Inlet Over Existing Storm Sewer - per each
- **Item D-751-5.2** Inlet or Manhole Adjustment - per each

**MATERIAL REQUIREMENT**

- **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)
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ITEM T-904 SODDING

DESCRIPTION

904-1.1 This item shall consist of furnishing, hauling, and placing approved live sod on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the Engineer.

MATERIALS

904-2.1 SOD. Sod furnished by the Contractor shall have a good cover of living or growing grass. This shall be interpreted to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted turf relatively free of weeds or other undesirable foreign plants, large stones, roots, or other materials that might be detrimental to the development of the sod or to future maintenance. At least 70% of the plants in the cut sod shall be composed of the species stated in the special provisions, and any vegetation more than six (6) inches (150 mm) in height shall be mowed to a height of three (3) inches (75 mm) or less before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness of two (2) inches not less than that stated in the special provisions.

a. Species: Bermuda (Cynodon Dactylon), Buffalo (Buchloe Dactyloides), or St. Augustine (Stenotaphrum Secundatum) Gulf Coast variety to match existing sod.

b. Contents: 95 percent permanent grass suitable to climate in which it is to be placed; not more than 5 percent weeds and undesirable grasses; good texture, free from obnoxious grasses, roots, stones and foreign materials.

c. Sod is to be supplied and maintained in healthy condition as evidenced by grass being normal green color.

904-2.2 LIME.

Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 mesh sieve and 50% will pass through a No. 100 mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate of [ ]. All liming materials shall conform to the requirements of ASTM C602.

904-2.3 FERTILIZER. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
c. A granular or pellet form suitable for application by blower equipment.

Caked, damaged, or otherwise unsuitable fertilizer will not be accepted. Fertilizer shall contain minimum percentages of following elements:

   a. Nitrogen: 12 Percent
   b. Phosphoric Acid: 4 Percent
   c. Potash: 8 Percent

Fertilizers shall be [ ] commercial fertilizer and shall be spread at the rate of 25 pounds per 1,000 square feet, minimum.

This item will not be measured for separate payment but shall instead be considered subsidiary to the cost of seed application.

904-2.4 WATER.

The water shall be sufficiently free from oil, acid, alkali, salt, or other harmful materials that would inhibit the growth of grass. It shall be subject to the approval of the Engineer prior to use.

904-2.5 SOIL FOR REPAIRS.

The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials, larger than 2 inches, that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the Engineer before being placed.

CONSTRUCTION METHODS

904-3.1 GENERAL.

Areas to be solid, strip, or spot sodded shall be shown on the plans. Areas requiring special ground surface preparation such as tilling and those areas in a satisfactory condition that are to remain undisturbed shall also be shown on the plans.

Suitable equipment necessary for proper preparation of the ground surface and for the handling and placing of all required materials shall be on hand, in good condition, and shall be approved by the Engineer before the various operations are started. The Contractor shall demonstrate to the Engineer before starting the various operations that the application of required materials will be made at the specified rates.

904-3.2 PREPARING THE GROUNDSURFACE.

After grading of areas has been completed and before applying fertilizer and limestone, areas to be sodded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris which might interfere with sodding, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes occurs after grading of areas and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

904-3.3 APPLYING FERTILIZER AND GROUND LIMESTONE.

Following ground surface preparation, fertilizer shall be uniformly spread at a rate which will provide not less than the minimum quantity of each fertilizer ingredient, as stated in the special provisions herein. If use of ground limestone is required, it shall then be spread at a rate that will provide not less than the minimum quantity stated in the special provisions. These materials shall be incorporated into the soil to a depth of not
less than 2 inches (50 mm) by discing, raking, or other suitable methods. Any stones larger than 2 inches (50 mm) in any diameter, large clods, roots, and other litter brought to the surface by this operation shall be removed.

**904-3.4 OBTAINING AND DELIVERING SOD.**

After inspection and approval of the source of sod by the Engineer, the sod shall be cut with approved sod cutters to such a thickness that after it has been transported and placed on the prepared bed, but before it has been compacted, it shall have a uniform thickness of not less than 2 inches (50 mm). Sod sections or strips shall be cut in uniform widths, not less than 10 inches (250 mm), and in lengths of not less than 18 inches (0.5 m), but of such length as may be readily lifted without breaking, tearing, or loss of soil. Where strips are required, the sod must be rolled without damage with the grass folded inside. The Contractor may be required to mow high grass before cutting sod.

The sod shall be transplanted within 24 hours from the time it is stripped, unless circumstances beyond the Contractor’s control make storing necessary. In such cases, sod shall be stacked, kept moist, and protected from exposure to the air and sun and shall be kept from freezing. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. Where the soil is too dry, permission to cut sod may be granted only after it has been watered sufficiently to moisten the soil to the depth the sod is to be cut.

**904-3.5 LAYING SOD.**

Sodding shall be performed only during the seasons when satisfactory results can be expected. Frozen sod shall not be used and sod shall not be placed upon frozen soil. Sod may be transplanted during periods of drought with the approval of the Engineer, provided the sod bed is watered to moisten the soil to a depth of at least 4 inches (100 mm) immediately prior to laying the sod.

The sod shall be moist and shall be placed on a moist earth bed. Pitch forks shall not be used to handle sod, and dumping from vehicles shall not be permitted. The sod shall be carefully placed by hand, edge to edge and with staggered joints, in rows at right angles to the slopes, commencing at the base of the area to be sodded and working upward. The sod shall immediately be pressed firmly into contact with the sod bed by tamping or rolling with approved equipment to provide a true and even surface, and ensure knitting without displacement of the sod or deformation of the surfaces of sodded areas. Where the sod may be displaced during sodding operations, the workmen, when replacing it, shall work from ladders or treaded planks to prevent further displacement. Screened soil of good quality shall be used to fill all cracks between sods. The quantity of the fill soil shall not cause smothering of the grass. Where the grades are such that the flow of water will be from paved surfaces across sodded areas, the surface of the soil in the sod after compaction shall be set approximately one inch (25 mm) below the pavement edge. Where the flow will be over the sodded areas and onto the paved surfaces around manholes and inlets, the surface of the soil in the sod after compaction shall be placed flush with pavement edges.

On slopes steeper than one (1) vertical to 2-1/2 horizontal and in v-shaped or flat-bottom ditches or gutters, the sod shall be pegged with wooden pegs not less than 12 inches (300 mm) in length and have a cross-sectional area of not less than 3/4 sq inch (18 sq mm). The pegs shall be driven flush with the surface of the sod.

**904-3.6 WATERING.**

Adequate water and watering equipment must be on hand before sodding begins, and sod shall be kept moist until it has become established and its continued growth assured. In all cases, watering shall be done in a manner that will avoid erosion from the application of excessive quantities and will avoid damage to the finished surface. The Contractor will be required to water sodded areas three days per week until the sod is well established, has good color and is approved by the Engineer. The Contractor shall water every other day such that the sod is watered at least three times per week. It is imperative that the Contractor water consistently to ensure proper sod growth. Water of areas previously opened to traffic will need to occur at
904-3.7 ESTABLISHING TURF.

a. **General.** The Contractor shall provide general care for the sodded areas as soon as the sod has been laid and shall continue until final inspection and acceptance of the work.

b. **Protection.** All sodded areas shall be protected against traffic or other use by warning signs or barricades approved by the Engineer.

c. **Mowing.** The Contractor shall mow the sodded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. In the event that weeds or other undesirable vegetation are permitted to grow to such an extent that, either cut or uncut, they threaten to smother the sodded species, they shall be mowed and the clippings raked and removed from the area. The Contractor shall mow installed vegetated areas so that the grass height is maintained between six (6) and twelve (12) inches at no expense to the Owner.

904-3.8 REPAIRING.

When the surface has become gullied or otherwise damaged during the period covered by this contract, the affected areas shall be repaired to re-establish the grade and the condition of the soil, as directed by the Engineer, and shall then be sodded as specified in paragraph 904-3.5.

904-3.9 MAINTENANCE OF SODDED AREAS.

The Contractor shall protect sodded areas against traffic or other use by warning signs or barricades, as approved by the Engineer. Surfaces gullied or otherwise damaged following sodding shall be repaired by regrading and resodding as directed. The Contractor shall mow, water as directed, and otherwise maintain sodded areas to the conditions as specified herein until final inspection and acceptance of the work.

METHOD OF MEASUREMENT

904-4.1 This item shall be measured on the basis of the area in square yards of the surface covered with sod and accepted.

BASIS OF PAYMENT

T-904-5.1 This item will be paid for on the basis of the contract unit price per square yard for sodding, which price shall be full compensation for all labor, equipment, material, staking, maintenance, and incidentals necessary to satisfactorily complete the items as specified.

Payment will be made under:

Item T-904-5.1 Sodding, Fertilizer - per square yard

MATERIAL REQUIREMENTS

ASTM C602 Standard Specification for Agricultural Liming Materials

END OF ITEM T-904
PART 1  GENERAL

1.01 SECTION INCLUDES

A. This item is intended to supplement the specifications for the Airfield Electrical, Lighting and Lighting Control requirements of this contract. It is the intent and meaning of the Plans and Specifications that the Contractor shall provide an electrical installation that is operational and complete, including all items and appurtenances necessary, reasonably incidental or customarily included, even though each and every item is not specifically called out or shown.

B. Installations and construction under these provisions shall be coordinated with the Airport Construction Manager. Specification requirements for approvals, reviews, or other involvements of the Engineer shall be transmitted by the Contractor through the Construction Manager to the Engineer.

1.02 APPLICABLE CODES AND STANDARDS.

A. Codes. All electrical work shall conform with the requirements and recommendations of the latest edition of the National Electrical Code. In conflicts among drawings, specifications and codes, the most stringent requirements shall govern.

B. Standards. The specifications and standards of the following organizations are by reference made part of these specifications and all electrical work, unless otherwise indicated, shall comply with their requirements and recommendations wherever applicable.

1. Institute of Electrical and Electronic Engineers (IEEE)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. Insulated Power Cable Engineers Association (ICEA)
5. National Institute of Standards and Technology (NIST).
6. National Electrical Contractor's Association (NECA)
7. National Electrical Manufacturer's Association (NEMA)
8. National Fire Protection Association (NFPA)
9. Underwriter's Laboratories, Inc. (UL)
PART 2  QUALITY ASSURANCE

2.01 REQUIREMENTS OF REGULATORY AGENCIES

A. Airport lighting equipment and materials covered by FAA specifications shall be certified under the Airport Lighting Equipment Certification Program described in Advisory Circular (AC) 150/5345-53, current edition, and be listed in the current Addendum of the AC. All Advisory Circulars referenced in these specifications shall be the latest edition.

B. All other equipment and materials, covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the Engineer.

C. The requirements and recommendations of the latest edition of the Occupational Safety and Health Act are by reference made a part of these specifications and all electrical work shall comply with their requirements and recommendations wherever applicable.

2.02 WORKMANSHIP AND PERSONNEL REQUIREMENTS

A. All electrical work shall be performed by workmen skilled in the electrical trade and licensed for the work either by the City of Houston or State of Texas. The Houston Airport System Airport Building Official will recognize the credentials of Master Electricians with valid current licenses from Houston. Credentials will be recognized of Journeyman Electricians with valid current licenses from Houston or other licensing entities having established reciprocal agreements with these municipalities.

B. A licensed Master Electrician will be required for the issuance of a building permit for constructing, installing, altering, maintaining, repairing or replacing any electrical wiring, apparatus, or equipment on any voltage level in the jurisdiction of the Airport.

C. A licensed Master Electrician or a licensed Journeyman Electrician is required to be on the job site whenever any electrical work is performed. Any airfield electrical work or associated electrical installations shall be accomplished under the direct supervision of a licensed Journeyman Electrician.

D. To insure compliance with Paragraph "c" above, only a documented Electrical work force with a ratio of a maximum ration of 3 licensed Apprentices for each licensed Journeyman Electrician shall be allowed to work on the airfield electrical systems.

E. Contractor shall prepare documentation associated with the electrical work force confirming adherence to the requirements of Paragraph "d" above. These documents shall be submitted to the Construction Manager for approval. Also,
any work force changes or revisions which affect compliance with paragraph "d" above shall also be submitted to the Construction Manager for approval.

F. All airfield circuits will be handled throughout the installation process by qualified licensed electrical personnel.

G. Every airfield lighting cable splicer shall be qualified in making airfield cable splices and terminations on cables rated above 1,000 volts A.C. The Contractor shall submit for approval of the Construction Manager proof of the qualifications of each proposed cable splicer for the cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splice medium voltage cable at airports.

H. At least thirty (30) days prior to performing any cable splicing/terminating, Contractor shall submit to the Construction Manager a written list of proposed cable splicing/terminating personnel, including written evidence that the proposed personnel have had a minimum of eight (8) hours of technical training by authorized splice/termination kit manufacturer personnel. Approved training shall include a thorough review of kit components and splicing/terminating techniques and procedures. Field splices shall only be installed by technicians approved by the Construction Manager and by HAS maintenance superintendent.

I. In addition, each trained cable splicer shall be required to install a splice and a connector on type and size of the cable to be used under this contract. Sample connections shall be accomplished in accordance with the manufacturer's instructions and in the presence of the Construction Manager.

J. All communications work shall be performed under the direct supervision of a Building Industry Consulting Service International, Inc. (BICSI) registered Cabling Installer/Technician level.

K. The Contractor performing construction on the airfield electrical and/or communication system shall have a minimum of 5 years of experience on construction of projects of similar type of work and of similar size and complexity. The owner will require all Electrical Contractors bidding on this project to submit proof of experience that they have successfully completed at least two projects of comparative size and complexity within the past 5 years.

L. Electrical contractor qualifications shall be based on previous work experience as follows:

1. Installed at least 500 L868 bases into existing facilities that were paved via a slipform method.
2. Retro-Fit existing airfield lighting control systems in at least two installations of the size and complexity of this project.
3. Retro-Fit/Modifications to an existing FAA approach system (ALSF and MALSR).
4. Installed semiflush and elevated runway guard light systems.
5. Perform construction activities within an active CAT II AOA.

2.03 EQUIPMENT, MATERIAL AND INSTALLATION REQUIREMENTS

A. The Contractor shall furnish and install all materials, equipment, accessories, connections and incidental items in accordance with the approved recommendations of the manufacturer and the best practices of the trade to provide a complete installation ready for use and operational by the Owner.

B. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the manufacturer's name, trademark and ASME, UL, and/or other labels in every case where a standard had been established for the particular item.

C. Where applicable, equipment shall be FAA approved design of a standard product of a manufacturer regularly engaged in the production of the required type of equipment, and shall be supported by a service organization reasonably convenient to the site, as determined by the Construction Manager.

D. The Contractor shall promptly notify the Construction Manager in writing of any conflict between any requirements of the Contract Documents and equipment manufacturer's directions and shall obtain written instructions from the Construction Manager before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or such written instructions from the Construction Manager, Contractor shall bear all costs arising in correcting deficiencies.

E. After review of equipment submittals, and instructions by the Engineer to proceed, equipment installations may require arrangements or connections different from those shown on the drawings. It is the responsibility of the Contractor to install the equipment to operate properly. The Contractor shall provide any additional equipment and/or materials required for installations to operate in accordance with the intent of the drawings and specifications.

F. It is the responsibility of the Contractor to insure that items installed fit the space available with adequate room for proper equipment operation and maintenance. Contractor shall make field measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that the final installation provides a complete and operational system that complies with the requirements of the drawings and specifications.

G. The Contractor shall be responsible for coordinating proper location of roughing in and connections by other trades. Changes associated with coordination requirements shall be made at no increase in the Contract amount or additional costs to other trades.

H. The Contractor shall support work and equipment plumb, rigid and true to line.
The Contractor shall determine how equipment, fixtures, conduit, etc., are to be installed, as required by codes, drawings and specifications. Foundations, bolts, inserts, stands, hangers, brackets and accessories required for proper support shall be provided by the Contractor, whether or not specifically indicated on the drawings.

I. Uniform illumination levels for similar lighting systems throughout the airfield shall be installed. Contractor shall insure illumination levels for installed airfield edge or centerline lighting systems do not vary due to faulty installations from illumination levels of similar airfield lighting systems.

2.04 SUBMITTALS

A. Submit manufacturer's data or shop drawings of the following items giving full information as to the dimensions, materials, and other information required to define compliance with the specifications. Other items to be submitted are listed in the specification sections.

<table>
<thead>
<tr>
<th>Handholes/Manholes/ Pull Boxes and Accessories</th>
<th>Multi-hole Adapter Ring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ductbanks</td>
<td>Fixture Bases, and accessories</td>
</tr>
<tr>
<td>Conduit</td>
<td>L-823 Connectors</td>
</tr>
<tr>
<td>Support Hardware</td>
<td>Splice Kits</td>
</tr>
<tr>
<td>#8 5KV L-824C Cable</td>
<td>Identification Tags</td>
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<tr>
<td>#6 Stranded Counterpoise Wire</td>
<td>Ground Rods</td>
</tr>
<tr>
<td>Airfield Lighting Fixtures</td>
<td>Grounding</td>
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<tr>
<td>Airfield Fixture Lamps</td>
<td>Support Hardware</td>
</tr>
<tr>
<td>Isolation Transformers</td>
<td>Shop Drawings</td>
</tr>
<tr>
<td>Cadweld</td>
<td>Tape 3/8+</td>
</tr>
<tr>
<td>Dual Coated Orange Steel Bolts</td>
<td>Fixture Installation and Location</td>
</tr>
</tbody>
</table>

B. When requested by the Engineer, samples of these items shall be submitted for approval. Equipment/installation diagrams shall also be submitted for approval, as required by project specifications and/or requested by the Engineer.

C. Contractor submittal package shall include a typewritten list indicating each bid item, with a breakdown of all item components and all parts that are assembled or associated with bid item installation.

D. Submittal package list shall indicate: (1) Bid item number, (2) Part numbers of associated item components, as required and (3) Reference page number where item and components information is located in the submittal package. The contractor shall organize submittals so that common components to multiple bid items are not duplicated in the submittals.

E. Checking of submittals by the Engineer is done only as an aid to the Contractor and approval of submittals shall not relieve Contractor of responsibility for any
errors or omissions in the submittals, nor shall it relieve the Contractor of total responsibility for proper and complete execution of the job.

2.05 INSPECTION AND TESTING

A. All work performed by the Contractor shall be subject to periodic inspections by the City Engineer, the Owner's Representative, and the Owner's Construction Manager to verify that the installation is in compliance with the applicable requirements of these specifications.

B. System and component testing shall be performed as specified in Section 16031 - Airfield Electrical Installation Testing (Item L-111). Test results shall be evaluated by the Engineer, HAS PDC and the Construction Manager based upon the criteria indicated.

C. Any installation found which does not conform to the required technical provisions of these specifications or any specimen which does not meet the test criteria defined in Section 16031 - Airfield Electrical Installation Testing (Item L-111), shall be immediately removed by the Contractor and then replaced at his expense. When required, testing shall be performed on the new specimen in place to verify compliance with the criteria defined in Section 16031 - Airfield Electrical Installation Testing (Item L-111).

PART 3 CONSTRUCTION PROVISIONS

3.01 AOA AREA INSTALLATION PROVISIONS

A. To enhance personnel safety and avoid contractual problems, the Contractor shall comply with the provisions indicated below.

3.02 ELECTRICAL WORK PROVISIONS.

A. Existing Underground Utilities. At least forty-eight (48) hours prior to beginning any excavation within the AOA, locations of all utility lines and FAA cables in the construction area will be identified and marked with surveyor flags by appropriate utility and/or FAA personnel. The Contractor shall be responsible for maintaining the location flags. Any flags displaced shall be replaced by the Contractor. The Contractor shall coordinate with Construction Manager any additional prior notification time required during weekend and/or holiday work periods.

B. Also at least forty-eight (48) hours prior to beginning any excavation within the AOA, the contractor shall request the HAS construction manager to have airport staff identify circuits in proposed excavation areas. The Contractor shall coordinate with Construction Manager any additional prior notification time required during weekend and/or holiday work periods.
C. The above noted line identification information shall not relieve the Contractor of the responsibility of pinpointing underground lines to avoid unplanned disruptions or disturbing of installation or operation of underground lines in construction areas. Contractor shall use cable tracing equipment or other methods approved by the Construction Manager at his disposal, to pinpoint line locations. Excavation shall not proceed until all underground lines have been identified to the satisfaction of the Construction Manager.

D. Contractor shall hand excavate in areas of Airport underground electrical lines to avoid disturbing circuits such as FAA, telecom and NAVAIDS.

E. Repair of underground lines damaged by the Contractor shall be the sole responsibility of the Contractor.

F. Lockout Procedure. Contractor shall adhere to requirements of latest edition of Section 16013 - Recommended Lockout Procedure for Airfield Lighting Circuit.

3.03 TEMPORARY AND BYPASS CIRCUIT PROVISIONS

A. Refer to Section 16090 and the following: During construction, temporary or bypass wiring or cable installations may be required to maintain operation of certain equipment and/or airfield lighting circuits, as indicated in Construction Documents and/or as specified. Temporary/bypass circuit installations shall adhere to provisions indicated below.

1. General Requirements. Contractor shall review the requirements in the specifications and Construction Documents, including, but not restricted to: Phasing and Sequencing Plans, Demolition Plans and Wiring Diagrams. Contractor shall determine locations, sizes and quantities of temporary/bypass wiring and conduits required for project construction.

2. At least 14 days prior to commencement of installation of temporary/bypass wiring, the Contractor shall submit a layout of proposed temporary/bypass conduits and circuits to the Construction Manager for review and approval, including proposed installation protection provisions.

3. Equipment and Materials. Temporary/bypass wiring shall meet the requirements of Section 16113 - Installation of Underground Cable for Airports (Item L-108), and shall also conform to the Construction Plans. Temporary/bypass wiring shall be identified at junction points with brass tags as approved by the Construction Manager.

4. Installation. Temporary/bypass circuits shall be installed with due consideration to personnel safety and circuit protection against physical damage. All damage to existing circuits as a result of Contractor action or inaction shall be corrected accordingly at the Contractor's expense and corrective action approved by the Owner.

5. Temporary/bypass, high voltage lighting system cables shall be protected from damage by vehicles with suitable fencing, barriers and/or adequately sized boards or timbers.
6. Temporary/bypass circuits shall be removed immediately upon completion of construction or purpose for which the wiring was installed. Upon removal of boards or timbers fastened to the pavement surface to protect temporary/bypass circuits, the Contractor shall repair the pavement with materials and methods approved by the Construction Manager. Temporary/bypass cable and counterpoise shall be removed and discarded off the Airport by the Contractor.

3.04 EXISTING ELECTRICAL EQUIPMENT AND MATERIALS

A. The Contractor shall remove all existing wiring and electrical equipment made unnecessary by the new installation. All materials removed shall become property of the Contractor and disposed of by the Contractor. The Contractor shall list materials according to type, class and/or size, and store or dispose of materials as directed by the Construction Manager.

3.05 POWER SERVICE CONTINUITY

A. Provide labor, materials and supervision required to maintain full capacity power service continuity when connection or modifications are made to existing systems and facilities. Do not interrupt service without prior consent of the Construction Manager, with a definite understanding of time and duration of outage. All outages will take place at a time for minimum disruption of facility activity. Coordinate with Owner.

3.06 AS-BUILT DRAWINGS

A. The Contractor shall maintain a set of as-built drawings on the job site as required the General Provisions of the Contract. Contractor shall mark on the as-built drawings all work details, alterations installed to meet site conditions and changes made by Change Notices. As-built drawings shall be kept available for inspection by the Construction Manager and/or the City Engineer at all times.

B. Airfield wiring verification diagrams shall be maintained throughout the project and later submitted to HAS Planning, Design, and Construction upon completion. These field wiring diagrams shall depict the exact routing and number of cables installed in each conduit originating from the airfield lighting vaults and extending to each manhole, handhole, pullbox, sign, and lighting fixture for each new circuit or circuit revision.

PART 4 MEASUREMENT AND PAYMENT

4.01 There will be no separate measurement or payment on the work discussed in this section. All work will be considered incidental for complete installation of the work to which it is related.
RECOMMENDED LOCKOUT PROCEDURE
FOR AIRFIELD LIGHTING CIRCUIT

PART 1  GENERAL

1.01 DESCRIPTION

A. The Contractor is required to lockout the power source feeding any airfield lighting circuit that he will come in contact with (either by hand or with equipment) during the course of the workday. Coordinate with the Construction Manager and IAH Electric Shop, Airfield lighting circuits can be locked out with the approval of the Owners representative. They must be returned to service the same day unless prior arrangements have been made. Cloudy or overcast days may delay or cancel a scheduled lockout.

B. In order to gain access to the circuit power source, the Contractor will contact his Construction Manager (CM) at least 48 hours prior to the day and hour when the circuit lockout is required. The Contractor will identify, in writing, his work area and the circuit to be locked out.

C. The CM will then contact the Owners Representative or Center Point at least 24 hours in advance, with all the pertinent information, so the work may be scheduled, and verify that the circuit can be turned off as requested. The Owners Representative or Center Point will determine if the circuit can remain de-energized outside of daylight hours. Request for lockouts that occur on recognized holidays, or Saturdays and Sundays, or after normal working hours, (0800 to 1600), will require special notice. In this case the Owners Representative or Center Point must be notified a minimum of two regular working days in advance of the lockout occurrence. The Contractor, the CM, and the Owners Representative, if required, will meet at the vault for the lockout. The Contractor shall provide a 5000-volt, direct current megger. The megger shall be a 120-volt A.C. device, as opposed to a hand crank type, and calibrated within the last three months. The Owners Representative will de-energize the circuit. *(See note at the end of the procedure). The Contractor will install his lock on the scissor clip, locking out the disconnect.

D. The Contractor will insulate between the field contact of the S-1 switch of all 6.6 AMP or 20 AMP series circuits to be locked out prior to megging. The insulating piece(s) will remain in place until all circuits are meggred for release of lockout. The Contractor will megg the circuit in the presence of the Owners Representative and the CM. The megg will be connected to the circuit and allowed to energize the circuit for a full three minutes at 1000 volts, before the reading is taken. The Contractor will record the reading by completely filling out the lockout log form (example attached) on the tablet at the door of the regulator.
The CM will notify the Owners Representative to report the circuit lockout time and the megger reading.

E. The Contractor will install an appropriate Safety Tag on the locked out disconnect switch. The tag will show the name of the Contractor, and the date.

F. As soon as practical after the work is complete, but no later than the same day unless prior arrangements have been made, the Contractor will notify the CM, who will in turn notify the Owners Representative that the circuit is ready to be re-energized. The Contractor, the Owners Representative and the CM will meet at the vault to re-test the circuit.

G. The Contractor will megger the circuit for five minutes in the presence of the Owners Representative and the CM and record the reading on the form. He will also, at this time, megger across the field connections of the S-1 switch if present to insure continuity and correct field connections. If the readings are acceptable to the Owners Representative and the CM, then the Contractor will remove his safety tag and lock. If the readings are not acceptable, then the Contractor must correct the problem immediately or prove that the problem is not in his work area. An acceptable megger reading must be registered before the circuit can be released (acceptance of the circuit at this time does not relieve the Contractor of liability for damage discovered later which results from faulty workmanship). If the circuit is to be left off after dark, the CM must notify the Owners Representative with detailed information concerning the outage. Some outages will require continued work to re-energize circuits.

H. Under no circumstance will the Circuit Disconnect Switch be turned back on by anyone other than the Owners Representative or their Representative. The CM will notify the Owners Representative to report the time the circuit was released and the megger reading.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 MEASUREMENT AND PAYMENT

4.01 There will be no separate measurement or payment of the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION
PART 1 DESCRIPTION

1.01 SECTION INCLUDES

A. This item shall consist of furnishing all equipment, materials and appliances necessary for testing of airfield lighting circuit installations and associated systems.

B. The Contractor shall provide testing to confirm installations are acceptable for ground rod testing and airfield lighting circuit testing.

C. Requirements under this item shall be coordinated with the Airport Construction Manager. Specification requirements for approvals, reviews or other involvement of the Engineer shall be transmitted by the Contractor through the Construction Manager to the Engineer.

1.02 RELATED SECTIONS

A. Section 16013 - Recommended Lockout Procedures for Airfield Lighting Circuit
B. Section 16113 - Installation of Underground Cable for Airports
C. Section 16530 – Installation of Airport Lighting Systems

PART 2 EQUIPMENT AND MATERIALS

2.01 GENERAL

A. Materials and equipment covered by this item shall be subject to acceptance through manufacturer’s certification of compliance with the applicable specification, when requested by the Engineer.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. The Contractor shall furnish all necessary equipment and appliances for testing installations as indicated below.
3.02 GROUND ROD TESTING.

A. Contractor shall provide equipment and personnel to measure the resistance to earth for all ground rods installed. Earth resistance measurement tests shall adhere to recommendations of IEEE Standard 142, latest edition. Contractor shall submit testing procedure, equipment and report form to the Construction Manager for approval.

B. As each rod is installed, tests shall be administered. Any rod that does not have a resistance to ground of 25 ohms or less shall be augmented by an additional rod not less than 10 feet away. No testing of the additional rod is required. Testing results, including confirmation of installation of augmenting ground rods, shall be submitted to the Engineer for approval.

3.03 AIRFIELD LIGHTING CIRCUITS TESTING.

A. The Contractor shall notify the CM and Facilities Maintenance 24-hours prior to cable testing. All testing shall be conducted in the presence of the CM and Airport Facilities Maintenance. All test results shall be simultaneously recorded by the Contractor and IAH Electrical Maintenance. Contractor shall provide test report information to the CM and IAH Electrical Maintenance for approval. Test procedures for the following required tests, including field test report forms, shall be submitted to the CM for approval prior to testing.

1. Testing Requirements.
   a. All Circuits. Prior to commencement of work on any circuit the Low Voltage Tests shall be performed in accordance with procedures below.
   b. All Circuits. Upon completion of all rewiring of each circuit, the Low Voltage Tests shall be performed on the completed circuit following paragraph 2 below, to determine if the circuits are free of grounds. Circuits tested shall meet the requirements of paragraph 3 below. Any faults indicated by these tests shall be corrected before proceeding with additional testing. All test results shall be submitted to the CM for approval.

2. Testing Procedures.
   a. Low Voltage Tests. Low Voltage Continuity and Insulation-Resistance (Megger) Tests
      1) Test Required. As noted in Part A above, circuits and portions of circuits shall be subjected to a low voltage (1000 volt) continuity test and a low voltage (1000 volt) insulation-resistance (megger) test.
      2) Test Products. Contractor shall provide a 5000-volt direct current Megger for low voltage testing. Megger tester shall be non-crank type, as manufactured by Associated Research Meg-Check, the James Biddle Megger, General Radio Mega-Ohmmeter or approved equivalent. The Contractor shall be responsible for providing any required 120V AC power source at testing locations remote from
available power. Products calibration information shall be readily available for review by the CM, as requested.

3) Test Procedures. Refer to Section 16013 – Recommended Lockout Procedure for Airfield Lighting Circuit for lock-out procedure requirements. Test procedures for the required tests, including field test report forms, shall be submitted to the CM for approval prior to testing.

4) Test Results. Test values not meeting the requirements of paragraph 3 below shall be considered faulty and shall be corrected accordingly. Refer to paragraph D below for cables not meeting testing requirements.

3. Testing Results.
   a. New Circuits and New Portions of Existing Circuits.
      1) Low Voltage Tests shall demonstrate to the satisfaction of the HAS the following:
      2) All circuits are properly connected following the applicable wiring diagrams.
      3) All lighting power and control circuits are continuous and free from short circuits.
      4) All circuits are free from unspecified grounds.
      5) The insulation-resistance to ground is equivalent to or greater than 100 mega-ohms for all new non-grounded series circuits.

4. Deficient Testing Results (Circuits Not Meeting Requirements).
   a. New Circuits and New Portions of Existing Circuits.
      1) Cables not meeting the requirements of sub-paragraph 3 above shall be considered faulty. Faulty cables shall be corrected, if possible, and re-tested. If acceptable test values cannot be obtained, cables shall be removed from the conduit and replaced with new cable at Contractor's expense, as directed by the CM. Required testing of new cable in place shall then be implemented.

5. Submittal of Testing Data.
   a. Low Voltage Tests. Contractor shall submit 5 copies of tests reports for approval by the HAS, IAH Airport Electrical Maintenance, and the Engineer-of-Record. Report shall include all measured data including applied voltage, time length of voltage application of cable within a circuit.

   | DATE          | CABLE NUMBER |
---|-----------------|--------------|
| START TIME    | OPERATING VOLTAGE |
| END TIME      | MAX. TEST VOLTAGE |
| CABLE B/M NO. | FROM PRODUCTS   |
| DESCRIPTION   | TO PRODUCTS     |
| TEMP. MEASURE | HUMID. MEASURE  |
| EQUIP. NO.    | EQUIP. NO.      |
| CALIBRATION DUE DATE | RELATIVE HUMIDITY |
| AMBIENT TEMPERATURE |                |

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3.04 SYSTEM TESTS

A. After the airfield lighting systems installation is complete and at such times as the Engineer may direct, the contractor shall conduct airfield lighting systems operating tests for approval.

B. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the Engineer or his authorized representative. The contractor shall furnish all equipment and personnel required for the test.

C. Each applicable switch in the control tower lighting panels shall be operated so that each switch position is engaged at least ten times. During this process, all lights and associated equipment shall be observed to determine that each control device properly commands the corresponding circuit. Radio communication between the operator and the observers shall be provided by the Contractor.

D. The above tests shall be repeated from the local control switches on the regulators. Each installed or revised lighting circuit shall be tested by operating the lamps throughout the range of applicable steps and shall be operated separately at Step 3 or Step 5 as appropriate for full intensity or as directed by the Engineer, for not less than 1 hour. Visual examination shall be made at the beginning and at the end of this test to determine that the installed airfield light fixtures are illuminating at full intensity.

E. If circuit regulators are installed under project construction, regulator output ampacity shall be adjusted for proper outputs following manufacturer's recommendations and requirements to insure proper circuit operation.

F. Systems tests shall confirm by demonstration in service that all lighting circuits are in good operating condition to the satisfaction of the Engineer if the tests are unsatisfactory, lighting systems installed shall be corrected and systems tests shall again be implemented.

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION
PART 1 DESCRIPTION

1.01 DEFINITIONS

A. Alterations shall mean any change or rearrangement in the component parts, including structural, mechanical, electrical systems, or internal or external arrangements of an existing structure.

B. Removal shall mean the dismantling of existing materials, components, equipment, and utilities. Removed items shall be handled, prepared for storage, transported to storage areas as specified.

C. Demolition shall mean the dismantling and disposal of existing materials, components, equipment, and utilities which cannot or will not be reused or which will have no salvage value, or which cannot be reused due to unreparable damage caused by age, non-demolition related reasons, etc. All demolished items not designated to be turned over to the Owner shall be disposed of in a safe manner and at a location acceptable to the Owner.

D. All items to be turned over to the Owner shall be properly enclosed or boxed to protect the items from damage and transported by the Contractor to a location on the Owner’s property, designated by the Engineer and/or the Owner.

E. The installation and/or removal of lighting equipment may be critical to airport operations; therefore, the Contractor shall follow the work schedule established in the plans and specifications or as directed by the Engineer. The system shall be installed in accordance with the National Electrical Code and/or local code requirements.

F. The Contractor shall provide temporary wiring as required to reconnect existing circuits to provide guidance for aircraft to pass through the construction areas on those taxiways/runways which must remain open. The Contractor shall check all temporary circuits before dark each day to assure that they are operational. In the event of failure, the Contractor shall immediately take steps to restore operation. The cost of temporary and reconnected lighting shall be absorbed in the various work items.

1.02 CONDITION OF EXISTING FACILITIES

A. The Contractor shall verify the areas, conditions, and features necessary to tie into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The
Contractor shall be responsible for the accurate tie-in of the new work to existing facilities.

B. Special attention is called to the fact that there may be piping, fixtures or other items in the existing systems which must be removed or relocated in order to perform the alteration work. All conduit, wiring, boxes, etc., that do not comply with these specifications shall be removed or corrected to comply with these specifications. All unused conduit not removed shall be identified and a pull line shall be installed. The work shall include all removal and relocation required for completion of the alterations and the new construction.

C. Whenever the scope of work requires connection to an existing circuit, the circuit’s insulation resistance shall be tested, in the presence of the Owner and Engineer. The Contractor shall record the results on the forms included in these specifications. When the circuit is returned to its final condition, the circuit’s insulation resistance shall be checked again in the presence of the Owner and Engineer. The Contractor shall record the results on the forms included in these specifications. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance Manuals as described in Section 16010 – General Provisions - Electrical.

1.03 OCCUPANCY AND USE OF EXISTING FACILITIES

A. The Owner will occupy and use the facilities within the areas of work during the entire construction period. The Contractor shall be required to plan and coordinate his activities in order to provide all necessary controls for the abatement of dust, noise, and inconvenience to the Owner personnel during all phases of the work.

1.04 VACATING OCCUPIED AREAS

A. The Owner will remove all portable items of furniture, equipment, and fixtures prior to the start of work.

1.05 SAFETY REQUIREMENTS

A. The Contractor shall conduct alterations and removal operations in a manner that will ensure the safety of persons in accordance with the requirements of CFR 29 PART 1926 and 1910.

1.06 CLASSIFICATION OF REMOVED/DEMOLISHED ITEMS

A. Existing materials and equipment indicated to be removed will be classified as "salvageable" and shall remain the property of the Owner or will be classified as "debris" and shall be disposed of legally off the airport.
B. Salvageable Items

1. Reusable salvaged items:
   a. Salvaged materials and equipment shall be reused in the work as described on the contract drawings, unless noted otherwise.

2. Retained salvaged items:
   a. Salvaged materials and equipment to be retained by the Owner but not reused in the work shall be turned over to the Owner at a site at the facility to be determined by the Owner. Retained salvaged items shall be stored on Owner property where indicated by the Owner.

C. Debris Items

1. Items classified as debris shall be legally disposed of off the airport property. The cost of such disposal shall be included in the cost of other items of work.

1.07 TEMPORARY PROTECTION

A. The Contractor shall provide and maintain the following requirements.

1. Protection of persons and property shall be provided throughout the progress of the work in accordance with these specifications.

2. Provide temporary facilities and infrastructure prior to starting alterations and removal of work. Such items shall protect existing materials, equipment, and other remaining system components from damage by weather and construction operations.

3. Provide temporary jet blast structures which will withstand the jet blast with a safety factor of 2.

PART 2 EXECUTION

2.01 DISCONNECTING UTILITIES

A. Prior to the start of work, the necessary utilities serving each area of alteration or removal will be shut off by the Owner and shall be disconnected and sealed by the Contractor, as required. Lockout/Tag/Try procedures shall be utilized in accordance with Section 16013 – Recommended Lockout Procedure for Airfield Lighting Circuit.

2.02 TEMPORARY UTILITY SERVICES

A. The Contractor shall install temporary utility services in satisfactory operating condition before disconnecting existing utilities. Such temporary services shall be maintained during the period of construction and removed only after new permanent services have been tested and are in operation.
2.03 TEMPORARY AIRFIELD ELECTRICAL SERVICES

A. The Contractor shall install temporary electrical airfield services in satisfactory operating condition before disconnecting existing electrical services. Such temporary services shall be maintained during the period of construction and removed only after new permanent services have been tested and are in operation. Temporary electrical airfield provisions shall include, but not be limited to new electrical conductors installed in existing pathways, above ground or in new conduit. Temporary sign panels and blanking out of existing light fixtures as required by HAS airport operations to close or re-route traffic around the construction area and all associated electrical incidentals such as conduit or cable protection, connector kits, splicing of cables, etc as required for a complete temporary airfield electrical system. Approved methods for blanking out of existing fixtures shall include the following:

1. Elevated Fixtures: Install PVC pipe to cover the complete fixture. Pipe to be nominal 18"H x 6"-8" diameter as needed with cap.

2. Inpavement Fixture: Mask fixture light source using tape. Use only heavy duty black duct tape. Do not allow sticky surface of tape to touch fixture lens. Install a section of tape double upon itself so there is no sticky surface over the lens portion of the fixture. Provide overall taped covering with sticky surface attached to fixture housing only for complete fixture cover. Painting over a fixture to mask is strictly prohibited.

2.04 REMOVAL WORK

A. The Contractor shall not disturb the existing construction beyond that indicated or necessary for installation of new work. Temporary shoring and bracing for support of building components to prevent settlement or other movement shall be as indicated and as required to protect the work.

B. The Contractor shall provide protective measures to control accumulation and migration of dust and dirt in all areas of work, particularly those adjacent to occupied areas. The Contractor shall remove dust, dirt, and debris from the areas of work daily.

2.05 SALVAGEABLE MATERIALS AND EQUIPMENT

A. The Contractor shall remove all salvageable materials and equipment in a manner that will cause the least possible damage thereto. Removed items which are to be retained by the Owner or re-installed at a future date shall be carefully handled, stored, and protected.

B. The Contractor shall provide identification tags on all items boxed or placed in containers, indicating the type, size, and quantity of materials.
2.06 BUILDINGS AND STRUCTURES

   A. The Contractor shall perform removal operations in existing buildings as indicated and as otherwise required to complete the work.

   B. Existing concrete shall be demolished, removed, and disposed of. Square, straight edges shall be provided where existing concrete adjoins new work and at other locations where indicated. Existing steel reinforcement shall be protected where indicated; otherwise, it shall be cut off flush with face of concrete.

   C. The Contractor shall dismantle steel components at field connections and in a manner that will prevent bending or damage.

   D. The use of flame-cutting torches will be permitted only when other methods of dismantling are not practical, and when approved in writing by the Owner and/or Engineer.

2.07 ELECTRICAL EQUIPMENT AND FIXTURES

   A. Wiring systems and components shall be salvaged. Loose items shall be boxed and tagged for identification.

   B. All unused conduit not removed shall have a pull string installed and shall be noted on the record drawings.

   C. Primary, secondary, control, communication, and signal circuits shall be disconnected at the point of attachment to their distribution system.

   D. The Contractor shall remove and salvage electrical fixtures. Incandescent lamps, LED lamps, and fluorescent lamps shall be salvaged, boxed and tagged for identification, and protected from breakage.

   E. The Contractor shall remove and salvage switches, receptacles, fixtures, transformers, constant current regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. These items shall be boxed, and tagged for identification according to type and size.

   F. The Contractor shall remove and dispose of conductors and conduits not used in the finished work and shown to be demolished on the plans.

PART 3  DEMOLITION, DISPOSAL, AND ALTERATION

3.01 DEMOLITION OPERATIONS

   A. Demolition operations shall be conducted to ensure the safe passage of persons to and from facilities occupied and used by the Owner and to prevent damage by falling debris or other cause to adjacent buildings, structures, and other facilities.
B. The sequence of operations shall be such that maximum protection from inclement weather will be provided for materials and equipment located in partially dismantled structures.

3.02 MAINTAINING TRAFFIC

A. Demolition operations and removal of debris to disposal areas shall be conducted to ensure minimum interference with runways, taxiways, aprons, roads, streets, walks, and other facilities occupied and used by the Owner.

B. Streets, walks, runways, taxiways and other facilities occupied and used by the Owner shall not be closed or obstructed without written permission from the Owner.

3.03 REFERENCE STANDARDS REQUIREMENTS

A. Demolition operations shall be conducted to ensure the safety of persons in accordance with ANSI A 10.6 Safety Requirements for Demolition.

B. Demolition shall be conducted in accordance with OSHA, State and local requirements.

3.04 DISPOSAL OF DEMOLISHED MATERIALS

A. General

1. The Contractor shall dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from demolition operations. Demolished materials shall not be stored or disposed of on Airport property.

B. Removal From Property Owner

1. Materials classified as debris shall be transported from Owner property and legally disposed of at no additional cost to the Owner. Permits and fees for disposal shall be paid by the Contractor.

3.05 ALTERATION WORK

A. General

1. Cutting, patching, repairing, and other alteration work shall be done by tradesman skilled in the particular trade or work required.

2. Where required to patch or extend existing construction, or both, such alteration work shall match existing exposed surface materials in finish, color, texture, and pattern.

3. Salvaged items for reuse shall be as approved by the Engineer and Owner.
PART 4  MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. Temporary Electrical Provisions shall be measured by the lump sum for all project phases and scope and shall include installation of temporary L-824C, #8 5KV cables, associated conduit where required by operations, trench where required by operations, temporary sign panels as directed by Operations, blanking out of existing fixtures including both in-pavement and elevated as required by Operations, splicing of existing cables, L-823 connectors, removal, site restoration and all incidentals, complete in place. There is no separate measurement for work zone or project phase.

4.02 BASIS OF PAYMENT

A. Payment will be made at the contract price for required temporary electrical provisions. This item includes all materials, labor, transportation, incidentals and services required for the temporary electrical provisions needed to maintain the airfield electrical systems to the satisfaction of the Airport Authority during each noted construction phase shown on the plans. This item includes any temporary wiring, fixtures, sign panels, blanking of fixtures or sign panels, etc. required to maintain the existing airfield lighting systems to the satisfaction of the Owner and Engineer. It is the intent of the temporary electrical provisions pay item that all temporary electrical modifications necessary to properly close the work area for construction while maintaining adjacent utilities is complete during construction and removed following construction and set back to proper operation. There is no additional payment for work zones.

Payment will be made under:

16090-1  Temporary Electrical Provisions – Per Lump Sum

END OF SECTION
PART 1 DESCRIPTION

1.01 GENERAL

A. This item shall consist of furnishing and installing underground cable in accordance with specifications at the locations shown in the plans. This item shall include the installation of cable, ductbanks, or conduit. It shall include splicing, cable marking and testing of the installation and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the City Engineer. This item shall include the installation of counterpoise in same trench and with ductbanks.

1. Construction under these specifications shall be coordinated with the Airport Construction Manager, hereby referred to as the CM. "CM" is hereby defined as being an equivalent and interchangeable term to the "City Engineer" references throughout these specifications. Specification requirements for approvals, reviews, or other involvement of the City Engineer shall be transmitted by the Contractor through the CM to the City Engineer.

2. Project shall be constructed in operating condition as a completed unit to the satisfaction of the CM.

1.02 RELATED SECTIONS

A. Section 16013 - Recommended Lockout Procedure for Airfield Lighting Circuit

B. Section 16031 - Airfield Electrical Installation Testing

C. Section 16116 – Installation of Airport Underground Electrical Duct Banks and Conduits

D. Section 16530 – Installation of Airport Lighting Systems

1.03 REFERENCE DOCUMENTS

A. NFPA No. 70 National Electrical Code (NEC)

B. MIL-S-23586C Sealing Compound, Electrical, Silicone Rubber


D. 150/5340-30 - Design and Installation Details For Airport Visual Aids
PART 2 PRODUCTS

2.01 GENERAL

A. Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified under the Airport Lighting Equipment Certification Program described in Advisory Circular (AC) 150/5345-1, current edition.

B. All other products covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the City Engineer.

C. All Advisory Circulars referenced in these specifications shall be the edition indicated or the latest edition.

2.02 CABLE

A. Underground cable shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits.

1. Cable for airfield lighting service shall be Type C, # 8 AWG, copper, 7 strand, single and multiple conductor cable with 5,000 volt cross-linked polyethylene insulation.

2. Limits on conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

3. Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Federal Specification J-C-30. Types THWN, or other types with equivalent or superior insulation characteristics shall be installed.

4. Control cable conductor size shall be as indicated on the plans.

2.03 COUNTERPOISE

A. Counterpoise cable shall be No. 6 AWG, stranded, bare copper wire conforming to ASTM Specifications B-3 and B-8. Counterpoise cable shall be UL listed and shall be bare.

B. Number and location of counterpoise wires shall be as indicated on plans, details and as specified.

C. Ground rods shall be one piece, copper clad, ten (10) foot long by 3/4 inch in diameter.

2.04 CABLE CONNECTIONS

A. In-line connections of underground primary cables shall be of the type called for on the plans and as specified.
1. The Cast Splice. A cast splice will not be permitted. This means connector kits must be used.

2. Connectors. Connectors to be used in connecting L-824 primary cable in light fixture bases and other junction points shall conform to the requirements of the specification for L-823 Connectors in AC 150/5345-26C. L-823 connectors kits shall be as manufactured by Elastimold or approved equivalent. Connectors shall be individually marked to be compatible for use with the size and type of L-824 cable specified.

3. Heat Shrinkable Splice. Heat shrinkable splice kits meeting the requirements of IEEE-404-1977, ICEA-66-524 and 516 shall be used to splice the specified L-824 primary cable. Splice kits shall include cable preparation provisions and products. All splices shall be made using long barrel copper compression connectors, Burndy Hylink YS. All splices shall be 5kV rated. Splice kits shall be manufactured by Raychem or approved equivalent. Splice kits and proposed installation locations shall be submitted for approval by the City Engineer.

4. Tape specified to be used in association with above noted connections shall be field-applied rubber or synthetic tape covered with plastic tape. The rubber tape shall meet the requirements of ASTM-D4388-1997 and the plastic tape shall comply with Mil. Spec. MIL-I-24391C or Fed. Spec. Commercial Item A-A-55809. Submit tape to be used for approval.

5. Contractor shall use approved cable stripper/penciller, Crouse-Hinds Model WS49 for #6 or #8 5kV, L-824 Type 'C' cable or approved equivalent for all cable connections.

6. Conductor crimping shall be accomplished using crimping tool that requires a complete crimp before tool can be removed.

PART 3  CONSTRUCTION METHODS

3.01 GENERAL

A. The Contractor shall install the specified cable at the approximate locations indicated on the plans. Coordinate specific locations with CM.

1. Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without splices, unless otherwise authorized in writing by the Engineer or shown in the plans.

2. Cable splices in conduit shall not be permitted.

3. Connection of primary underground cable to the primary leads of the individual isolation transformers shall be in light fixture bases only.

4. Where cable is required to be brought above ground to make connections or for future maintenance purposes, a minimum amount of 3-foot of cable slack shall be installed to allow the cable to be extended at least one foot vertically.
above the top of the junction point structure. This includes such junction points directed by the CM, such as: light fixture bases, handholes, junction boxes, etc. This requirement also applies where primary cable passes through empty light fixture bases, to allow for future connections to light fixtures. Manholes/handholes shall have 10-foot of slack laced in the manhole/handhole.

5. Excessive lengths of excess cable gathered at one location shall not be allowed, as determined by the CM.

6. Homerun cables shall not be interleaved with fixture cabling in same conduit.

3.02 INSTALLATION IN DUCT OR CONDUIT

A. This item includes the installation of the cable in duct or conduit as described below.

1. The maximum number and voltage ratings of the cables installed in each single duct or conduit and the current-carrying capacity of each cable shall be in accordance with the plans and schedules.

2. The Contractor shall make no connections or joints of any kind in cables installed in conduits or ducts.

3. The duct or conduit shall be installed as a separate item following Section 16116 - Installation of Airport Underground Electrical Duct Banks and Conduits.

4. Contractor shall run a mandrel through installed conduit or duct to insure the conduit/duct is open, continuous and clear of debris before installing cable. Mandrel size shall be compatible with conduit size and use shall be approved by the CM.

5. The cable shall be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation or damage to the outer protective covering.

6. The ends of all cables shall be sealed with moisture-seal heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made.

7. When more than one cable is to be installed in a duct under the same contract, all cable shall be pulled in the duct at the same time.

8. Cable shall not be installed through a conduit/duct containing existing cables. Existing cables shall be removed and salvaged and all new cables shall be installed through the conduit/duct, for both the existing and new circuit runs. Removal and re-installation of existing cables shall not be permitted.

9. The pulling of a cable through ducts or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. A non-hardening lubricant recommended for use with the type of cable being installed, such as CRC "Wire Pulling Lubricant", shall be used during pulls to decrease pulling tensions. Submit to the CM the lubricant to be used.

10. Greenlee Multiplex Polyester rope or the approved equivalent shall be used for cable pulls through non-metallic conduits.
11. Maximum cable pulling tensions shall be per cable manufacturer's recommendations. Contractor shall submit maximum pulling tension values to the CM prior to any cable installations.

3.03 CABLE IDENTIFICATION

A. Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector on each airport lighting cable entering or leaving cable junction points, such as manholes, handholes, pullboxes, junction boxes, etc.

1. Markers shall be stainless steel and of sufficient size for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch in size. The cable circuit identification shall match the circuits noted on the construction plans.

3.04 SPLICING

A. Cable connections shall be installed as indicated on the plans and as specified. Types of cable connections indicated below shall be accomplished by experienced personnel confirmed as meeting the requirements of Section 16010 - General Provisions – Electrical. Cable connections shall be made as follows:

1. L-823 Connectors. This connection shall be installed at all L-824 airfield lighting cable junction points and as indicated in construction plans.
   a. Connections shall be assembled as per manufacturer's instruction and as approved by the CM. Connections shall be made by plugging directly into mating connectors. In all cases, the joint where the connectors come together shall be wrapped with at least one layer of synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches on each side of the joint.

2. Heat Shrinkable Splice. This connection shall be installed where specifically indicated in the plans and details and approved for use by the CM. Splice shall be installed as per manufacturer's instruction.
   a. Contractor shall use approved cable stripper/penciller, Crouse-Hinds Model WS49 for #6, 5kV, L-824 Type 'C' cable or approved equivalent, for all cable connections. Conductor crimping shall be accomplished using crimping tool that requires a complete crimp before tool can be removed.

3.05 COUNTERPOISE INSTALLATION AND GROUNDING FOR LIGHTNING PROTECTION

A. The counterpoise wiring specified shall be installed for lightning protection of underground airfield lighting cables.

1. If shown in the plans or specified in job specifications, a stranded bare copper wire, No. 6 AWG minimum size, shall be installed for lightning protection of the underground cables. The bare counterpoise wire shall be installed in the
same trench of the insulated cables. It is designed to protect, and shall be placed at a distance of 4 inches above the conduit. The counterpoise wire shall be attached to the light fixture base grounding lug. Each fixture base shall also include a separate light base ground and ground rod. The counterpoise shall be installed. A counterpoise shall be installed 4" above ductbanks providing 45 degree zone of protection below the counterpoise. More than one counterpoise may be needed for wider ductbanks. The counterpoise wire shall also be exothermic welded to copper or copper-clad ground rods installed not more than 500 feet apart around the entire circuit. The ground rods shall be of the length, diameter and type specified in the plans, but in no case shall they be less than 10 feet long nor less than 3/4 inch in diameter.

2. The counterpoise system shall terminate at the existing counterpoise system. The connections shall be made by exothermic welding as shown in the project plans and specifications.

3. The counterpoise conductor is bonded to ground rods that are located on each side of a duct crossing. Where conduit or duct runs continue beneath pavement (i.e., apron areas, etc.), install the counterpoise a minimum of 4 inches above conduits or ducts along the entire run.

3.06 EXOTHERMIC BONDING.

A. Bonding of bare copper wire to metal light fixtures shall be by the exothermic welding process, except where shown otherwise on plan details.

1. Only personnel experienced in and regularly engaged in this type of work shall make these connections. Welding kits shall be "Cadweld" type by Erico Products, Inc.

2. Contractor shall demonstrate to the satisfaction of the CM, the welding kits, products and procedures to be used at for welded connections at light fixture bases, ground rods and other typical installations prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:
   a. Cut cable with approved cutter without deforming cable. Oil filled or greasy cable shall be cleaned with rapid drying nonflammable solvent (such as mineral spirits), which leave no residue. Wet cable shall be dried with alcohol or heat from hand torch. Corroded cable shall be cleaned of all corrosion products using emery cloth or wire brush.
   b. All grease, oil, dirt, or other foreign material shall be removed from the surface using suitable hand tools and/or solvents such as mineral spirits. The cleaned surface shall be filed or ground to bright metal using a file, rasp, or grinding wheel.
   c. Proceed with exothermic welding process, as per manufacturer's instructions. For weld connections on light fixture base cans, weld cartridge shall be sized correctly so as to prevent excessive "melt" of base can galvanizing and weld dry mold shall be properly configured to match the curvature of the respective base size.
d. All slag shall be removed from welds.

e. For welds at light fixture base cans, all galvanized coated surface areas and "melt" areas, both inside and outside of base cans, damaged by exothermic bond process shall be restored by coating with a liquid cold-galvanizing compound conforming to U.S. Navy galvanized repair coating meeting Mil. Spec. MIL-P-21035, such as Sealube Company Z.R.C. Surfaces to be coated shall be prepared and compound applied following manufacturer's recommendations.

f. All exposed copper and weld material at weld connections shall be thoroughly coated with heat shrinkable tubing (Raychem Corp. Heat Shrink Sleeves) or coated with coal tar bitumastic material (Carboline Co. Bitumastic 50) to prevent surface exposure to corrosive soil or moisture.

3.07 TESTING

A. Contractor shall furnish all necessary products and appliances for testing the installations as required in Section 16031- Airfield Electrical Installation Testing.

PART 4  METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

MATERIAL REQUIREMENTS

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

FED SPEC J-C-30 Cable and Wire, Electrical Power, Fixed Installation (cancelled; replaced by A-A-59544 Cable and Wire, Electrical (Power, Fixed Installation))

FED SPEC A-A-55809 - Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

ASTM B 3 - Soft or Annealed Copper Wire

ASTM D 4388 - Rubber tapes, Nonmetallic Semiconducting and Electrically Insulating

END OF SECTION
PART 1  DESCRIPTION

1.01  GENERAL

A. This item shall consist of underground electrical ducts installed in accordance with this specification at the locations and in accordance with the dimensions, designs, and details shown in the plans. This item shall include the installation of all underground electrical ducts or underground conduits. It shall also include all trenching, backfilling, removal, and restoration of any paved areas; manholes, concrete encasement, mandrel installation of nylon pull string and duct markers, capping, and the testing of the installation as a completed duct system ready for installation of cables, to the satisfaction of the Construction Manager.

1.02  RELATED SECTIONS

A. Section 16113 - Installation of Underground Cable for Airports

B. Section 16530 – Installation of Airport Lighting Systems

1.03  FAA DOCUMENTS

A. 150/5340-30 - Design and Installation Details For Airport Visual Aids

PART 2  EQUIPMENT AND MATERIALS

2.01  GENERAL

A. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the City Engineer.

2.02  MATERIAL REQUIREMENTS

A. Fed.Spec.W-C-1094 Conduit and Conduit Fittings; Plastic, Rigid (cancelled; replaced by UL 514 Boxes, Nonmetallic Outlet, Flush Device Boxes, & Covers, and UL 651 Standard for Conduit & Hope Conduit, Type EB & A Rigid PVC)

B. Underwriters Laboratories Standard 6 - Rigid Metal Conduit

C. Underwriters Laboratories Standard 514B - Fittings for Cable and Conduit
D. Underwriters Laboratories Standard 1242 - Intermediate Metal Conduit

E. Underwriters Laboratories Standard 651 Schedule 40 and 80 Rigid PVC Conduit (for Direct Burial)

F. Underwriters Laboratories Standard 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit (for concrete encasement)

2.03 STEEL CONDUIT

A. Rigid steel conduit and fittings shall conform to the requirements of Underwriters Laboratories Standard 6, 514, and 1242. Rigid steel conduit and fittings shall also conform to the requirements of Federal Specification WW-C-581d and shall be hot dipped galvanized inside and out.

2.04 CONCRETE

A. Concrete shall conform to Item P-610, Structural Portland Cement Concrete and duct banks shall be 3000 psi.

2.05 PLASTIC CONDUIT

A. Plastic conduit and fittings shall conform to the requirements of Fed. Spec. W-C-1094 and Underwriters Laboratories Standards UL-651 and UL-651A, or UL-651B for HDPE, and shall be one of the following, as specified in the construction plans.

B. Type II Schedule 40 PVC suitable for either above ground or underground use.

C. Type III Schedule 40 PVC Carlon P&C Lock Duct, or approved equivalent, for split duct installation around existing cable.

D. Conduit Color

1. Use gray conduit for electrical circuits.
2. Use white conduit for drainage.

2.06 MANHOLES, HANDHOLES AND PULLBOXES

A. Pre-cast or cast-in-place manholes, handholes, and pullboxes shall be located as shown on the plans.

B. Dimensions and reinforcement shall be as noted on plans.

C. Design loads shall consist of dead load, live load, impact, and in addition, loads due to water table, and any other loads which may be imposed upon the structure. Live loads shall be for H-20 per AASHTO Standard Specifications or aircraft rated type. Design wheel load shall be 16 kips for H-20 and 200,000 lbs for aircraft
rated. The live load shall be that loading which produces the maximum shears and bending moments in the structure.

D. The Contractor shall prepare and submit detailed shop drawings for pre-cast and cast-in-place concrete pullboxes and manholes indicating reinforcement, dimensions and details of each miscellaneous item.

1. All shop drawings shall be checked by the fabricator before being submitted for approval to the Construction Manager and Engineer-of-Record.
2. The Contractor shall be responsible for the correctness and completeness of the drawings and fit and field connections even if the drawings have been approved by the Construction Manager.

E. Concrete used for the construction of pre-cast or cast-in-place manholes and pullboxes shall conform to the requirements of Item P-610, Structural Portland Cement Concrete.

F. All reinforcing steel shall be of the size and in the location as shown on the plans. Reinforcing steel shall conform to the requirements of Item P-610, Structural Portland Cement Concrete.

G. Duct terminators or end bells shall be provided in manhole, pull box, and handhole walls. They shall have a smooth, bull-nosed edge.

1. Terminators shall be formed of high impact, high strength, prime virgin acrylonitrile butadiene styrene (ABS) plastic, containing the proper number, size and arrangement of openings to receive ducts installed under this contract, with 2-inch nominal separation between openings.
2. Terminators shall be hollow, 6 inches outside-to-outside of interior and exterior surfaces, to allow placement of reinforcing steel inside. Terminators shall be provided and installed for reception of future ducts. Only factory-fabricated plastic plugs of proper size shall be furnished and installed in the duct openings.

H. Frames and covers shall be East Jordan Iron Works, Inc.; Neenah Foundry Company, or as shown on the plans, or approved equivalent. Frames and covers shall be constructed in accordance with the details and shall be placed carefully to the lines or grades indicated on the plans. Frames and covers shall be hinged and vermin proof. Covers shall have built-in, flush lifting eyes or pockets with stainless steel rods for ease of cover lifting. Bolted-on or U-bolt type devices shall not be acceptable as cover lifting eyes. Cover bolts shall be corrosion resistant, all thread, 18-8, type 304 stainless steel. Threaded studs are not acceptable for bolting down covers. Covers are to include torsion assist stainless steel springs.

I. Castings, whether carbon-steel, gray steel iron or ductile iron, shall conform to the shape and dimensions shown on the plans and shall be clean, substantial castings, free from sand or blow holes or other defects. Surfaces of the casting shall be free from burnt-on sand and shall be reasonably smooth.
1. Bearing surfaces between manhole covers and frames shall be cast and machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact.


3. Ductile iron castings shall conform to the requirements of the Standard Specifications for "Modular Iron Casting," ASTM Designation A536.

J. Pulling rings for cable installations shall be cast iron. Rings shall be Line Material Industries, Milwaukee, Wisconsin, Model No. DU2T2, or as otherwise shown on the plans, or approved equivalent. U-bolt or bolted-in type pulling rings shall not be acceptable.

K. Threaded inserts shall be Star Holzin, or approved equivalent, 1/2-inch diameter x 2 3/8-inch, unless otherwise noted on the drawings. Bolts shall be of the size indicated on drawings or as required.

L. Provide all manholes and handholes that are 4 feet deep and larger with cable support racks.

M. Except for manhole and pullbox covers, frames and their related fittings and ground rods, all items specified under this section shall be galvanized after fabrication. Galvanizing of bolts, nuts, threaded inserts, and other connection devices shall conform to ASTM A 153, Class C or D, or to ASTM B633. Galvanizing of other steel items shall conform to ASTM A 123 or A 153.

N. Provide conduit plugs in all manhole, handhole and pullboxes for all empty conduits, including empty conduits with pull string only.

2.07 TRENCH MARKING TAPE

A. The Contractor shall furnish and install trench marking tape (warning tape) over the top of concrete encased single and multi-way duct bank for the full length of the duct bank and below the ground surface in the non-encased conduit trench at no separate payment. Distances above duct bank and above non-encased conduit shall be as shown on the plans. The tape shall be 6 inches (150 mm) wide except where shown otherwise on the plans, 4 mils thick, bright red in color, marked “Electric Line Buried Below”.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. The Contractor shall install underground ducts at the approximate locations indicated in the airport layout plans. The City Engineer shall indicate specific locations as the work progresses. Ducts shall be of the size, material, and type indicated in the plans or specifications. Where no size is indicated in the plans or
specifications, the ducts shall be not less than 2 inches inside diameter. All duct lines shall be laid so as to grade toward handholes, manholes and duct ends for drainage. Grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct lines shall be graded from the center in both directions toward manholes, handholes, or duct ends. Pockets or traps where moisture may accumulate shall be avoided.

B. The Contractor shall mandrel each duct. An iron-shod mandrel, not more than $\frac{1}{4}$-inch (6 mm) smaller than the bore of the duct shall be pushed through each duct by means of jointed conduit rods. The mandrel shall have a leather or rubber gasket slightly larger than the duct hole.

C. All ducts installed shall be provided with a nylon pull string for pulling the permanent wiring. Sufficient length shall be left in manholes or handholes to bend the drag wire back to prevent it from slipping back into the duct. Where spare ducts are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed by the duct manufacturers, or with hardwood plugs conforming accurately to the shape of the duct and having the larger end of the plug at least $\frac{1}{4}$-inch (6 mm) greater in diameter than the duct.

D. All ducts shall be securely fastened in place during construction and progress of the work and shall be plugged to prevent seepage of grout, water, or dirt. Any duct section having a defective joint shall not be installed.

E. All ducts installed under runways, taxiways, aprons, and other paved areas shall be encased in a concrete envelope and as shown on the plans and details.

F. Trenches for ducts may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of road patrols or graders shall not be used to excavate the trench. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All excavation shall be unclassified.

G. Coordinate any items involving telecommunications infrastructure with Division 27 requirements.

H. The contractor is required to coordinate with the edge drain system contractor. No ducts shall be encased when passing thru the edge drain system. Use porous backfill material only as noted on the D03 series. All conduit penetrations and terminations at the edge drain system shall follow the edge drain and fabric manufacturer’s recommendations.

3.02 DUCTS ENCASED IN CONCRETE

A. Unless otherwise shown in the plans, concrete-encased ducts shall be installed so that the top of the concrete envelope is not less than 60 inches below the finished grade where installed under runways, taxiways, aprons, or other paved
areas, and not less than 24 inches below finished grade where installed in unpaved areas. Ducts under paved areas shall extend at least 10 feet beyond the edges of the pavement or 10 feet beyond any underdrains, which may be installed alongside the paved area. Trenches for concrete-encased ducts shall be opened the complete length before concrete is laid so that if any obstructions are encountered, proper provisions can be made to avoid them. All ducts for concrete encasements shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. Where two or more ducts are encased in concrete, the Contractor shall space them not less than 1½ inches (37 mm) apart (measured from outside wall to outside wall) using spacers applicable to the type of duct. As the duct laying progresses, concrete not less than 3 inches (75 mm) thick shall be placed around the sides and top of the duct bank. End bells or couplings shall be installed flush with the concrete encasement where required.

B. When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where otherwise shown on the plans. under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5 foot (150 cm) intervals.

3.03 DUCTS WITHOUT CONCRETE ENCASEMENT

A. Trenches for single-duct lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide, and the trench for 2 or more ducts installed at the same level shall be proportionately wider. Trench bottoms for ducts without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the duct along its entire length.

B. A layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the duct. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a ¼-inch (6 mm) sieve. The bedding material shall be tamped until firm.

C. Unless otherwise shown in plans, ducts for direct burial shall be installed so that the tops of all ducts are at least 18 inches (45 cm) below the finished grade.

D. When two or more ducts are installed in the same trench without concrete encasement, they shall be spaced not less than 2 inches (50 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.

E. Trenches shall be opened the complete length before duct is installed so that if any obstructions are encountered, proper provisions can be made to avoid them.
3.04 DUCT MARKERS

A. The location of the ends of all ducts shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 inches (100 mm) thick extending approximately 1 inch (25 mm) above the surface. The markers shall be located above the ends of all ducts or duct banks, except where ducts terminate in a handhole, manhole, or building.

B. The Contractor shall impress the word “duct” on each marker slab. He shall also impress on the slab the number and size of ducts beneath the marker. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 2-inch (12 mm) and 1/4-inch (6 mm) deep or as large as the available space permits.

3.05 BACKFILLING

A. All installation of ducts to be inspected and approved by a City Engineer prior to backfill operation.

B. After concrete-encased ducts have been properly installed and the concrete has had time to set, the trench shall be backfilled in at least two layers with excavated material not larger than 4 inches (100 mm) in diameter and thoroughly tamped and compacted to at least the density of the surrounding undisturbed soil. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.

C. Trenches shall not be excessively wet and shall not contain pools of water during backfilling operations.

D. The trench shall be completely backfilled and tamped level with the adjacent surface: except that, when sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

E. Any excess excavated material shall be removed and disposed of in accordance with instructions issued by the City Engineer.

F. For ducts without concrete envelope, 8 inches (200 cm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the ducts and carefully tamped around and over them with hand tampers. The remaining trench may be filled with regular run of excavated material and thoroughly tamped as specified above.

3.06 RESTORATION

A. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the trenching, storing of dirt, cable laying, pad construction and other work shall be restored to its original
condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, sprigging, or mulching. All such work shall be performed in accordance with the FAA Standard Turfing Specifications. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. Sodding and restoration to match adjacent surfaces

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

MATERIAL REQUIREMENTS

Fed.Spec.W-C-1094 Conduit and Conduit Fittings; Plastic, Rigid (cancelled; replaced by UL 514 Boxes, Nonmetallic Outlet, Flush Device Boxes, & Covers, and UL 651 Standard for Conduit & Hope Conduit, Type EB & A Rigid PVC)

Underwriters Laboratories Standard 6 Rigid Metal Conduit

Underwriters Laboratories Standard 514B Fittings for Cable and Conduit

Underwriters Laboratories Standard 1242 Intermediate Metal Conduit

Underwriters Laboratories Standard 651 Schedule 40 and 80 Rigid PVC Conduit (for Direct Burial)

Underwriters Laboratories Standard 651A Type EB and A Rigid PVC Conduit and HDPE Conduit (for concrete encasement)

END OF SECTION
PART 1  DESCRIPTION

1.01 SECTION INCLUDES. This section shall consist of all lighting systems furnished and installed following the project plans and specifications and the applicable advisory circulars.

A. The systems shall be installed at the locations and following the dimensions, design and details shown on plans. It is the intent and meaning of the plans and specifications that the Contractor shall provide an electrical installation that is complete, including all items and appurtenances necessary, reasonably incidental or customarily included, even though each and every item is not specifically called out or shown.

B. Installations and construction under these provisions shall be coordinated with the Airport Construction Manager, hereby referred to as the CM. Specification requirements for approvals, reviews or other involvement of the City Engineer shall be transmitted by the Contractor through the CM to the City Engineer.

C. This item shall include the furnishing of all products, labor and incidentals necessary to place the systems in operation as completed units to the satisfaction of the CM. Refer to provisions of Section 16010 – General Provisions - Electrical (Item L-100).

D. Airport lighting and products covered by Federal Aviation Administration (FAA) specifications shall have the prior approval of the FAA and shall be listed in latest edition of Advisory Circular (AC) 150/5345-1, Airport Lighting Equipment.

E. All Advisory Circulars referenced in this specification shall be the edition indicated or the latest edition.

1.02 RELATED SECTIONS

A. Section 16013 - Recommended Lockout Procedure for Airfield Lighting Circuit

B. Section 16031 - Airfield Electrical Installation Testing

C. Section 16113 - Installation of Underground Cable for Airports

D. Section 16116 – Installation of Airport Underground Electrical Duct Banks and Conduits
1.03 RELATED DOCUMENTS

A. AC 150/5340-18 Standards for Airport Sign Systems
B. AC 150/5340-30 Design and Installation Details for Airport Visual Aids
C. EB-67 Light Sources Other Than Incandescent and Xenon For Airport and Obstruction Lighting Fixtures.

PART 2 PRODUCTS

2.01 GENERAL

A. All commercial items of electrical products not covered by Federal Aviation Administration specifications shall conform to the applicable rulings and standards of the National Electrical Code.

B. Some products shall be City Furnished for installation by the Contractor, as indicated in these specifications and/or on the construction plans and details.

2.02 APPROVAL PROCESS REQUIREMENTS

A. As part of the approval procedure, a sample of all proposed models and/or types of the following products, shall be submitted and become the property of the Airport.

1. Taxiway Centerline Light
2. Connector splice kit.

B. Submittal information shall include, but shall not be limited to, the following, where applicable.

1. Bolt pattern information for fixture bases.
2. Insulating transformer ratings
3. Sign legend, module information, and technical information.

C. Submittals shall comply with Section 16010 – General Provisions - Electrical on submittals.

2.03 LIGHT FIXTURES.

A. Light fixtures and lamps specified shall be low wattage and energy efficient, unless noted otherwise.

B. The fixtures shall meet the latest edition of FAA Specifications in the applicable Advisory Circulars listed and shall be approved under the Airport Lighting Equipment Certification Program described in AC150/5345-53.
C. The lighting fixtures shall be ADB, Crouse-Hinds, or approved equivalent.

D. The guidance signs shall be ADB, quartz lamp, to match existing Siemens signs, or approved equivalent.

E. The guidance sign replacement panels shall be supplied by the manufacturer of the sign, to ensure continued photometric performance.

2.04 PRODUCTS COMMON TO ALL SYSTEMS

A. Primary Cable. Primary L-824 cable shall as specified in Section 16113 – Installation of Underground Cable for Airports.

B. Counterpoise Wire. Counterpoise wire shall as specified in Section 16113 – Installation of Underground Cable for Airports.

C. Isolation Transformers. Isolation transformers shall be of rating compatible with associated light fixture and conforming to requirements of AC 150/5345-47.

D. Fixture Bases. Provide L-868 and L-867, Class I bases that conform to the requirements of AC 150/5345-42 for all fixtures.

1. Certain applications shall require additional entrance hubs, as shown on the plans.
2. All fixture mounting holes in base top shall be drilled completely through and then tapped.
3. Provide L-868, Class I, two-piece bases with factory installed anti-rotation tabs.
4. Coordinate bolt hole patterns for bases with fixtures to be installed. Stainless Steel Hardware to include nylon insert locking nuts. Reference bolt circle dimensions on fixture schedule noted on plans. In general, to match fixtures, bolt hole pattern for bases off concrete pavement shall be 10-1/4 inch diameter and bolt hole pattern for bases in concrete pavement, other than bases for runway edge lights, shall be 11-1/4 inch diameter.

E. Connectors. L-823 connectors used to splice the L-824 primary cables shall be as specified in Section 16113 - Installation of Underground Cable for Airports. Fixtures shall be provided with a single connecting lead plug for connection to L-830 transformers.

F. Ducts and Conduits. Ducts and conduits shall be as specified in Section 16116 – Installation of Airport Underground Duct Banks and Conduits.

G. Tape and Heat Shrinkable Splices. Tapes and splices to be used on primary L-824 cable shall be as specified in Section 16113 - Installation of Underground Cable for Airports.
H. Concrete. Concrete shall adhere to requirements of Structural Portland Cement Concrete Item P-610. Reinforcing steel shall conform to provisions of Item P-610.

I. Sealer Products. Products used shall conform to applicable requirements of Joint Sealing Filler Item P-605. Submit materials with satisfactory adhesive and waterproofing qualities for approval of the CM.

J. Joints. Use joint sealing material conforming to Section Item P-605 across concrete pavement joints. Where conduit is being installed in saw cut trench in existing pavement, OZ Gedney Type DX Expansion Fitting shall be installed at intersection of conduit installation and existing concrete pavement expansion joints.

K. Fixture Hold Down Bolts. Fixture hold down bolts and installations shall adhere to the following requirements.

1. Bolts shall conform to FAA Engineering Brief 83

2. Bolts shall be orange all-thread, 18-8, Grade 5 carbon steel with Fluoropolymer coating.

3. Bolts information shall be submitted for approval of the CM. Submittal shall be specifically identify, as a minimum, the bolt material, dimensions and threading.

4. Bolt material shall be readily identifiable in the field by appropriate ASTM markings on the bolts or by having material identified on bolt packaging, as approved by the City Engineer.

5. Normally, bolts are supplied with the bases, not the fixtures. However, the usual bolts supplied with the bases are too short to extend into base can. The Contractor shall install bolts long enough to extend 1 inch inside the rim of the can after proper installation to hold down fixtures. Bolts of appropriate length shall be ordered accordingly.

6. Fluoropolymer coated bolts shall not receive anti-seize compound.

7. Lock washers shall be installed on each bolt as per fixture base manufacturer’s recommendations. Appropriate lock washers are usually provided with bases.

L. Spacer Rings. Light fixture spacer rings shall be used where shown and required for fixture adjustments. Only 2 spacer rings will be allowed per fixture base. City to retain additional spacers as spare parts.

2.05 PRODUCTS FOR RUNWAY CENTERLINE LIGHTING

A. Light Fixtures. Fixtures shall be furnished complete, ready for installation on a base and shall comply with requirements of AC 150/5345-46. All fixtures shall be style 3. Drawings will indicate use of LED or Quartz Fixtures.
1. Runway centerline light fixtures shall be L-850A. Fixtures shall be bi-directional with white/white or white/red color lenses or uni-directional with red lens, as indicated on construction plans and light fixture schedule. Fixture lamps shall be as shown on plans, or as manufacturer provides.

2. Runway Touch Down Zone light fixtures shall be L-850B. Fixtures shall be uni-directional with white color lenses, as indicated on construction plans and light fixture schedule. Fixture lamps shall be as shown on plans.

3. Fixtures shall be provided with connecting leads for power connections, optical system, lamp and mounting assembly.

B. Isolation Transformer. Transformers shall be L-830, isolation transformers complying with requirements of AC 150/5345-47 for 6.6 ampere series circuits. Transformer wattage rating shall be as shown on plans.

C. Light Base and Transformer Housing. Fixtures shall be installed on L-868 base complying with requirements of AC-150/5345-42.

1. Bases shall house isolation transformer and shall be 12” diameter, two-piece cylindrical body with a top flange having an 11-1/14 inch bolt circle.

2. Empty bases installed for future use shall be as specified above.

2.06 PRODUCTS FOR TAXIWAY CENTERLINE LIGHTING

A. Light Fixtures. Fixtures shall be furnished complete, ready for installation on a base and shall comply with requirements of AC 150/5345-46. All fixtures shall be style 3. Drawings will indicate use of LED or Quartz Fixtures.

1. Taxiway centerline light fixtures shall be L-852C for straight sections and L-852D or L-852K for curved sections as noted on the contract drawings. Fixtures shall be bi-directional with green/green or green/amber color lenses or uni-directional with green or amber lens, as indicated on construction plans and light fixture schedule. Fixture lamps shall be as shown on plans, or as manufacturer provides.

2. Taxiway centerline intersection light fixtures shall be L-852F. Fixtures shall be omni-directional with amber color lenses, as indicated on construction plans and light fixture schedule. Fixture lamps shall be as shown on plans.

3. Taxiway centerline clearance bar fixtures shall be L-852C and shall have uni-directional yellow color lenses, unless indicated otherwise on construction plans and/or light fixture schedule. Fixture lamps shall be as shown on plans.

4. Fixtures shall be provided with connecting leads for power connections, optical system, lamp and mounting assembly.

B. Isolation Transformer. Transformers shall be L-830, isolation transformers complying with requirements of AC 150/5345-47 for 6.6 ampere series circuits. Transformer wattage rating shall be as shown on plans.

C. Light Base and Transformer Housing. Fixtures shall be installed on L-868 base complying with requirements of AC-150/5345-42.
1. Bases shall house isolation transformer and shall be 12” diameter, two -piece cylindrical body with a top flange having an 11-1/14 inch bolt circle.
2. Empty bases installed for future use shall be as specified above.

2.07 ADDITIONAL REQUIREMENTS FOR LED FIXTURES

A. LED fixtures shall comply to the FAA EB-67, Light Sources Other Than Incandescent and Xenon For Airport and Obstruction Lighting Fixtures latest version, and support the dimming curve as stated in EB-67.

B. Out of tolerance circuit current behavior. The fixture shall not fail or enter the failed or open circuit state automatically, when the input current is applied starting from zero amps RMS, and increasing linearly, to the maximum allowed by the constant current regulator. This shall include current levels that not at the correct nominal steps defined in AC 150/5345-10F for CCRs.

C. Light Output Dependency on Current waveform. The light output level of the fixture shall not depend on the duty cycle or crest factor of the input current. Light output shall operate at the nominal steps with full conduction sinusoidal current with a crest factor of 1.414 and partial conduction waveform up to and including a maximum crest factor as specified in AC 150/5345-10 for CCRs. If the RMS current is set for a given step, the fixture shall not change the light output anywhere within the full range of current crest factors.

D. Transient current behavior LED fixtures operating at a selected step, with the associated brightness output, and it encounters a transient in the circuit current, followed by a return to the same RMS current, it shall return to the correct selected step with the associated brightness output for the RMS current as was present before the transient event.

E. LED Fixture Dimming. LED Fixtures shall provide linear dimming as described in EB-67. The fixtures shall average the RMS input current to determine the brightness of the fixture, and not reflect momentary or transient current dips or surges in the light output. Discrete step fixtures are not acceptable.

F. Conducted emissions. The LED fixture and all LED fixtures on the circuits in the contract drawings shall not cause emissive currents in excess of minus 6dBmA at frequencies from 1 to 150 KHz, measured into a 50 ohm load

G. Fixture Step Support. The LED fixture shall support both 3 and 5 step brightness levels as specified in AC 150/5345-10.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL
A. Install conduit, cables, counterpoise and supports necessary to insure a complete and operable electrical installation for lighting systems as specified and shown on the plans.

B. Install and mount the products to comply with the requirements of the National Electric Code, Section 16031 – Airfield Electrical Installation Testing, and Section 16113 – Installation of Airport Underground Cable for Airports.

C. General Light Fixture Base Installation Requirements.

1. Caution shall be exercised during light base installation to prevent the collection of foreign matter in products and on operating components. All installation residue shall be collected as installation progresses. As directed by CM, a cover shield shall be used to protect components from foreign matter during installation.

2. Fixture base shall be installed in existing reinforced concrete or asphalt pavements with connecting conduit as shown on the plans.

3. Light bases shall be set level. Leveling jig shall be required as specified and as directed by the CM.

4. Flexible, seal tight steel conduit shall not be used unless specifically approved by the CM. If approved for use, a maximum length of two (2) feet of flexible, seal tight steel conduit can be installed at the connection point to fixture base cans, only where rigid conduit connections cannot be made. Any flexible, seal tight steel conduit bend radius shall meet the cable manufacturer’s minimum bend radius requirements or shall meet bend radius requirements for rigid conduit. The more stringent requirement shall govern, as determined by the CM.

5. Light or bases shall have 1, 2 or more 2-inch threaded metallic hubs for all required conduit entrances, or as indicated on the plans. Grommeted conduit entrances are strictly prohibited. The cable entrance hubs shall be oriented in the proper direction so as to align with the connecting conduit.

6. Stub-in conduit connections into existing light bases shall be Meyers Hub installation, where required on the plans and as noted on plan details.

7. When existing light fixtures are removed for the purpose of installing new conductors or light fixtures, or cover plates are installed, new SS CEC lockwashers shall be installed using new Grade 5 carbon steel fluoropolymer hold down bolts and bolts shall extend 1 inch below flange into base can. Submit bolts information for approval.

8. Breakage of fixture hold down bolts normally and regularly occurs in the field during fixture removal or fixture installation. When breakage occurs, the Contractor shall adhere to the following requirements:
   a. The Contractor shall submit a broken bolt removal process for approval of the CM.
   b. Submittal shall include information about the planned broken bolt removal process and jig required to effectively drill and tap broken bolts, when necessary.
   c. Whenever encountered, broken bolts shall be removed.
d. Where drilling and tapping is required, a jig approved for use by the CM shall be used. Use Jaquith Industries L867B/L868B drill repair fixture or equivalent.

e. All broken bolts shall be replaced with 3/8"-16 new Grade 5 carbon steel fluoropolymer bolts. In the event that light fixture bases are permanently damaged in the course of removing broken bolts, the Contractor shall be held responsible for the immediate repair/replacement of the lighting base. Permanent damage includes drilling of holes which exceed the required 3/8" bolt diameter and/or any "off centered" impressions that penetrate the inner lip of the existing bolt holes.

f. Use of "helicoils" shall be strictly prohibited as a method of dealing with stripped bolt holes, unless specifically approved in extreme emergency conditions by the CM.

g. Light fixture bases to be used as junction boxes shall be installed at the approximate locations indicated in the plans, or as directed by the CM.

D. General Cable Installation Requirements

1. The primary cable shall enter the light base and transformer housing as shown on the plans.

2. Primary cable slack shall be provided inside the light fixture base following Section 16113 – Installation of Underground Cable for Airports. In general, enough slack shall be left in the cable to permit installation aboveground of the connections between the primary cable and the isolation transformer primary leads. A similar length of primary cable slack shall be provided for any unconnected cable installed in a fixture base can.

3. The transformer secondary leads shall be connected to the lamp leads with a disconnecting plug and receptacle. The secondary connection shall not be taped; the cable connections to the insulating transformer’s leads shall be made following Item Section 16113 – Installation of Underground Cable for Airports.

4. The connector joints in the primary circuit shall be wrapped with at least 1 layer of synthetic rubber tape and 2 layers of plastic tape, one-half lapped, extending at least 1-1/2 inches on each side of the joint.

5. Ends of cables shall be sealed with heat shrinkable tubing until the splice is made to prevent the entrance of moisture.

E. General Duct and Conduit Installation Requirements. Trenching, installation of ducts and conduits, concrete backfilling, trench backfilling, installation of duct markers and the type of material used shall conform to Section 16116 – Installation of Airport Underground Electrical Duct Banks and Conduits.

F. Installing Light Fixtures at Existing Bases

1. At locations indicated on the plans, the Contractor shall install light fixtures at existing fixture bases. This shall include providing the following items, as required and directed by the CM.
a. Remove and salvage existing base cover plates.
b. Refurbish and prepare the base flange with flange rings or spacer rings, as required and directed by the CM, in order to properly install the specified light fixture.
c. Clean out and refurbish the interior of the bases, including conduits.
d. Install primary airfield lighting circuit cable.
e. Provide new Grade 5 carbon steel fluoropolymer bolts and CEC stainless lock washers.
f. Install fixture isolation transformers of proper specified rating and wattage.
g. Install specified fixtures.

G. Demolition and Salvage. At locations noted on plans, the following shall be required.

1. Existing light fixtures, bases, cables and other materials identified as salvageable by the CM shall be removed. Salvageable materials shall be delivered to City salvage area or disposed of as directed by the CM.

3.02 LIGHT FIXTURE INSTALLATIONS IN RIGID PAVEMENT AREAS

A. Toe-In Requirements. Taxiway centerline light fixture installations require that the base shall be angled from a straight set to provide toe-in.

1. Taxiway toe-in for curved taxiway centerline light fixture installations require that the base shall be angled from a straight set to provide toe-in. Taxiway centerline light toe-in shall be left or right, as required, 4 degrees from a line parallel to the centerline of the runway. The Contractor shall submit his written installation method to the CM for approval prior to installation, to provide the proper toe-in as the bases are being set.

B. Light Base Installation Requirements for Class I Bases. Install light fixture bases as per general requirements as noted below.

1. Conduit trench shall be filled with a concrete slurry of well graded aggregate mix with a top size aggregate of 3/8 inches. This concrete shall have a minimum cement content of six (6) sacks per cubic yard and a slump of 5 to 6 inches. The aggregate and other material shall meet the requirements of Item P-610. The level of the slurry fill shall remain 1 (1) inch below the bottom of the pavement slab as shown on the plans.
2. Concrete anchor block around the light base shall be constructed in accordance with Plan details.
3. Light base setting and leveling jig shall not be removed until concrete has set and sufficiently cured to allow stable installation for remainder of system.
4. Before the paving operation, the 1/8 inch mud plate shall be installed over the 5/8 inch construction ring and 3/4 inch plywood cover.
5. After placement of the overlay, the center of the light base is to be located. A properly sized core is to be centered over the base and the asphalt is to be cored and removed. Obtain measurement from the top of the L-868 bottom
section to the top of the pavement and custom fabricate the L-868 top section, allow for installation of 1/8" spacer ring between top section and multi-hole adapter ring. Remove construction ring and cover plate and replace with custom made L-868 top section, spacer ring and fixture as shown in plan details.

6. After installation of the light fixture, the azimuth of the light beam shall not vary more than +1/2 degree from the required direction. The elevation of the light fixture outside edge shall be flush with the surrounding surface elevation such that the elevation of the fixture is not more than +0 inches higher than or -1/16 inch lower than the elevation of the pavement. If this tolerance is not met, the Contractor shall, at his expense, remove and replace the fixture to the satisfaction of the City.

7. In-concrete light bases shall have 1, 2 or more 2-inch threaded metallic hubs for all required conduit entrances, as indicated on the plans. Grommeted conduit entrances are strictly prohibited.

C. Light Fixtures. Assemble the light fixture following the manufacturer's instructions. Connect the secondary leads of the transformer to the fixture leads with a disconnecting plug and receptacle conforming to AC 150/5345-26A without taping the joint. Install a lamp of the proper rating in the fixture. Level each fixture as recommended by the manufacturer.

3.03 TAXIWAY CENTERLINE AND FLUSH MOUNTED EDGE LIGHTING SYSTEMS

A. Description. The taxiway centerline lighting system shall consist of single semi-flush lights installed on a line parallel to the geometrical center of the taxiway.

1. Longitudinal Spacing. Light fixtures shall be spaced longitudinally as shown on the plans. A tolerance of plus or minus 10 percent of the longitudinal spacing specified to eliminate interferences shall be allowed and subject to the approval of the CM. Taxiway lights shall be displaced a maximum of 2 feet from the geometrical centerline of the taxiway. This lateral tolerance shall be applied consistently to avoid abrupt and noticeable changes in alignment, i.e., "zigzagging" from 1 side to the other side of the centerline.

2. Long Radius Taxi Exits Greater Than 1,200 Feet. The configuration shown on the plans shall be used to establish the starting point on the runway, spacing, and other details necessary to provide guidance to aircraft from the runway centerline into the "throat" of a long radius taxi exit.

3. Taxiway Crossing or Intersecting Another Taxiway. Taxiway centerline lighting shall continue across the intersection when a taxiway intersects or crosses another taxiway. An omni-directional, L-852F fixture shall be installed at the point of intersection of the 2 centerline light systems as shown in the details in the plans.

4. Taxiways Crossing a Runway. Taxiway centerline lighting shall normally stop where taxiways intersect or cross a runway. Lights shall not encroach within the confines of an intersecting runway except where shown on the plans.

5. Orientation of light beams shall adhere to the following requirements.
a. On Straight Portions. On all straight portions of taxiway centerlines, the axis of the light beam shall be parallel to the centerline of the taxiing path.

b. On Curved Portions. The axis of the 2 beams of bi-directional lights shall be oriented parallel to the tangent of the nearest point of the curve designated as the true centerline of the taxiway path. The axis of a unidirectional light beam shall be oriented so that it is "toed-in" to intersect the centerline of the light fixture path radius at a point approximately equivalent to 4 times the spacing of lights on the curved portion. This spacing shall be measured along the chord of the curve.

6. Flush mounted edge lights shall be located as indicated on the drawings and shall be a part of the taxiway edge lighting system.

B. Installation. Taxiway centerline and flush mounted edge lights shall be installed following details shown on the plans.

C. Testing and Inspection

1. General. Because certain components may be inaccessible after final installation, lighting shall be tested concurrently with installation.

2. Elevation and Alignment. Light unit installation procedures shall be checked during construction and after the system has been completed to determine that the recommended fixture elevation and alignment is following design and manufacturer's installation requirements.

3. Securing Screws or Bolts. All fixture securing screws or bolts shall be tightened following the manufacturer's recommendations.

4. Light Channels and Lenses. Each light fixture shall be checked to determine that the lenses and the channels in front of the lenses are clean.

5. Cables, Wiring and Splices. All cables, wiring, and splices shall be tested following Item Section 16113 – Installation of Underground Cable for Airports.

6. The airfield electrical installations shall be tested following the requirements of Section 16031 – Airfield Electrical Installation Testing.

7. Systems Tests shall also be conducted following Item Section 16031 – Airfield Electrical Installation Testing.

8. Any system installation errors or unacceptable discrepancies of installation shall be corrected, as directed by CM and to the satisfaction of the CM.

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. Replacement of an in-pavement light fixture in a pavement panel will be paid for at the contract unit price for each item completed in accordance with the plans and specifications that is installed by the contractor and accepted by the Engineer. The scope will include removing the existing fixture and re-installation of the fixture in a new base can with all conduit and cabling replacement for the complete pavement panel section. The removal scope includes removing and storing the existing in-pavement light fixture including all salvageable components, removal
of the light base with associated conduit and counterpoise wire removed for the entire pavement panel repair area and the associated L-824C cables removed from the noted fixture to each adjacent fixture. The re-installation scope include installation of the new base can with associated 2” schedule 40 PVC conduit and #6AWG counterpoise wire for the duration of the pavement panel repair, new #8AWG L-824C conductors of same quantity as demolished from the new base can to the two adjacent light fixtures, new ground rod at the base can, reinstallation of the existing fixture in the new base can with new safety ground, new isolation transformer and connector kits for the reinstalled fixture and the two adjacent fixtures, all complete in place and accepted. Additional incidentals to this item include the multihole adapter ring, cable tag, fixture ID, terminations, new stainless steel hardware and CEC lock washers, and all items necessary to complete installation and accepted by the Engineer. Separate measurement will be made for each pavement type only. There will be no separate measurement for the in-pavement fixture type.

4.02 METHOD OF PAYMENT

A. The light fixture replacement will be paid for at the contract unit price for each item completed in accordance with the plans and specifications that is installed by the contractor and accepted by the Engineer. This price shall be full compensation for furnishing all materials, labor, tools and incidentals necessary to install the light, complete in place in accordance with the plans and specifications.

Payment will be made under:

16530-1 Replace in-pavement light in PCC Pavement Panel – Per Each
16530-2 Replace in-pavement light in HMAC Pavement – Per Each

END OF SECTION
Section 16535

MEDIUM-INTENSITY APPROACH LIGHTING SYSTEM
WITH RUNWAY ALIGNMENT INDICATOR LIGHTS (MALSR) (Item L-130)

PART 1 DESCRIPTION

1.01 GENERAL.

A. This item shall consist of systems furnished and installed in accordance with this specification, any referenced specifications, and the applicable Federal Aviation Administration Advisory Circulars and orders. The systems and equipment shall be installed at the location and in accordance with the dimensions, layout, design, and details shown in the plans. This item shall include furnishing and infrastructure required for a FAA certified Category I Instrument Landing System (ILS), testing of the installation and all incidentals and appurtenances necessary to place the systems in operation as completed units to the satisfaction of the Engineer.

B. The Contractor shall install equipment provided by FAA and furnish and install equipment not provided to complete the infrastructure required for the ILS. The installation work shall include, but not be limited to, glide slope antenna, localizer antenna array, glide slope shelter, localizer array shelter, equipment foundations, access roads, maintenance areas, site preparation, excavation, grading, backfill, compaction, fiber optic cabling, power and communications services equipment and cabling, and grounding and bonding systems. The work shall include the installation of necessary equipment, infrastructure, etc. to facilitate a FAA certified system. The Contractor shall certify the installation is in accordance with FAA criteria and testing completed. Copies of certification and test reports shall be submitted to the Owners. After testing is complete and the installation has been accepted, FAA will commence with the installation of the electronics, final connections of wiring and equipment, testing, flight checking, and establishment of the facilities for public use.

C. The following specification cover MALSR equipment developed for use in performance of Category I (CAT I) service. The ILS equipment shall be approved under Federal Aviation Regulation (FAR) Part 171 and Annex 10 to the Convention on International Civil Aviation (ICAO).

1.02 REFERENCED MATERIALS.

A. Additional details pertaining to specific systems covered in this section are contained in the Federal Aviation Administration (FAA) Advisory Circulars (AC's), latest edition, listed below:

1. 150/5345-1 Approved Airport Equipment

16535-1
10-13-17
2. 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
3. 150/5345-26 FAA Specification for L-823 Plug and Receptacle, Cable Connectors
4. 150/5345-42 Specification for L-823 Plug and Receptacle, Cable Connectors
5. 150/5345-53 Airport Lighting Equipment Certification Program
6. 150/5370-2 Operational Safety on Airports During Construction
7. 150/5370-10 Standards for Specifying Construction of Airports
8. 150/5345-28D Precision Approach Path Indicator (PAPI) Systems
9. 150/5345-51 Specification for Discharge-Type Flashing Light Equipment
10. FAA-C-1217F Electrical Work – Interior
11. FAA-C-1391B Installation and Splicing of Underground Cables
12. FAA-E-2013D Cable, Electrical Power, Exterior 600 Volts
13. FAA-E-2042C Cable, Electrical Control, Exterior
14. FAA-E-2072C Cable, Telephone, Exterior
15. FAA-STD-019E Lightning and Surge Protection, Grounding, Bonding and Shielding Requirements for Facilities and Electronic Equipment
16. FAA Order 6850.2A Visual Guidance Lighting Systems
17. FAA Order 6750.16D Siting Criteria for Instrument Landing Systems

B. The Contractor is responsible for obtaining and using the latest edition of the referenced FAA Advisory Circulars. This is not all inclusive but is offered as a convenience to the contractor.

1.03 SUBMITTALS.

A. Shop drawings of each airfield lighting component, indicating FAA approval, shall be submitted to the Engineer for review and approval and be approved prior to ordering any material for this item. This submittal shall include the proposed method of installation for all airfield lighting components. The submittal shall include data on all component parts of the item or system, and shall include the manufacturers list of recommended spare parts for one year’s use. The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the contract documents. The Contractor’s submittals shall be in accordance with Item L-106, Submittals, Record Documents and Maintenance Manuals.

1.04 QUALIFICATIONS.

A. The engineer reserves the right to reject any and all equipment, materials or procedures, which, in the Engineer’s opinion, does not meet the system design and the standards and code, specified herein.
B. The term “Subcontractor” shall mean the specialty contractor as specified herein providing all the work of this section. The contractor shall be a Subcontractor or employ a Subcontractor to perform the work of this section.

C. The Subcontractor shall be fully responsible for the work of this section and shall provide all of the work of this section. The Subcontractor shall not delegate any work of this section to other Subcontractors without prior approval from the Engineer. Any such Subcontractors shall be fully bound by all the Contract documents and as specified herein.

1.05 QUALITY ASSURANCE.

A. The Subcontractor shall have at least seven (7) years direct experience with devices, equipment, and systems of the type and scope specified herein. The Subcontractor shall be a business entity that is substantially engaged in the work of this section and has successfully done so for the past three consecutive years at a minimum. The Subcontractor shall as part of the foregoing business have a fully staffed, parts stocked, equipped maintenance and repair facility.

B. The supervisor of the work of this section shall have at least five (5) years direct professional experience with devices, equipment, system installations of the type and scope specified herein.

C. All personnel engaged in the installation of this section have at least three (3) years direct experience with devices, equipment, and system installations of the type and scope specified herein.

1. The subcontractor shall submit the following:
2. A list of at least five (5) successful installations comparable in scope and complexity to that specified herein.
3. Proof that the firm is regularly engaged in the business of designing, installing, and servicing systems of the type specified herein.
4. Verification (names and biographies) of the firm’s design, installation, service, and maintenance personnel and facilities with a maintained stock of service parts showing competence.
5. A list of all test equipment as specified below showing manufacturer, model number, all installed options, and dates of last calibration.

D. The following is a list if ILS Installers/Subcontractors:

1. DACO Construction Company, Inc., Norfolk NE – (402) 379-3165
2. Hy-Lite Construction Company, Strongsville, OH – (216) 238-9090
3. Jess Howard Electric
4. DME
5. Schouten Construction
6. Chappy Construction
7. Precision Approach
PART 2  MATERIALS

2.01  GENERAL.

A. Equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified and listed under Advisory Circular (AC) 150/5345-53, Airport Lighting Equipment Certification Program, and FAA Order 6850.2A, and FAA Order 6750.16D, latest editions, where applicable.

B. All other equipment and materials covered by other referenced specification shall be subject to acceptance through manufacturer’s certification of compliance with the applicable specification. The Contractor shall submit the manufacturer’s certificate of compliance with the applicable specification sections to the Engineer for approval before the equipment and material are ordered.

C. Manufacturers certifications shall not relieve the Contractor of his responsibility to provide materials in accordance with these specifications and acceptable to the Engineer. Materials supplied and/or installed that do not materially comply with these specifications shall be removed, when directed by the Engineer and replaced with materials, which do comply with these specifications, at the sole cost of the Contractor.

2.02  GUARANTEES.

A. Except as modified below, all equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of twelve (12) months or the manufacturer’s standard guarantee period whichever is greater, from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner’s discretion, with no additional cost to the Owner.

2.03  CABLES.

A. Cables shall comply with specification L-108, Installation of Underground Cable for Airports and L-111 Section 16120, Wire and Cables.

2.04  L-823 CONNECTORS.

A. Connectors shall comply with specification L-108, Installation of Underground Cable for Airports.

2.05  FRANGIBLE COUPLINGS.

A. All elevated items shall be installed on frangible couplings in accordance with the respective Federal Aviation Administration Advisory Circular. Frangible couplings shall be metallic and provide an electrical grounding path between the fixture/sign and the base can.
2.06 TAPE.

A. Plastic electrical tapes shall be Scotch Electrical Tape number 88 as manufactured by the Minnesota Mining and Manufacturing Company, or an approved equivalent. Electrical coating shall be Scotchkote as manufactured by the Minnesota Mining and Manufacturing Company, or approved equivalent.

2.07 CONCRETE.

A. Concrete for backfill shall comply with Specification P-610, Structural Portland Cement Concrete and have a maximum size coarse aggregate of 1-inch and shall have a 28-day comprehensive strength of not less than 4,000 psi and increasing with age.

2.08 CONDUIT.

A. Conduit shall comply with specification L-110, Installation of Airport Underground Electrical Duct and L-111 Section 16111, Conduit Systems.

2.09 HEAT SHRINK KIT.

A. Heat shrinkage tubing with integral sealant for waterproofing L-823 connectors shall be Sigmaform Corporation Type APL, or Raychem Corporation Type ADL, or Crouse Hinds Type HSK or approved equivalent.

2.10 IDENTIFICATION/NUMBER PLATES.

A. The identification/number plates shall be 2-inch diameter brass tags/monuments unless otherwise noted as shown in the plans and details. The identification shall be permanently stamped. Text height shall be 3/8-inch.

2.11 REINFORCING STEEL.

A. All reinforcing steel shall be ASTM A 615, Grade 60.

2.12 BOLTING HARDWARE.

A. All airfield bolting hardware shall be stainless steel and shall meet FAA requirements. All bolts \( \frac{1}{4} \)-inch and larger shall be hex head type. All bolts smaller than \( \frac{1}{4} \)-inch trade size shall be recessed allen type. All bolted connections shall utilize an anti-rotational locking type device. The base can cover and fixture mounting bolts shall extend through the base can mounting flange into the base can minimum of 0.5-inches. The bolts shall have enough thread length so they do not shoulder out before the fixture is securely tightened.

2.13 ANTI-SEIZE COMPOUND.

A. The anti-seize compound shall be Ideal “Noalox” or approved equivalent. Use GE-RTV-118 non-curing sealant to seal between sections of base cans, spacer 16535-5

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rings, adaptor rings or fixtures.

2.14 FILLERS AND ADHESIVES.

A. Joint sealing filler shall comply with Specification P-605, Joint Sealing Filler and adhesive compounds shall comply with Specification P-606, Adhesive Compounds, Two-Component, For Sealing Wire and Lights and Pavement. The P-605 and P-606 compounds shall be formulated so they are compatible with the pavement type with which they are to be used.

2.15 STRAIN RELIEF CONNECTORS.

A. Strain relief connectors shall be Liquid Tight Thomas & Betts 2500 series with WMG-PG wire mesh cable grip or approved equivalent.

2.16 IDENTIFICATIONS MARKERS.

A. Fixture, manhole and sign identification markers shall be brass bench markers by Surv-Kap of Tucson, Arizona model number M/M-B2 with flat top or approved equivalent.

2.17 DELIVERY, STORAGE AND HANDLING.

A. Ship materials and equipment disassembled only to the extent necessary for reasons of shipping limitations, handling facilities, and to avoid damage during shipment. Maintain materials and equipment in new condition. This shall include the use of heat lamps, suitable coverings, indoor storage, etc. to properly protect the equipment and materials. Any equipment or materials, in the opinion of the Owner or Engineer, damaged during construction or storage periods shall be replaced by and at the expense of the Contractor.

PART 3 CONSTRUCTION METHODS

3.01 INSTALLATION.

A. All equipment shall be installed as shown in the plans or approved shop drawings and in accordance with the applicable FAA Advisory Circulars and manufacturers’ recommendations. Survey instruments shall be used to position all items to insure precise orientation. Tolerances given in the FAA Advisory Circulars, these specifications, and the plans shall not be exceeded. Where no tolerance is given, no deviation is permitted. Items not installed in accordance with the FAA Advisory Circulars, these specifications and plans shall be removed and replaced by and at the expense of the Contractor.

B. The Contractor shall install all equipment in accordance with manufacturer’s recommendations and per FAA standards. All work shall be performed in a neat and workmanlike manner and shall conform to all applicable local, state and
federal building codes. The installation of all MALSR equipment shall be tested as the completion of work and test reports shall be provided. After testing is complete and the installation has been accepted, FAA will commence with the installation of the electronics, final connections of wiring and equipment, testing, flight checking, and establishment of the facilities for public use.

C. The Contractor shall use a licensed surveyor to layout all of the facilities. The Contractor shall provide the Engineer with proof of the surveyor's State licensing credentials. The Contractor's surveyor shall layout the project in accordance with the applicable drawings and specifications. All taped measurements shall be made with a steel (non-stretch) tape. The Contractor shall not proceed with any construction or installation until each layout by the Contractor's surveyor has been confirmed and accepted by the Engineer.

D. All loose material shall be removed from all excavations for electrical equipment, raceways, manholes, pads, etc. The bottom of the excavation shall be compacted to 95% compaction in accordance with ASTM D 1557 prior to the installation of the electrical item and backfill.

E. In new or existing pavement all conduits, duct banks, counterpoise, base cans, etc. shall be installed prior to the placement of the final lift of pavement.

F. An identification tag shall be installed with each piece of equipment as shown in the plans. Brass circuit identification tags identifying each circuit shall be attached to each circuit as shown in the plans.

G. Painted and galvanized surfaces that are damaged shall be repaired according to the manufacturer's recommendations, to the satisfaction of the Owner and Engineer. Use LPS-1G cold galvanizing compound or approved equivalent to repair galvanized surfaces. Obtain paint and primer, of same batch number, from the equipment manufacturer to repair painted surfaces.

H. GE RTV-118 non-curing sealant or approved equivalent shall be used to seal between sections of base cans, spacer rings, adapter rings or fixtures.

I. All threaded portions of frangible couplings, etc., shall be coated with Ideal "Noalox" compound or approved equivalent before being assembled.

J. Dewatering necessary to construct items and related erosion and turbidity control shall be in accordance with federal, state, and local requirements and is incidental to its respective pay item as a part of L-130. The cost of all excavation regardless of type of material encountered shall be included in the unit price bid for this item.

3.02 INSTALLATION OF CONCRETE FOUNDATIONS FOR THRESHOLD LIGHT BAR.

A. The Contractor shall layout and construct the concrete foundations for the
threshold light bar in accordance with the specifications and drawings. The threshold bar consists of eighteen (18) lights with light bases encased in a concrete foundation.

3.03 INSTALLATION OF CONCRETE FOUNDATIONS FOR EMT PEDESTALS.

A. The Contractor shall layout and construct the concrete pedestal foundation in accordance with the specifications and drawings. The pedestal foundation is used for light bars that are mounted to a light plane height of 6’-0” and below.

3.04 INSTALLATION OF CONCRETE FOUNDATIONS FOR LOW IMPACT RESISTANT (LIR) TOWERS.

A. The Contractor shall layout and construct the concrete tower foundations in accordance with the specifications and drawings. The tower foundations are used for light bars or flashers mounted on LIR Towers from 6’-1” to 40’-0” in height.

3.05 INSTALLATION OF EQUIPMENT SHELTER FOUNDATION.

A. The Contractor shall layout and construct the foundation for the equipment shelter in accordance with the specifications and drawings.

B. The Contractor shall carefully install all conduits, which are to pass through the foundation, prior to placement of the shelter. All conduits shall be extended down to a minimum trench dept of 30 inches below grade or as shown on the drawings.

3.06 INSTALLATION OF LOW-IMPACT RESISTANT (LIR) TOWER STRUCTURE.

A. The Contractor shall provide the labor and equipment required to assemble and install the LIR/MG tower structures in accordance with contract drawings, specifications and as specified herein. The Drawing Series D-6155, Low-impact Resistant Structures-Assembly Drawings are to be used in addition to applicable contract drawings.

B. The Contractor shall install the LIR tower structures, with all associated hardware, on concrete foundations in accordance with manufacturer instructions furnished with the structures and all applicable contract drawings and specifications.

C. The Contractor shall install lights on the LIR structures including all associated electrical work in accordance with the contract drawings and specifications. All tolerances of the lights on top of these structures shall be in accordance with the specifications.

D. The Contractor shall demonstrate to the satisfaction of the Engineer the smooth operation of the mechanical system of the installed LIR assembly after all
associated electrical work is completed. In the event that the mechanisms do not perform satisfactorily, the test shall be stopped. No excessive force shall be used to operate or correct the system. The test shall be repeated anew after proper adjustment.

3.07 POWER DISTRIBUTION AND TERMINATION.

A. The Contractor shall provide power to the equipment shelter and light stations, including installation, distribution, and termination of the power cables in accordance with the specifications and drawings.

3.08 CONTROL DISTRIBUTION AND TERMINATION.

A. The MALSR shall be controlled by landline from the Control Tower Cab. FAA will install all control equipment in the Control Tower. The Subcontractor shall provide all control equipment and wiring in the shelter and between approach lighting stations as required.

3.09 TESTING.

A. This section describes the testing and demonstrations furnished by the Contractor. All items furnished and/or installed by the Contractor shall be tested and demonstrated in accordance with these specifications. All equipment and labor required for testing and demonstrations shall be furnished by the Contractor.

1. Fully test the installation by continuous operation for a period of not less than seventy-two (72) hours as a completed unit, prior to acceptance by the Owner.

2. Up to two (2) walk-throughs may be initiated by the Owner or the Engineer during which the airfield lighting units would be required to be in operation. Additional walk-throughs may be necessary depending upon the number of discrepancies found on the previous walk-throughs.

3. The Contractor is responsible for lamp replacements and necessary maintenance of airfield items during the testing, construction and walk-through periods.

4. Test cabling per specification L-108, Installation of Underground Cable for Airports.

5. Demonstrate all features and functions of all systems and instruct the Owner’s personnel in the proper and safe operation of the Systems.

6. The Contractor shall perform the necessary inspection and tests for some items concurrently with the installation because of subsequent inaccessibility of some components. The Engineer shall be notified by the Contractor forty-
eight (48) hours in advance of any testing.

7. The contractor shall perform the necessary adjustments required at the discretion of the FAA following the flight check.

8. Test the ESS grounding system. The resistance at all test wells must not exceed 10 ohms. Refer to Section SS-L-111.

B. There are no approved “repair” procedures for items that have failed testing other than complete replacement. Any other corrective measures shall be approved in writing by the Engineer.

3.10 OPERATION AND MAINTENANCE MANUALS.

A. The Contractor shall provide data for all equipment, material and components supplied or furnished under this section in the Operation and Maintenance Manuals. This data shall include cut sheets from the manufacturer and the manufacturer’s installation, operation and maintenance manuals, recommended spare parts lists, any required test results, and other data as required by Section L-106, Submittals, Record Documents and Maintenance Manuals. The manuals shall be in accordance with Section L-106. Final Payment for any contract amounts shall not be processed without proper submittal of these manuals and review and approval by the Engineer.

3.11 CONTRACT DRAWINGS.

A. Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the functions to be performed, even though some minor details are not shown, the Contractor shall furnish all equipment, material, and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation. Further, the Contractor shall be responsible for taking the necessary actions to ensure that all electrical work is coordinated and compatible with the civil plans.

3.12 MINOR DEPARTURES.

A. Minor departures from exact dimensions shown in the electrical plans may be permitted where required to avoid conflict or unnecessary difficulty in placement of a dimensional item, provided contract requirements are met. The Contractor shall promptly obtain approval from the Owner and/or the FAA Resident Engineer prior to undertaking any such proposed departure.

PART 4 MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. Replace MALSR in-pavement 5-light Bar will be measured per lump sum. This
item shall include work associated with the removal and re-installation of the existing MALSR in-pavement 5-Light Bar located within a pavement panel. The scope will include removing the existing fixture and re-installation of the fixture in a new base can with all conduit and cabling replacement for the complete pavement panel section. The removal scope includes removing and storing the existing inpavement light fixture including all salvageable components, removal of the light base with associated conduit and guard wire removed for the entire pavement panel repair area and the associated FAA cables removed from the noted fixture to each adjacent fixture. The re-installation scope include installation of the new base cans with associated 2” schedule 40 PVC conduit and #1/0 AWG guard wire for the duration of the pavement panel repair, new conductors of same type and quantity as demolished from the new base cans to the light fixtures in the two adjacent light bars, new ground rod at each new base can, reinstallation of the existing fixtures in the new base cans with new safety ground, new isolation transformer and connector kits for the reinstalled fixtures and the two adjacent light bar fixtures, all complete in place and accepted. Additional incidentals to this item include the multihole adapter ring, cable tag, fixture ID, terminations, new stainless steel hardware and CEC lock washers, testing, commissioning, coordination with FAA and all labor, equipment, tools and incidentals necessary to complete, in place, the item in accordance with these specifications and as indicated on the drawings and all items necessary to complete installation and accepted by the FAA.

4.02 BASIS OF PAYMENT

A. Payment will be made at the lump sum price for the item completed in accordance with the plans and specifications that is installed by the Contractor and accepted by the Engineer. This price shall be full compensation for furnishing all materials and for all preparation, assembly and installation of these materials, and for all labor, equipment, tools, incidentals, and appurtenances necessary to complete these items.

Payment will be made under:

16535-1 Replace MALSR In-pavement 5-Light Bar in Pavement Panel– per Lump Sum.

END OF SECTION