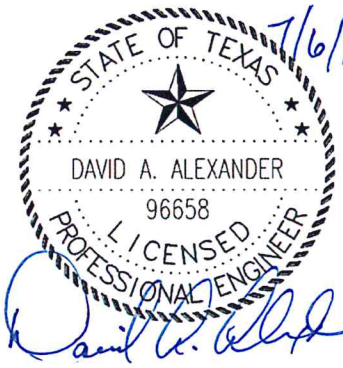
TECHNICAL SPECIFICATIONS

SAN ANGELO REGIONAL AIRPORT – MATHIS FIELD

Taxiway Reconfiguration Project

CITY RFB No. AP-02-17
FAA AIP No. 3-48-0191-035-2017
KSA Project No. SAN.059



JULY, 2017

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TBPE Firm Registration No. F-1356

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San Angelo Regional Airport – Mathis Field
Taxiway Reconfiguration Project
City RFB No. AP-02-17
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CIVIL SPECIFICATIONS

Project Specific Specifications

Part 1 – General Provisions

Part 2 – Earthwork

FAA Standard Specifications

Part 2 - Earthwork

Part 5 – Flexible Surface Courses

Part 7 - Miscellaneous

Part 9 – Drainage

Part 10 – Turfing

ELECTRICAL SPECIFICATIONS

Project Specific Specifications

Part 11 – Lighting Installation

FAA Standard Specifications

Part 11 – Lighting Installation

Attachments

1. Geotechnical Investigation
2. AC 150/5370-2F – Operational Safety on Airports During Construction
3. AC 150/5345-53D – Airport Lighting Equipment Certification, Appendix 1 Addendum
4. AC 150/5370-15 – Airside Applications for Artificial Turf
5. Index of Sheets

TECHNICAL SPECIFICATION REFERENCES

The technical specifications included herein were prepared from the following sources:

- Project specific specifications (KSA-###) prepared by the Engineer
- Federal Aviation Administration specifications (D-###, L-###, P-###, T-###) from Advisory Circular 150/5370-10G.

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CIVIL: PROJECT SPECIFIC SPECIFICATIONS

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ITEM KSA-100 PROJECT SCHEDULE, MOBILIZATION AND FIELD OFFICE

DESCRIPTION

100-1.1 The work covered by this section consists of preparatory work and operations, including but not limited to those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of all offices, buildings, and other facilities necessary for work on the project; and for all other work and operations which must be performed or costs incurred prior to beginning work on the various items on the project site.

This item shall also cover the mandatory project schedule to be updated and provided to the Engineer, as described herein.

100-1.2 PROJECT SCHEDULE. A complete project schedule shall be provided by the Contractor at the Pre-Construction meeting and shall be explained by the Contractor to the meeting attendees. Any necessary runway and /or taxiway shutdown dates may be determined at the Pre-Construction meeting, or at a later time, as approved by the airport manager and coordinated by the Resident Project Representative.

Interim project schedules shall be provided prior to processing each month's pay request and shall include the following, as necessary:

a. Original baseline schedule;

b. Updated schedule to current construction activity;

c. Adjusted critical path; and

d. Adjusted runway and/or taxiway shutdown dates.

Each month's pay request will not be processed until the updated interim project schedule has been submitted to the Engineer. Any delay in the Engineer receiving the updated interim project schedule will cause a delay in processing that month's pay request. Refer to the General Notes as shown on the plans for any additional requirements.

100-1.3 STAGING AREA. The area designated on the plans as the Contractor's staging area, including ingress and egress to the construction site, shall be prepared for the storage of equipment and supplies. This shall include, but not be limited to, grading, gates (for the Contractor's equipment and supplies), power supply, telephone service, field offices, etc., necessary for the Contractor to perform his responsibilities as required by the Contract. Restoring the site to pre-project conditions by grading and establishing grass shall be included in this item. The installation of a safety fence around the perimeter of the staging areas shall also be included in this bid item, as necessary.

100-1.4 FIELD OFFICE. A temporary field office with security lock and "complete" set of keys separated from the Contractor's Field Office shall be furnished to the Engineer for his sole use. The office shall be in clear view of the project area. The office shall be structurally sound, meet all local building codes for temporary structures and have a minimum of the following:

a. 150 square feet of floor space;

b. Entrance steps, as necessary;

c. One office desk with office chair;

d. One table suitable for drafting and layout with drafting chair;

e. One table with chairs suitable for meetings;

f. Filing cabinet and storage shelves;

g. Commercial power supply with adequate outlets and lights;

h. Approved heating and/or cooling units;

i. Drinking water;

j. Toilet facilities;

k. Separate phone line and equipment including local phone service;

l. 3 MBps Internet service;

m. Copy machine and supplies; and

n. Portable hand-held aviation band radio.

Contractor shall be responsible for payment of all monthly utility bills and installation fees.

100-1.5 ADDITIONAL REQUIREMENTS. Refer to the General Notes as shown on the plans for additional requirements.

METHOD OF MEASUREMENT

100-2.1 Measurement for this item will be by the lump sum as the work progresses.

BASIS OF PAYMENT

100-3.1 All work covered by this section will be paid for at the contract lump sum price for "Mobilization, Etc."

Partial payments for the "Mobilization, Etc." bid item will be made with the first and second partial pay estimates paid on the contract, and will be made at the rate of 50% of the lump sum price for "Mobilization, Etc." on each of these partial pay estimates, provided the amount bid for "Mobilization, Etc." does not exceed 10% of the total amount bid for the contract. Where the amount bid for the item of "Mobilization, Etc." exceeds 10% of the total amount bid for the contract, 5% of the total amount bid will be paid on each of the first two partial pay estimates, and that portion exceeding 10% will be paid on the last partial pay estimate.

Payment will be made under:

Item 100-3.1	Mobilization, Etc.	Per lump sum

END OF ITEM 100

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ITEM KSA-101 SHOP DRAWINGS, PROJECT DATA, AND SAMPLES

DESCRIPTION

101-1.1 Contractor shall furnish all labor, materials, tools, equipment, and perform all work and services necessary for or incidental to the furnishing, processing, delivery, reproduction and other necessary functions incidental to scheduling and handling of shop drawings, project data, and samples as indicated on the plans and/or as specified, in accordance with provisions of the Contract Documents, and completely coordinated with work of all trades.

a. Although such work is not specifically shown or specified, all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for completion of work under this item shall be furnished and performed as part of this item.

b. See appropriate sections for specific items for which data and/or samples are required.

101-2.1 SUBMITTAL, ADDRESS. All items shall be submitted electronically. The preferred method of submission is utilizing the Newforma Info Exchange project page provided by KSA. KSA will provide a link to the project page for the Contractor to make submittals, to submit RFI's, and upload large files as necessary. There is no cost for using this service. If for some reason the Contractor cannot utilize the Newforma Info Exchange project page for submission, the Contractor shall submit one scanned copy of the submittal via the email to the Design Engineer, Will Davidson, at wdavidson@ksaeng.com.

101-3.1 SUBMITTALS, GENERAL.

a. Contractor shall be responsible for and make all submissions. All items shall be transmitted electronically and include a Contractor's review stamp.

b. Each transmittal will be sequentially numbered starting with No. 1.

(1) An item that is resubmitted will retain the original number but with an added suffix starting with A.

(2) Only one specification division should be covered by one letter of transmission.

(3) Sufficient catalog information together with catalog cuts and technical data must be submitted to allow an evaluation to be made to determine whether or not the item in question is acceptable.

c. No submittals will be returned to subcontractors. Submittals transmitted to the Engineer by anyone other than the Prime Contractor will be returned to the Prime Contractor.

d. Submit items sufficiently in advance of date required to allow reasonable time for review, and to allow for resubmission if necessary. Items submitted without Contractor's approval stamp will be returned, without action, for resubmission. Items that are not submitted in accord with the provisions of this item will be returned, without action, for resubmission.

e. Operation and Maintenance Manual, and/or warranties where required, shall be separate transmittal.

101-4.1 SUBMITTALS, SHOP DRAWINGS PROCEDURE.

a. Submit as indicated above. Identify submittals as to manufacturer, item, use, type, project designation, specification section or drawing detail reference, and other pertinent information.

b. Submit an electronic copy of each submittal until approval is obtained.

c. Allow clear space for stamping on right hand side. Contractor shall stamp his approval on drawings prior to submission to Engineer as indication of his checking and verification of dimensions and coordination with interrelated items. Marks on submittals by Contractor shall not be in red.

d. Submit standard items like equipment brochures, cuts of fixtures, or standard catalog items (reproducible not required). Indicate exact item or model and all proposed options. Include scale details, sizes, dimensions, performance characteristics, capacities, wiring diagrams, controls, and other pertinent data.

101-5.1 SUBMITTALS, SAMPLES.

a. Submit to address indicated above. Identify submittals as to manufacturer, item, use, type, project designation, specification section of drawing detail reference, and other pertinent information.

b. Forward with transmittal letters. Include brochures, shop drawings, and installation instruction. Contractor shall stamp his approval on drawings prior to submission to Engineer as indication of his checking and verification of dimensions and coordination with interrelated items. Resubmit samples of rejected items.

c. Approved samples submitted or constructed, constitute criterion for judging completed work. Finished work or items not equal to samples will be rejected.

d. Samples will be retained for comparison purposes and/or the Contractor shall remove samples as directed. Contractor shall pay all costs of furnishing and removing samples.

101-6.1 SUBMITTALS, APPROVAL OR REJECTION.

a. Transmittals returned with Approval are considered ready for fabrication and/or installation. If for any reason a transmittal that has an A or B approval is resubmitted, it must be accompanied by a letter pointing out the changes that have been made and the reason for the re-submittal. It shall be the Contractor's responsibility to assure that the previously approved documents are destroyed when they are superseded by a re-submittal as such.

b. Transmittals with approval combined with Action "Revise and Resubmit" or "Rejected" will be individually analyzed giving consideration as follows:

(1) If the items or system proposed is acceptable and the majority of the major individual components (Drawings or Documents) are in compliance; however, there are some minor items not in compliance. The portion of the transmittal given "Revise and Resubmit" or "Rejected" will not be distributed (unless previously agreed to otherwise). Copies of the "Revise and Resubmit" or "Rejected" drawings will be marked up and returned to the Contractor electronically. It shall be the Contractor's responsibility to insure that these items are corrected and resubmitted.

(2) If the items or system proposed are acceptable; however, the major part of the individual drawings or documents are incomplete or require revision, the entire submittal will be given "Revise and Resubmit" or "Rejected" action. Again, it is reiterated that this is at the sole discretion of the Engineer and some drawings may contain relatively few or no comments for the statement, "Resubmit" to maintain a complete package. Distribution to the Owner and field will not be made unless previously agreed to otherwise.

(3) Approval is general and does not permit departure from Contract Documents; relieve Contractor from responsibility for errors in detail, dimensions or related items; approve departure from previous instructions or details; components, wiring, etc., required to make item operational or usable.

(4) Manufacture or fabrication of items prior to final approval is at Contractor's own risk.

101-7.1 REQUIRED SHOP DRAWINGS, CERTIFICATE, OR REPORTS. Shop drawings, certificate, or reports shall be submitted on the following items, as appropriate, for approval. The following list is not considered all-inclusive. The Contractor shall supply all submittals required by the plans and specifications.

a. Concrete Mix Design for each class of concrete used

b. Reinforcing Steel

c. Seed, Fertilizer, Hydromulch, Lime, and Nutrients Certificates

d. Joint Sealing Materials (Backer Rods, Sealants & Expansion Material)

e. Glass Beads for Pavement Markings

f. Aggregate Samples and Test Results for Crushed Aggregate Base Material

g. HMAC Mix Designs

h. Lime Certificates and Data for Material to be Used in Lime Stabilized Subgrade

i. Erosion Control Matting

j. Silt Fencing

k. Precast Headwalls and/or Safety End Treatments

l. Pavement Paint Certificates

m. Bituminous Prime Coat

n. Bituminous Tack Coat

o. Reinforced Concrete Pipe

p. Pipe Bedding Material

q. Storm Water Pollution Prevention Plan (Not for Review)

r. Embankment Material

s. Topsoil

t. Electrical Components

u. Structural Geogrid Subgrade Materials

v. Underdrain Materials

END OF ITEM 101

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ITEM KSA-105 BARRICADES AND MARKINGS FOR PAVEMENT CLOSURES

DESCRIPTION

105-1.1 The work covered by this section consists of furnishing all materials, equipment, and labor and performing all necessary operations to maintain a satisfactory and safe barricade system, runway and taxiway closures and temporary displaced thresholds for the duration of the project. The required project barricades, markings and lighting are detailed in the project plans. The Contractor shall be responsible for maintaining the barricades, lights, markings and displaced thresholds in their proper location, in good working order, and clean for 24 hours per day throughout the contract period.

105-1.2 The Contractor will be required to remove barricades and runway or taxiway closure markings at the end of the work day and to reinstall the same prior to commencing work the following morning in some cases to allow for the reopening of certain sections of the airport for evening and night-time operations.

105-1.3 This section also includes the installation and maintenance of temporary displaced threshold markings (out board) with temporary displaced threshold lights in accordance with the details in the plans.

METHOD OF MEASUREMENT

105-2.1 Measurement for this item will be by lump sum as the work progresses.

BASIS OF PAYMENT

105-3.1 All work performed and materials furnished as prescribed in this item shall be measured and paid for at the contract lump sum price for "Barricades and Markings for Pavement Closures". The total lump sum shall be paid pro-rata per month and the monthly amount shall be calculated by dividing the lump sum by the contract time in months.

Payment will be made under:

Item 105-3.1	Barricades and Markings for Pavement Closures	Per lump sum

END OF ITEM 105

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ITEM KSA-206 STORMWATER POLLUTION PREVENTION PLAN (SWP3)

DESCRIPTION

206-1.1 The Contractor shall provide a project Stormwater Pollution Prevention Plan (SWP3) Document as directed in the plans and specifications and in accordance with Texas Pollutant Discharge Elimination System (TPDES) General Permit (GP) TXR150000. The Contractor shall bear sole responsibility for the SWP3 provisions of this contract as well as bear sole responsibility for the development, implementation, and maintenance of the SWP3, best management practices (BMPs), and facilities utilized to meet TPDES GP TXR150000. The SWP3 and Notice of Intent (NOI) shall be completed prior to beginning any work or stockpiling of any materials.

SUBMITTALS

206-2.1 For projects with soil disturbance of less than an acre, no submittal to TCEQ shall be required but the Contractor shall follow the erosion control operations as indicated in the plans and specifications. For projects with soil disturbance of one acre to less than five acres, a Small Site Notice shall be submitted to TCEQ and shall be posted at site once approved. For projects with soil disturbance of five acres or more, a Notice of Intent and Large Site Notice shall be submitted to TCEQ and shall be posted at site once approved.

206-2.2 Notice of Intent (NOI). The Contractor shall submit a NOI, if applicable, with the TCEQ under the TPDES GP TXR150000 at least 7 days prior to initiation of work at the project site. At the time of the submittal to the TCEQ, the Engineer shall be given a copy of the NOI. The Contractor shall **p**ost the NOI at the project site as required by the TPDES GP TXR150000.

206-2.3 Notice of Change (NOC). The Contractor shall submit a NOC, if applicable, letter to the TCEQ within 14 days of discovery of a change/revision to the NOI. The Contractor shall submit a signed copy of the NOC to the Engineer at the time of submittal.

206-2.4 Notice of Termination (NOT). The Contractor shall submit a NOT, if applicable, to the TCEQ within 30 days of the Engineer's approval that 70% native background vegetative cover is met or equivalent permanent stabilization have been employed in accordance with the TPDES GP TXR 150000. The Contractor shall provide a signed copy of the NOT to the Engineer at the time of submittal.

EMPLOYEE QUALIFICATIONS AND REQUIREMENTS

206-3.1 Contractor Superintendent Qualifications and Responsibilities. The Contractor shall provide a superintendent that is competent and has experience with and knowledge of stormwater management and is knowledgeable of the requirements and the conditions of the TPDES GP TXR150000. The superintendent shall be responsible for managing and overseeing the day to day operations/activities at the project site; working with the Contractor Responsible Person Environmental (CRPe) to provide effective Stormwater Management at the project site; representing and acting on-behalf of the Contractor; and attend the Preconstruction Conference for the project. The Contractor and CRPe may be the same person.

206-3.2 CRPe Qualifications and Responsibilities. The Contractor shall **p**rovide a CRPe who has overall responsibility for the project's stormwater management. The CRPe shall oversee and observe stormwater control measure monitoring and management of the entire project site. The CRPe shall monitor the entire project site daily to ensure compliance with the TPDES GP TXR150000 and the SWP3 document. The CRPe shall document and provide monitoring reports to the Engineer within 48 hours. If necessary, the CRPe shall provide recommendations to the Engineer to improve effectiveness of control measures. Records of all Monitoring Reports shall be maintained at the project site field office.

CONSTRUCTION

206-4.1 Responsibilities.

a. Operator. The Contractor is an operator under the TPDES GP TXR150000 and responsible for Part III, Section B.2. Primary Operators with Day-to-Day Operational Control, of the TPDES GP TXR150000.

1. Implementation of Design.

2. Maintenance of Field Devices.

3. Directing Contractor Employees and Communicating Requirements and Changes to Subcontractors.

4. Meeting the CGP as Primary Operator with Day to Day Operational Control.

5. For Design, Implementation, Maintenance of Project Specific Locations.

6. Notifying the Engineer of Changes Needed for the SWP3.

7. Maintenance of the SWP3 Document.

b. Stormwater Management. The Contractor shall **i**mplement the SWP3 for the project site in accordance with TPDES GP TXR150000. The Contractor shall coordinate stormwater management with all other work on the project. The Contractor shall prevent or reduce water pollution from stormwater associated with construction activities from entering any surface water or property on or adjacent to the project site.

206-4.2 Implementation. At the Preconstruction Conference, the Contractor shall designate in writing a CRPe to be the representative of the Contractor for the project's stormwater management. The CRPe shall be responsible for implementing the SWP3 and taking or directing corrective measures to remedy deficiencies in installation and maintenance of pollution BMPs. The CRPe must be accessible by phone, and able to direct and respond to stormwater management emergencies 24 hours per day.

a. Commencement. The Contractor shall follow the SWP3 and install erosion control measures as shown in the plans, as directed by the Engineer, or as needed by the Contractor after receiving prior approval from the Engineer. The Contractor shall install control measures as

indicated in the plans and specifications, and according to manufacturers' guidelines. The Contractor shall not make changes to the location of any control measure or implement any other changes to the SWP3 without the approval of the Engineer. Minor adjustments to meet field conditions are allowed but should be noted in the SWP3 document. The Contractor shall submit Contractor-proposed recommendations to improve effectiveness of control measures to the Engineer for approval. Changes must conform to guidelines established in the TPDES GP TXR150000.

b. Phasing. In new phases of the project, prior to the commencement of construction activities that result in soil disturbance, the Contractor shall implement control measures. The Contractor shall phase and minimize the soil disturbance to the area shown on the plans throughout each phase. The Contractor shall coordinate temporary control measures with permanent control measures and all other work on the project to assure economical, effective, safe, continuous water pollution prevention. The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent pollution of ground waters and surface waters. Clearing and grubbing operations shall be scheduled and performed so that grading operations and stabilization measures shall follow immediately thereafter if the project conditions permit. All grading sections shall be brought to final grade as soon as possible, and all temporary and permanent erosion prevention and sediment control measures shall be implemented at the earliest reasonable time. The Contractor shall employ temporary stabilization measures when required. Under no circumstances shall the Contractor prolong final grading and shaping so that the entire project can be permanently seeded at one time. The Contractor shall preserve vegetation where possible throughout the project, and minimize clearing, grubbing, and excavation within stream banks, bed, and approach sections.

206-4.3 General.

a. Temporary Alterations or Control Measure Removal. Altering or removal of control measures is allowed as long as control measures are restored within the same working day.

b. Stabilization. The Contractor shall stabilize disturbed areas where construction activities shall be stopped (temporarily or permanently) within 14 calendar days in accordance with the TPDES GP TXR150000. Utilize the establishment of uniform vegetative cover or other stabilization practice in accordance with the TPDES GP TXR150000 to meet this requirement.

c. Finished Work. Upon the Engineer's acceptance of vegetative cover or other final stabilization practice, the Contractor shall remove and dispose of all temporary control measures, unless otherwise directed by the Engineer. The project shall not be accepted until all soil disturbing activities are completed and a uniform perennial vegetative cover with a 70% density of existing adjacent undisturbed areas is obtained as described in the TPDES GP TXR150000. An exception shall be allowed in arid areas as defined in the TPDES GP TXR150000.

d. Restricted Activities and Required Precautions. The Contractor shall not discharge onto the ground or surface waters any pollutants such as chemicals, raw sewage, fuels, lubricants, coolants, hydraulic fluids, bitumens, and any other petroleum products. The Contractor shall operate and maintain equipment on site in a manner as to prevent actual or potential

water pollution. The Contractor shall manage, control and dispose of litter on site such that no adverse impacts to water quality occur. The Contractor shall prevent dust from creating a potential or actual unsafe condition, public nuisance, or condition endangering the value, utility, or appearance of any property. Washing out of concrete trucks shall not be allowed on the project site. The Contractor shall utilize appropriate controls to minimize the offsite transport of suspended sediments and other pollutants if it is necessary to pump or channel standing water (i.e. dewatering). The Contractor shall prevent discharges that would contribute to a violation of Edwards Rules, water quality standards, the impairment of a listed water body, or other state or federal law.

206-4.4 Installation, Maintenance, and Removal Work. The Contractor shall perform work in accordance with the SWP3 as provided in the plans and specifications and the TPDES GP TXR150000. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until earthwork construction and permanent erosion control features are in place or the disturbed area has been adequately stabilized as determined by the Engineer. The Contractor shall maintain effective control measures, and correct or replace ineffective control measures within 2 days of discovery of the deficiency unless documented "Too Wet". If a correction is deemed critical by the Engineer, immediate action is required.

If, in the opinion of the Engineer, the Contractor cannot control soil erosion and sedimentation resulting from construction operations, the Engineer shall further limit the disturbed area to that which the Contractor is able to control.

The Contractor shall remove devices upon approval or when directed by the Engineer. Upon removal, the Contractor shall finish-grade and dress the area. The Contractor shall stabilize disturbed areas in accordance with the permit, and as shown on the plans or as directed by the Engineer.

206-4.5 Records and Documentation.

a. Monitoring. The CRPe shall monitor the control measures on a daily basis at the project site. Monitoring shall consist of, but is not limited to, observing and inspecting site locations with control measures and discharge points by walking or other means to provide maintenance and inspection of controls as described in the SWP3. The Contractor shall keep written records of daily monitoring. The Contractor shall document in the daily monitoring report the control measure condition, the date, required corrective actions, responsible person for making the correction, if a corrective action was made note the date completed. The Contractor shall maintain records of all monitoring reports at the project site.

b. SWP3 Document. The SW3P Document shall be kept separately from other documents by the Contractor in a 3 ring binder labeled and tabbed by sections in the format and order described in the SWP3 Document Table of Contents shown in the plans. The Contractor shall update SWP3 documentation promptly and continually with current information. SWP3 documentation examples are, but not limited to, roles and responsibilities, project specific locations, material storage locations, monitoring reports, BMP placement, maintenance and changes, etc.

The Contractor shall provide the Engineer with an initial updated copy of the SWP3 Document at the Preconstruction Conference.

The Contractor shall maintain the SW3P document by updating sheets and drawings as changes occur. The Contractor shall provide the Engineer copies of the updated sheets on a weekly basis.

The SWP3 Document shall have a Table of Contents and structured per the following:

TABLE OF CONTENT for SWP3 Document

Section I. Responsibilities of Operators

- **A.** Control over Construction Plans and Specifications
  - **1.** Certification Statement
- **B.** Contractor Day-to-Day Operational Control
  - **1.** Certification Statement

Section II. Project Description

- **A.** General Location Map
- **B.** Site Description
- **C.** Description and Schedule or Sequence of Soil Disturbing Activities
- **D.** Acreage, Material Storage, and Soil Types
- **E.** Site Description(s) for Support Facilities
- **F.** Site Description(s) for Receiving Waters
- **G.** Location of Concrete Truck Washout Areas

Section III. Best Management Practices (BMPs)

- **A.** Erosion Controls and Sediment Controls and Stabilization Practices/Detailed Site Map
- **B.** Off-Site Transfer of Pollutant Controls/Good Housekeeping Practices
- **C.** Soil Disturbance Activities
  - **1.** Dates when soil disturbance activities will occur.

2. Dates when construction activity will temporarily or permanently cease on the site.

3. Dates when stabilization measures are initiated.

D. Stabilization Practices

E. Structural Control Practices

F. Permanent Stormwater Controls

G. Other Stormwater Controls

Section IV. Inspection/Oversight

A. Names and Qualifications of Project Inspectors

B. Inspector Qualification Statement Form

Section V. Environmental Permits, Issues & Commitment (EPIC) Sheet

Section VI. TPDES General Permit TXR 150000 (CGP)

Section VII. Small Site Notice/Large Site Notice/Notice of Intent (NOI)/Project Specific Locations (PSL's)

Section VIII. Nationwide Permit(s) (CORP)

Section IX. Weekly Inspection Form

Section X. Contractor Daily Monitoring Log

Section XI. Temporary Erosion, Sediment & Water Pollution Standard Devices Drawings

Section XII. Stormwater Pollution Prevention Plan (SWP3) Sheet

Section XIII. Project Specific Locations

METHOD OF MEASUREMENT

206-5.1 Measurement for work performed under this item shall be specified under FAA Item P-156, Temporary Air and Water Pollution, Soil Erosion and Siltation Control.

BASIS OF PAYMENT

206-6.1 Payment for work performed under this item shall be as specified under FAA Item P-156, Temporary Air and Water Pollution, Soil Erosion and Siltation Control.

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<u>CIVIL:</u> FAA STANDARD SPECIFICATIONS AND MODIFICATION PAGE

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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 in place.

CONSTRUCTION

101-3.1 REMOVAL OF EXISTING PAVEMENT.

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 and installing new dowels. 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. 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 be broken to a maximum size of 1 inch (mm).

101-3.2 PREPARATION OF JOINTS AND CRACKS.

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.

101-3.2 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.

101-3.3 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 2 inches (50 mm) outside the affected area and 2 inches (50 mm) deep. The deteriorated material shall be removed to a depth where the existing material is firm or cannot be easily removed with a geologist pick. The removed area shall be filled with 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 4 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 101-3.1b. 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.

101-3.4 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 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.

101-3.5 PREPARATION OF ASPHALT PAVEMENT 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 101-3.4.

b. Repair joints and cracks in accordance with paragraph 101-3.2.

c. Remove oil or grease that has not penetrated the asphalt pavement by 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.

101-3.6 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.

101-3.7 PREPARATION OF JOINTS IN RIGID PAVEMENT.

101-3.8.1 Removal of Existing Joint Sealant. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch (2 mm) from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry. Allow sufficient time to dry out joints prior to sealing.

101-3.8.2 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.

101-3.8 PREPARATION OF CRACKS IN FLEXIBLE PAVEMENT.

101-3.9.1 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.

101-3.9.2 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 Pavement removal. The unit of measurement for pavement removal shall be the number of square yards removed by the Contractor. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment.

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	Asphaltic Concrete Pavement Removal – per square yard

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.

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.

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.

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. 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 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.

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 **8"** 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.

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.

f. Proof rolling. After compaction is completed, the subgrade area shall be proof rolled with a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of 30,000 pounds (13.6 metric tons) and inflated to a minimum of 125 psi (0.861 MPa) in the presence of the Engineer. Apply a minimum of **3** coverages, 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.

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.

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**. 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 **D698**. Under all areas to be paved, the embankments shall be compacted to a depth of **8”** 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 Engineer 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.

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 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 **300** 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.

BASIS OF PAYMENT

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

Payment will be made under:

Item P-152-4.1	Unclassified Excavation - per cubic yard

TESTING REQUIREMENTS

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2700 kN-m/m^3))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM 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-153 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

DESCRIPTION

153-1.1 This item shall consist of furnishing, transporting, and placing a controlled low-strength material (CLSM) as flowable backfill in trenches or at other locations shown on the plans or as directed by the Engineer.

MATERIALS

153-2.1 Materials.

a. Portland cement. Portland cement shall conform to the requirements of ASTM **C150** Type **I**. If for any reason, 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.

b. Fly ash. Fly ash shall conform to ASTM C618, Class C or F.

c. Fine aggregate (sand). Fine aggregate shall conform to the requirements of ASTM C33 except for aggregate gradation. Any aggregate gradation which produces performance characteristics of the CLSM specified here will be accepted, except as follows.

Sieve Size	Percent Passing by weight
3/4 inch (19 mm)	100
No. 200 (0.075 mm)	0 - 12

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

MIX DESIGN

153-3.1 PROPORTIONS.

The Contractor shall submit, to the Engineer, a mix design including the proportions and source of aggregate, fly ash, cement, water, and approved admixtures. No CLSM mixture shall be produced for payment until the Engineer has given written approval of the proportions. The proportions shall be prepared by a laboratory and shall remain in effect for the duration of the project. Laboratory costs are incidental to this item. The proportions shall establish a single percentage or weight for aggregate, fly ash, cement, water, and any admixtures proposed.

a. Compressive strength. CLSM shall be designed to achieve a 28-day compressive strength of 100 to 200 psi (690 to 1379 kPa) when tested in accordance with ASTM D4832. There should be no significant strength gain after 28 days.

b. Consistency. CLSM should be designed to achieve a consistency that will produce an approximate 8-inch (200 mm) diameter circular-type spread without segregation when tested by: (1) filling a 3-inch inside diameter by 6-inch length flow cylinder (non-absorbent pipe) (2) strike off of the flow cylinder and start of lift within five seconds of filling and (3) by steady upward pull, lift the cylinder in a time period of between two and four seconds. Adjustments of the material proportions should be made to achieve proper solid suspension and flowable characteristics,

however the theoretical yield shall be maintained at one cubic yard (cubic meter) for the given batch weights.

CONSTRUCTION METHODS

153-4.1 PLACEMENT.

a. Placement. CLSM may be placed by any reasonable means from a mixing unit into the space to be filled. Agitation is required during transportation and waiting time. Placement shall be performed so structures or pipes are not displaced from their final position and intrusion of CLSM into unwanted areas is avoided. The material shall be brought up uniformly to the fill line shown on the plans or as directed by the Engineer. Each placement of CLSM shall be as continuous an operation as possible. If CLSM is placed in more than one layer, the base layer shall be free of surface water and loose foreign material prior to placement of the next layer.

b. Limitations of placement. CLSM shall not be placed on frozen ground. Mixing and placing may begin when the air or ground temperature is at least 35°F (2°C) and rising. At the time of placement, CLSM shall have a temperature of at least 40°F (4°C). Mixing and placement shall stop when the air temperature is 40°F (4°C) and falling or when the anticipated air or ground temperature will be 35°F (2°C) or less in the 24 hour period following proposed placement.

153-4.2 CURING AND PROTECTION

a. Curing. The air in contact with the CLSM shall be maintained at temperatures above freezing for a minimum of 72 hours. If the CLSM is subjected to temperatures below 32°F (0°C), the material may be rejected by the Engineer if damage to the material is observed.

b. Protection. The CLSM shall not be subject to loads and shall remain undisturbed by construction activities for a period of 48 hours or until a compressive strength of 15 psi (105 kPa) is obtained. The Contractor shall be responsible for providing evidence to the Engineer that the material has reached the desired strength. Acceptable evidence shall be based upon compressive tests made in accordance with paragraph 153-3.1a.

153-4.3 ACCEPTANCE.

Acceptance of CLSM delivered and placed as shown on the plans or as directed by the Engineer shall be based upon mix design approval and batch tickets provided by the Contractor to confirm that the delivered material conforms to the mix design. The Contractor shall verify by additional testing, each 1,000 cubic yards (765 m^3) of material used. Verification shall include confirmation of material proportions and tests of compressive strength to confirm that the material meets the original mix design and the requirements of CLSM as defined in this specification. Adjustments shall be made as necessary to the proportions and materials prior to further production.

METHOD OF MEASUREMENT

153-5.1 MEASUREMENT.

Controlled low-strength material shall be not be measured directly but shall be considered subsidiary to the item in which it is placed.

BASIS OF PAYMENT

153-6.1 PAYMENT.

Controlled low –strength material will not be paid for directly but shall be considered subsidiary to the item in which it is placed.

TESTING REQUIREMENTS

ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low-Strength Material (CLSM) Test Cylinders

MATERIAL REQUIREMENTS

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements

END OF ITEM P-153

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ITEM P-155 LIME-TREATED SUBGRADE

DESCRIPTION

155-1.1 This item shall be used for soil modification to achieve specific needs that require strength gain to a specific level. This item shall consist of constructing one or more courses of a mixture of soil, lime, and water in accordance with this specification, and in conformity with the lines, grades, thicknesses, and typical cross-sections shown on the plans.

MATERIALS

155-2.1 Lime. Quicklime and hydrated lime, either high-calcium dolomitic, or magnesium lime, as defined by ASTM C51, shall conform to the requirements of ASTM C977. Lime not produced from calcining limestone shall not be permitted.

155-2.2 Commercial lime slurry. Commercial lime slurry shall be a pumpable suspension of solids in water. The water or liquid portion of the slurry shall not contain dissolved material in sufficient quantity naturally injurious or objectionable for the purpose intended. The solids portion of the mixture, when considered on the basis of "solids content," shall consist principally of hydrated lime of a quality and fineness sufficient to meet the following requirements as to chemical composition and residue.

- **a. Chemical composition.** The "solids content" of the lime slurry shall consist of a minimum of 70%, by weight, of calcium and magnesium oxides.
- **b. Residue.** The percent by weight of residue retained in the "solids content" of lime slurry shall conform to the following requirements:
  - **(1)** Residue retained on a No. 6 (3360 micron) sieve = maximum 0.0%
  - **(2)** Residue retained on a No. 10 (2000 micron) sieve = maximum 1.0%
  - **(3)** Residue retained on a No. 30 (590 micron) sieve = maximum 2.5%
- **c. Grade.** Commercial lime slurry shall conform to one of the following two grades:
  - **(1)** Grade 1. The "dry solids content" shall be at least 31% by weight, of the slurry.
  - **(2)** Grade 2. The "dry solids content" shall be at least 35%, by weight, of the slurry.

155-2.3 WATER.

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

155-2.4 SOIL.

The soil for this work shall consist of inorganic natural materials on the site or selected materials from other sources; uniform in quality and gradation; and shall be approved by the Engineer. The soil shall be free of roots, sod, weeds, and stones larger than 2-1/2 inches (60 mm).

COMPOSITION

155-3.1 SOIL-LIME MIXTURE.

Lime shall be applied at the rate specified on the plans for the depth of subgrade treatment shown.

155-3.2 TOLERANCES.

At final compaction, the lime and water content for each course of subgrade treatment shall conform to the following tolerances:

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

WEATHER LIMITATIONS

155-4.1 WEATHER LIMITATION.

Do not construct subgrade when weather conditions detrimentally affect the quality of the materials. Do not apply lime unless the air temperature is at least 40°F (4°C) and rising. Do not apply lime to soils that are frozen or contain frost. If the air temperature falls below 35°F (2°C), protect completed lime-treated areas by approved methods against the detrimental effects of freezing. Remove and replace any damaged portion of the completed soil-lime treated area with new soil-lime material in accordance with this specification.

EQUIPMENT

155-5.1 EQUIPMENT.

The equipment required shall include all equipment necessary to complete this item such as: grading and scarifying equipment, a spreader for the lime or lime slurry, mixing or pulverizing equipment, sheepsfoot and pneumatic or vibrating rollers, sprinkling equipment, and trucks.

CONSTRUCTION METHODS

155-6.1 GENERAL.

This specification is to construct a subgrade consisting of a uniform lime mixture which shall be free from loose or segregated areas. The subgrade shall be of uniform density and moisture content, well mixed for its full depth, and have a smooth surface suitable for placing subsequent courses. The Contractor shall be responsible to meet the above requirements.

Before beginning lime treatment, the subgrade shall be constructed as specified in Item P-152, Excavation, Subgrade and Embankment, and shaped to conform to the typical sections, lines, and grades as shown on the plans. If the Contractor elects to use a cutting and pulverizing machine that will remove the subgrade material accurately to the secondary grade and pulverize the material at the same time, he will not be required to expose the secondary grade nor windrow the material. The machine must give visible indication at all times that it is cutting the material uniformly to the proper depth over the entire width of the cut.

If a cutting and pulverizing machine is not used, the material to be treated shall be excavated to the secondary grade (proposed bottom of lime treatment) and removed or windrowed to expose the secondary

grade. The excavated material shall then be spread to the desired cross-section and uniformly mixed and compacted.

155-6.2 APPLICATION.

Lime shall be spread only over an area where the initial mixing operations can be completed during the same work day. The application and mixing of lime with the soil shall be accomplished by the methods described as "Dry Placing" or "Slurry Placing." The Contractor may use either method when hydrated lime is specified.

a. Dry placing. The lime shall be spread uniformly over the subgrade by an approved screw-type spreader box or other approved spreading equipment. The amount of lime spread shall be the amount required for mixing to the specified depth that will result in the amount determined in the soil-lime mixture or as specified on the plans. The material shall be sprinkled until the specified moisture content has been reached.

The lime shall be distributed in a manner that will minimize scattering by wind. Lime shall not be applied when wind conditions, in the opinion of the Engineer, are detrimental to proper application. A motor grader shall not be used to spread the lime.

b. Slurry placing. The lime shall be mixed with water in trucks with approved distributors and applied as a thin water suspension or slurry. Commercial lime slurry shall be applied with a lime percentage not less than that applicable for the grade used. The distribution of lime shall be by successive passes over a measured section of subgrade until the specified amount of lime has been spread. The amount of lime spread shall be the amount required for mixing to the specified depth that will result in the amount determined in the soil-lime mixture or as shown on the plans. The distributor truck shall continually agitate the slurry to keep the mixture uniform.

155-6.3 MIXING.

The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as described below:

a. Preliminary mixing. The full depth of the treated subgrade shall be mixed with an approved mixing machine. Lime shall not be left exposed for more than six (6) hours. The mixing machine shall make two coverages. Water shall be added to the subgrade during mixing to provide a moisture content approximately 5% above the optimum moisture of the material and to ensure chemical action of the lime and subgrade. After mixing, the subgrade shall be lightly rolled to seal the surface and help prevent evaporation of moisture. The water content of the subgrade mixture shall be maintained at a moisture content above the optimum moisture content for a minimum of 48 hours or until the material becomes friable. During the curing period, the material shall be sprinkled as directed by the Engineer.

b. Final mixing. After the required curing time, the material shall be uniformly mixed by approved methods. If the mixture contains clods, they shall be reduced in size by blading, discing, harrowing, scarifying, or the use of other approved pulverization methods so that the remainder of the clods shall meet the following requirements when tested dry by laboratory sieves. After curing, pulverize lime treated material until soil particles pass a one inch (25 mm) sieve and 60% pass the No. 4 (4.75 mm) sieve. If resultant mixture contains clods, reduce their size by scarifying, remixing, or pulverization to meet specified gradation.

155-6.4 COMPACTION.

Compaction of the mixture shall immediately follow the final mixing operation with no part of the mixture uncompacted more than 30 minutes after final mixing. The material shall be aerated or sprinkled as necessary to provide the optimum moisture content during compaction. The field density of the compacted mixture shall be at least 93% of the maximum density of laboratory specimens prepared from samples taken

from the material in place. The specimens shall be compacted and tested in accordance with ASTM D698 to determine maximum density and optimum moisture content. The in-place field density shall be determined in accordance with ASTM D6938, Procedure A, direct transmission method. Testing frequency shall be a minimum of one compaction test per **1000** square yards of stabilized base or as directed by the Engineer.

The material shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions, or weak spots that develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required, and reshaping and recompacting. The surface of the subgrade shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed on it or the work is accepted by the Engineer.

The full depth of the material shown on the plans shall be compacted to remain firm and stable under construction equipment. All testing shall be done by the Engineer. Perform in-place density test to determine degree of compaction between 24 and 72 hours after final compaction and 24 hour moist cure period. If the material fails to meet the density requirements, it shall be reworked to meet the density requirements. The shape of the course shall be maintained smooth and shall conform to the typical section shown on the plans and the established lines and grades. If the material loses the specified stability, density, and finish before the next course is placed or the work is accepted by the Engineer, the material shall be recompacted and refinished by the Contractor, and the cost shall be incidental to this item.

155-6.5 FINISHING AND CURING.

After the final layer or course of lime-treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling, as directed by the Engineer, with a pneumatic or other suitable roller sufficiently light to prevent hairline cracking. The finished surface shall not vary more than 3/8 inch (9 mm) when tested with a 12 feet (3.7 m) straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor in a manner satisfactory to the Engineer, and the cost shall be incidental to this item.

The completed section shall be moist-cured for a minimum of seven (7) days before further courses are added or any traffic is permitted, unless otherwise directed by the Engineer. Subsequent courses shall be applied within 14 days after the lime-treated subgrade is cured.

155-6.6 THICKNESS CONTROL.

The thickness of the final lime-treated subgrade shall be not less than the thickness specified. Thickness shall be determined by depth tests or cores taken at intervals so that each test shall represent no more than 300 square yards (250 sq m). When the base deficiency is more than 1/2 inch (12 mm), the Contractor shall correct such areas in a manner satisfactory to the Engineer. The Contractor shall replace the base material where borings are taken for test purposes. This cost shall be incidental to this item.

155-6.7 MAINTENANCE.

The Contractor shall protect and maintain the lime-treated subgrade from yielding until the lime-treated subgrade is covered by placement of the next layer. The cost of this maintenance shall be incidental to this item.

155-6.8 HANDLING AND SAFETY.

The Contractor shall obtain and enforce the lime supplier’s instructions for proper safety and handling of the lime to prevent physical eye or skin contact with lime during transport or application.

METHOD OF MEASUREMENT

155-7.1 Lime-treated subgrade shall be paid for by the square yard (square meter) in the completed and accepted work.

155-7.2 Lime shall be paid by the number of tons (kg) of Hydrated Lime, or the calculated equivalent, used in the completed and accepted work. "Calculated Equivalent" will be determined by the Engineer as follows:

a. Hydrated lime delivered to the project in dry form will be measured according to the actual tonnage either spread on the subgrade or batched on site into a slurry, whichever is applicable.

b. Lime delivered to the project in slurry form will be paid for on the basis of certified chemical composition tickets and batch weight tickets. The Owner shall reserve the right to have the dry lime content verified by an independent testing laboratory. If the chemical composition is reported on the basis of Pebble Quicklime, the equivalent hydrated lime will be determined in accordance with paragraph c. below.

c. If Pebble Quicklime is delivered to the project in dry form it will be measured for payment on the basis of the following formula:

$$\left(\begin{array}{c}\text{Total Quicklime}\\ \text{(CaO)(Tons)}\\ \times\\ \%\ \text{Purity} \times 1.32\ \text{Factor}\end{array}\right) + \left(\begin{array}{c}\text{Total Quicklime}\\ \text{(CaO)(Tons)}\\ \times\\ \%\ \text{Impurities} \times 1.00\ \text{Factor}\end{array}\right) = \begin{array}{c}\text{Equivalent Hydrated}\\ \text{Lime}\\ Ca(OH)_2\text{(Tons)}\end{array}$$

The above will apply whether the quicklime is spread dry (if allowed) or batched into a slurry.

BASIS OF PAYMENT

155-8.1 Payment shall be made at the contract unit price per square yard for the lime-treated subgrade at the thickness specified. The price shall be full compensation for furnishing all material, except the lime, and for all preparation, delivering, placing and mixing these materials, and all labor, equipment, tools and incidentals necessary to complete this item.

155-8.2 Payment shall be made at the contract unit price per ton of lime (application rate is based on dry weight of soil). This price shall be full compensation for furnishing, delivery, and placing this material.

Payment will be made under:

Item P-155-8.1	8" Lime-treated subgrade - per square yard
Item P-155-8.2	Hydrated Lime (7%) - per ton

TESTING REQUIREMENTS

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3)
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

MATERIAL REQUIREMENTS

ASTM C51	Standard Terminology Relating to Lime and Limestone (as used by the Industry)
ASTM C977	Standard Specification for Quicklime and Hydrated Lime for Soil Stabilization
ASTM D3551	Standard Practice for Laboratory Preparation of Soil-Lime Mixtures Using Mechanical Mixer

END OF ITEM P-155

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, 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 design, installed and maintained to minimize the creation of wildlife attractants that have the potential to attract hazardous wildlife on or near public-use airports.

MATERIALS

156-2.1 GRASS.

Grass that will not compete with the grasses sown later for permanent cover per Item T-901shall 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 ItemT-908. 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.

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

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.

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.

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 seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

Where erosion may be a problem, 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.

156-3.4 INSTALLATION, MAINTENANCE AND REMOVAL OF SILT FENCES.

Silt fences shall extend a minimum of 16 inches (41 cm) and a maximum of 34 inches (86 cm) above the ground surface. Posts shall be set no more than 10 feet (3 m) on center. Filter fabric shall be cut from a continuous roll to the length required minimizing joints where possible. When joints are necessary, the fabric shall be spliced at a support post with a minimum 12-inch (300-mm) overlap and securely sealed. A trench shall be excavated approximately 4 inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the silt fence. The trench shall be backfilled and the soil compacted over the silt fence fabric. The Contractor shall remove and dispose of silt that accumulates during construction and prior to establishment of permanent erosion control. The fence shall be maintained in good working condition until permanent erosion control is established. Silt fence shall be removed upon approval of the Engineer.

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. Temporary Sediment Control Fence will be measured by the linear feet installed and accepted by the Engineer in accordance with the plans and specifications.

b. Rock Construction Exits will be measured by each exit installed and accepted by the Engineer in accordance with the plans and specifications.

c. All work performed and materials furnished as prescribed for the Stormwater Pollution Prevention Plan (SWP3) Document shall be measured as a lump sum price for "Stormwater Pollution Prevention Plan (SWP3) Document".

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 "Temporary Sediment Control Fence" 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 "Rock Construction Exits" to be paid for shall be the number of exits 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.

c. All work performed and materials furnished as prescribed for the Stormwater Pollution Prevention Plan (SWP3) Document shall be measured as a lump sum price for "Stormwater Pollution Prevention Plan (SWP3) Document". The total lump sum shall be paid pro-rata per month and the monthly amount shall be calculated by dividing the lump sum by the contract time in months. If the Contractor fails to update the SWP3, and provide and properly maintain control measures in compliance with the Contract requirements, as determined by the Engineer, the Contractor will be considered in noncompliance with this Item. Each month's pay request will not be processed until the SWP3 has been updated. The total payment for this Item will not exceed 10% of the total Contract amount before 70% native vegetative cover has been established or final stabilization has been approved by the Engineer and the NOT has been submitted in accordance with the TPDES GP TXR150000. If all work is completed in accordance with the TPDES GP TXR 150000 and accepted by the Engineer and before payment of the amount allowed by this Item, the balance due shall be paid on the next estimate after the Engineer's approval that 70% native background vegetative cover is met or equivalent permanent stabilization have been employed in accordance with the TPDES GP TXR 150000.

Item P-156-5.1	Temporary Sediment Control Fence - per linear feet
Item P-156-5.2	Rock Construction Exit - per each
Item P-156-5.3	Storm Water Pollution Prevention Plan (SWPPP) - per lump sum

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-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.

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. The fine aggregate shall not contain more than 15% natural sand by weight of total aggregates. 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 ASTM D4318.

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) **64-22**. 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

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-strip 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. Samples shall be prepared at various asphalt contents and compacted using the gyratory compactor in accordance with ASTM D6925.

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.** Numbers of gyratioins**.**
- **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 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.

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

Table 1. Gyratory Compaction Criteria

Test Property	Pavements Designed for Aircraft Gross Weights of 60,000 Lbs (27216 kg) or More or Tire Pressures of 100 psi or More
Number of compactor gyrations	75
Air voids (%)	3.5
Percent voids in mineral aggregate, minimum	See Table 2

Table 2. Minimum Percent Voids In Mineral Aggregate (VMA)

Aggregate (See Table 3)	Minimum VMA
Gradation 3	16%
Gradation 2	15%
Gradation 1	14%

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

Sieve Size	Percentage by Weight Passing Sieve
1 inch (25 mm)	--
3/4 inch (19 mm)	100
1/2 inch (12 mm)	79-99
3/8 inch (9 mm)	68-88
No. 4 (4.75 mm)	48-68
No. 8 (2.36 mm)	33-53
No. 16 (1.18 mm)	20-40
No. 30 (0.60 mm)	14-30
No. 50 (0.30 mm)	9-21
No. 100 (0.15 mm)	6-16
No. 200 (0.075 mm)	3-6
Asphalt Percent:	
Stone or gravel	5.0-7.5
Slag	6.5-9.5

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 **300'** long and **25'** 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) 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.

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

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 inches (7.5 cm) or greater	40	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

401-4.2 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 used to transfer the material from the hauling equipment to the paver, shall use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation.

401-4.4 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 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 the mixture.

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.

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 and tack coat shall be applied in accordance with Item P-602 and P-603.

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 Contractor shall use a material transfer vehicle to deliver HMA to the paver.

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 401-4.4.1, 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. 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.

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 ravels, 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 under construction.

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

If the Contractor places any out of specification mix in the project work area, the Contractor is required to remove it at its own expense, to the satisfaction of the Engineer. If the Contractor has to continue placing non-payment HMA, as directed by the Engineer, to make the surfaces safe for aircraft operations, the Contractor shall do so to the satisfaction of the Engineer. It is the Contractor's responsibility to leave the facilities to be paved in a safe condition ready for aircraft operations. No consideration for extended closure time of the area being paved will be given. As a first order of work for the next paving shift, the Contractor shall remove all out of specification

material and replace with approved material to the satisfaction of the Engineer. When the above situations occur, there will be no consideration given for additional construction time or payment for extra costs.

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 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. 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 D6925 at the number of gyrations 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.

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.

(3) Acceptance. Acceptance of plant produced HMA for 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. Laitance 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

Mat density and air voids will be evaluated for acceptance in accordance with paragraph 401-5.2b(1). 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.

(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 sublot for density measurement. The maximum allowable deficiency at any point shall not be more than 1/4 inch (6 mm) 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 sublot 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 having an average profile index meeting the requirements of paragraph 401-8.1d when evaluated with a profilograph; and 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 a 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 paralel 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 ProfileIndex 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 **2,000 square yards** 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 **2,000** square yards, or one day's production: whichever is less. 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 m^2). Areas in excess of 15 square yards (12.5 m^2) 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. Gyratory Acceptance Limits For Air Voids, Density

TEST PROPERTY	Specification Tolerance	
	L	U
Air Voids Total Mix (%)	2	5
Mat Density (%)	96.3	101.3
Joint Density (%)	93.3	-

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.

(2) 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.

(3) 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. The cost for resampling and retesting shall be borne by the Contractor.

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

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.

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 sublot 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:

Control Chart Limits For Individual Measurements		
Sieve	**Action Limit**	**Suspension Limit**
3/4 inch (19 mm)	±6%	±9%
1/2 inch (12 mm)	±6%	±9%
3/8 inch (9 mm)	±6%	±9%
No. 4 (4.75 mm)	±6%	±9%
No. 16 (1.18 mm)	±5%	±7.5%
No. 50 (0.30 mm)	±3%	±4.5%
No. 200 (0.075 mm)	±2%	±3%
Asphalt Content	±0.45%	±0.70%
VMA	-1.00%	-1.50%

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)	
Sieve	**Suspension Limit**
1/2 inch (12 mm)	11%
3/8 inch (9 mm)	11%
No. 4 (4.75 mm)	11%
No. 16 (1.18 mm)	9%
No. 50 (0.30 mm)	6%
No. 200 (0.075 mm)	3.5%
Asphalt Content	0.8%

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 smoothness, 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[1]

Percentage of material within specification limits (PWL)	Lot pay factor (percent of contract unit price)
96 – 100	106
90 – 95	PWL + 10
75 – 89	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject [2]

[1] Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment above 100% 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 of asphalt concrete in lot) × (lot pay factor) × (unit price per ton) × (smoothness pay factor) = payment for lot

Table 7. Profilograph Average Profile Index Smoothness Pay Factor

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

[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.

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

401-8.1.1. PAYMENT.

Payment will be made under:

Item P-401-8.1.1 5" HMA Surface Course - per ton (kg)

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
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C183	Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D979	Standard Practice for Sampling Bituminous Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489	Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures

ASTM D2726	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D6084	Standard Test Method for Elastic Recovery of Bituminous Materials by Ductilometer
ASTM D6307	Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM D6926	Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus
ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gyratory Compactor.
ASTM E11	Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
AASHTO T030	Standard Method of Test for Mechanical Analysis of Extracted Aggregate
AASHTO T110	Standard Method of Test for Moisture or Volatile Distillates in Hot Mix Asphalt (HMA)
AASHTO T275	Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Paraffin-Coated Specimens
AASHTO M156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
AASHTO T329	Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method

Asphalt Institute Handbook MS-26, Asphalt Binder

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

MATERIAL REQUIREMENTS

ASTM D242	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
ASTM D946	Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3381	Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D4552	Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder

END OF ITEM P-401

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ITEM P-403 HOT MIX ASPHALT (HMA) PAVEMENTS
(BASE, LEVELING OR SURFACE COURSE)

DESCRIPTION

403-1.1 This item shall consist of a **base** course 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

403-2.1 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 50 percent 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 20% by weight of flat particles, elongated particles, and flat and elongated particles when tested in accordance with ASTM D4791 with a value of 3:1.

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 percent, 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. The fine aggregate shall not contain more than 15% natural sand by weight of total aggregates. 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 ASTM D4318.

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.

403-2.2 MINERAL FILLER.

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

403-2.3 ASPHALT CEMENT BINDER.

Asphalt cement binder shall conform to ASTM D6373 Performance Grade (PG) **64-22**. 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.

403-2.4 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 of fractured faces
- **(5)** Flat and elongated particles

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.

403-2.5 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

403-3.1 COMPOSITION OF MIXTURE.

The HMA plant mix shall be composed of a mixture of well-graded aggregate, filler and anti-strip 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).

403-3.2 JOB MIX FORMULA.

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 403-3.4. The HMA shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition. Samples shall be prepared at various asphalt contents and compacted using the gyratory compactor in accordance with ASTM D6925.

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 JMF.

b. Percent of asphalt cement.

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

d. Number of gyrations.

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 the 0.45 power gradation curve.

i. Graphical plots of 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.

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 is required for whatever reason, the subsequent cost of the Engineer's approval of the new or modified JMF 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 Gyratory Design Criteria applicable to the project shall meet the criteria specified in Table 1.

Table 1. Gyratory Compaction Criteria

Test Property	Value
Number of compactor gyrations	**75**
Air voids (%)	**3.5**
Percent voids in mineral aggregate, minimum	**See Table 2**

Table 2. Minimum Percent Voids In Mineral Aggregate (VMA)

Aggregate (See Table 3)	Minimum VMA
Gradation 3	16
Gradation 2	15
Gradation 1	14

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

Sieve Size	Percentage by Weight Passing Sieve
1 inch (25 mm)	100
3/4 inch (19 mm)	76-98
1/2 inch (12 mm)	66-86
3/8 inch (9 mm)	57-77
No. 4 (4.75 mm)	40-60
No. 8 (2.36 mm)	26-46
No. 16 (1.18 mm)	17-37
No. 30 (0.60 mm)	11-27
No. 50 (0.30 mm)	7-19
No. 100 (0.15 mm)	6-16
No. 200 (0.075 mm)	3-6
Asphalt Percent:	
Stone or gravel	4.5-7.0
Slag	5.0-7.5

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.

403-3.3 RECLAIMED ASPHALT CONCRETE (RAP).

RAP shall not be used.

403-3.4 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.

403-3.5 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 **300'** long and **25'** 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 (71ºC). The cold joint must be cut back using the same procedure that will be used during production in accordance with 403-4.12. 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 403-5.1 and 403-5.2. 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 the average mat density of the test section cores is greater than or equal to 96% and the average joint density of the test section cores is greater than or equal to 94%.

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 403-8.1.

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 the 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 403-6.1, has been approved, in writing, by the Engineer.

CONSTRUCTION METHODS

403-4.1 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

Mat Thickness	Base Temperature (Minimum)	
	Degrees F	Degrees C
3 inches (7.5 cm) or greater	40	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

403-4.2 HMA PLANTS.

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:

a. Requirements for all plants include:

(1) **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 weights 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.

(2) **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, and current reference standards to comply with the specifications and 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:

(a) Adequate artificial lighting.

(b) Electrical outlets sufficient in number and capacity for operating the required testing equipment and drying samples.

(c) A minimum of two (2) Underwriter's Laboratories approved fire extinguishers of the appropriate types and class.

(d) Work benches for testing.

(e) Desk with chairs and file cabinet.

(f) Sanitary facilities convenient to testing laboratory.

(g) Exhaust fan to outside air.

(h) 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.

(3) 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.

(4) 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:

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

(b) Stored in insulated storage 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.

403-4.3 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.

403-4.3.1 MATERIAL TRANSFER VEHICLE (MTV).

Material transfer Vehicles shall be required due to the improvement in smoothness and decrease in both physical and thermal segregation. To transfer the material from the hauling equipment to the paver, use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation.

403-4.4 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 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 the mixture.

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.

403-4.4.1 AUTOMATIC GRADE CONTROL.

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 stringline (wire) set to grade
- **c.** Short ski or shoe
- **d.** Laser control

403-4.5 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.

All rollers shall be specifically designed and suitable for compacting hot mix bituminous 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.

403-4.5.1 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 density 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.

403-4.6 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 bituminous material to the mixer at a uniform temperature. The temperature of the 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.

403-4.7 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.

403-4.8 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%.

403-4.9 PREPARATION OF THE UNDERLYING SURFACE.

Immediately before placing the HMA, the underlying course shall be cleaned of all dust and debris. A prime coat and tack coat shall be applied in accordance with Item P-602 and Item P-603, if shown on the plans.

403-4.10 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 403-4.3. 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 Contractor shall use a material transfer vehicle to deliver HMA to the paver.

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 403-4.4.1, provided grades of the first lift of bituminous surface course meet the tolerances of paragraphs 403-5.2b(5) 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 403-5.2b(5) 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 mixture shall be placed to the full width by a bituminous 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. 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 one foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course.

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

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

Areas of segregation in the 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.

403-4.11 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 mixture 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 mixture to the roller, the wheels shall be equipped with a scraper and kept properly moistened using a water soluble asphalt release agent approved by the Engineer.

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.

403-4.12 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 are 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. A 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.

403-4.13 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 ravels, 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.

403-4.14 NIGHTIME 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 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 under construction.

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

If the Contractor places any out of specification mix in the project work area, the Contractor is required to remove it at its own expense, to the satisfaction of the Engineer. If the Contractor has to continue placing non-payment HMA, as directed by the Engineer, to make the surfaces safe for aircraft operations, the Contractor shall do so to the satisfaction of the Engineer. It is the Contractor's responsibility to leave the facilities to be paved in a safe condition ready for aircraft operations. No consideration for extended closure time of the area being paved will be given. As a first order of work for the next paving shift, the Contractor shall remove all out of specification material and replace with approved material to the satisfaction of the Engineer. When the above situations occur, there will be no consideration given for additional construction time or payment for extra costs.

MATERIAL ACCEPTANCE

403-5.1 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.

a. Hot mixed asphalt. Plant-produced HMA shall be tested for air voids 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. 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 D6925 at the number of gyrations required by paragraph 403-3.2, Table 1. Each set of laboratory compacted specimens will consist of three test specimens prepared from the same sample.

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.

(3) Acceptance. Acceptance of plant produced HMA for air voids shall be determined by the Engineer in accordance with the requirements of paragraph 403-5.1.

a. 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 403-5.1a 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. 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 403-5.1a. 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 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. Laitance produced by the coring operation shall be removed immediately. The top most lift of bituminous material shall be completely bonded to the underlying layers of bituminous material. If any of the cores reveal that the surface is not bonded to the bituminous layer immediately below the surface then additional cores shall be taken as directed by the Engineer in accordance with paragraph 403-5.1b 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 403-5.1a(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 403-5.2b(1). Acceptance for joint density will be determined by the Engineer in accordance with the requirements of paragraph 403-5.2b(2).

b. Partial lots HMA. 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.

403-5.2 ACCEPTANCE CRITERIA.

a. General. Acceptance will be based on the following characteristics of the HMA and completed pavement and test results:

(1) Air Voids
(2) Mat density
(3) Joint density
(4) Thickness
(5) Smoothness
(6) Grade

Mat density will be evaluated for acceptance in accordance with paragraph 403-5.2b(1). Joint density will be evaluated for acceptance in accordance with paragraph 403-5.2b(2).

Thickness will be evaluated by the Engineer for compliance in accordance with paragraph 403-5.2b(3). Acceptance for smoothness will be based on the criteria contained in paragraph 403-5.2b(4). Acceptance for grade will be based on the criteria contained in paragraph 403-5.2b(5).

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. Acceptance of each lot of plant produced material for mat density shall be based on the average of all of the densities taken from the sublots. If the average mat density of the lot so established equals or exceeds 96%, the lot shall be acceptable. If the average mat density of the lot is below 96%, the lot shall be removed and replaced at the Contractor's expense.

(2) Joint density. Acceptance of each lot of plant produced HMA for joint density shall be based on the average of all of the joint densities taken from the sublots. If the average joint density of the lot so established equals or exceeds 94%, the lot shall be acceptable. If the average joint density of the lot is less than 94%, the Contractor shall stop production and evaluate the method of compacting joints. Production may resume once the reason for poor compaction has been determined and appropriate measures have been taken to ensure proper compaction.

(3) Thickness. Thickness of each 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 sublot for density measurement. The maximum allowable deficiency at any point shall not be more than 1/4 inch (6 mm) less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, shall not be less than the indicated thickness. Where thickness deficiency exceeds the specified tolerances, the lot or sublot 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) Grade. Grade shall be evaluated on the first day of placement and then every **2,000 square yards** 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 **2,000** square yards (square meters). 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 of pavement and replace with new material. Skin patching shall not be permitted. Isolated high points may be ground off providing the course thickness complies with the thickness specified on the plans. High point grinding will be limited to 15 square yard (12.5 sq m). 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. Areas in excess of 15 square yard (12.5 sq m) will require removal and replacement of the pavement in accordance with the limitations noted above. Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

c. Density outliers. If the tests within a lot include a very large or a very small value that appears to be outside the normal limits of variation, check for an outlier in accordance with ASTM E178, at a significance level of 5%, to determine if this value should be discarded.

403-5.3 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 403-5.1. Only one resampling per lot will be permitted.

(1) A redefined mat density shall be calculated for the resampled lot. The number of tests used to calculate the redefined mat density shall include the initial tests made for that lot plus the retests.

(2) The cost for resampling and retesting shall be borne by the Contractor.

b. Payment for resampled lots. The redefined mat density for a resampled lot shall be used to evaluate the acceptance of that lot in accordance with paragraph 403-5.2.

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

CONTRACTOR QUALITY CONTROL

403-6.1 GENERAL.

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 403-6.3, 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. Compaction

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 403-6.3 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.

403-6.2 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.

403-6.3 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 and 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 of the HMA 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.

403-6.4 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.

403-6.5 CONTROL CHARTS.

The Contractor shall maintain linear control charts both for individual measurements and range (i.e., difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each sublot 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 JMF target values as indicators of central tendency for the following test parameters with associated Action and Suspension Limits:

Control Chart Limits For Individual Measurements		
Sieve	**Action Limit**	**Suspension Limit**
3/4 inch (19 mm)	±6%	±9%
1/2 inch (12 mm)	±6%	±9%
3/8 inch (9 mm)	±6%	±9%
No. 4 (4.75 mm)	±6%	±9%
No. 16 (1.18 mm)	±5%	±7.5%
No. 50 (0.30 mm)	±3%	±4.5%
No. 200 (0.075 mm)	±2%	±3%
Asphalt Content	±0.45%	±0.70%
VMA	-1.00%	-1.5%

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)	
Sieve	**Suspension Limit**
1/2 inch (12 mm)	11%
3/8 inch (9 mm)	11%
No. 4 (4.75 mm)	11%
No. 16 (1.18 mm)	9%
No. 50 (0.30 mm)	6%
No. 200 (0.075 mm)	3.5%
Asphalt Content	0.8%

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.

403-6.6 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

403-7.1 MEASUREMENT.

Plant mix bituminous concrete pavement 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

403-8.1 PAYMENT.

Payment for a lot of HMA meeting all acceptance criteria as specified in paragraph 403-5.2 shall be made at the contract unit price per ton (kg) for HMA. 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.

Payment will be made under:

Item P-403-8.1	11" HMA Base Course - per ton (kg)

TESTING REQUIREMENTS

AASHTO M156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
ASTM C29	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C183	Standard Practice for Sampling and the Amount of Testing of Hydraulic Cement

ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D979	Standard Practice for Sampling Bituminous Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
ASTM D1074	Standard Test Method for Compressive Strength of Bituminous Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489	Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4125	Standard Test Methods for Asphalt Content of Bituminous mixtures by the Nuclear Method
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D5581	Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6 inch-Diameter Specimen)
ASTM D6307	Standard Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method
ASTM D6926	Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus

ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gyratory Compactor
ASTM D6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM E11	Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E178	Standard Practice for Dealing with Outlying Observations
AASHTO T030	Standard Method of Test for Mechanical Analysis of Extracted Aggregate
AASHTO T110	Standard Method of Test for Moisture or Volatile Distillates in Hot Mix Asphalt (HMA)
AASHTO T275	Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Paraffin-Coated Specimens).

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Asphalt Binder

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

MATERIAL REQUIREMENTS

ASTM D242	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
ASTM D946	Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3381	Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D4552	Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder

END OF ITEM P-403

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.

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 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

ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables

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

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Modifications to Item P-603

Bituminous Tack Coat

This modification page modifies, amplifies, or amends the technical specifications and plans. In the event of discrepancy, this modification shall take precedence over the plans and the technical specifications.

Paragraph 603-4.1 Delete this paragraph in its entirety and replace with the following:

Bituminous material for tack coat shall not be measured for separate payment.

Paragraph 603-5.1 Delete this paragraph in its entirety and replace with the following:

Bituminous material for tack coat shall not be measured or paid for separately, but shall be considered subsidiary to the item in which it is placed.

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ITEM P-603 BITUMINOUS TACK COAT

DESCRIPTION

603-1.1 This item shall consist of preparing and treating a bituminous or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

MATERIALS

603-2.1 BITUMINOUS MATERIALS.

The bituminous material shall be an emulsified asphalt indicated in ASTM D3628 as a bituminous application for tack coat appropriate to local conditions or as designated by the Engineer.

CONSTRUCTION METHODS

603-3.1 WEATHER LIMITATIONS.

The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the Engineer.

603-3.2 EQUIPMENT.

The Contractor shall provide equipment for heating and applying the 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 tack 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/or power blower suitable for cleaning the surfaces to which the bituminous tack coat is to be applied shall be provided.

603-3.3 APPLICATION OF BITUMINOUS MATERIAL.

Immediately before applying the tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

Emulsified asphalt shall be diluted by the addition of water when directed by the Engineer and shall be applied a sufficient time in advance of the paver to ensure that all water has evaporated before the overlying mixture is placed on the tacked surface.

The bituminous material including vehicle shall be uniformly applied with a bituminous distributor at the rate of 0.05 to 0.10 gallons per square yard (0.20 to 0.50 liters per square meter) depending on the condition of the existing surface. The type of bituminous material and application rate shall be approved by the Engineer prior to application.

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the Engineer. The Contractor shall protect the tack coat and maintain the surface until the next course has been placed.

603-3.4 BITUMINOUS MATERIAL CONTRACTOR'S RESPONSIBILITY.

The Contractor shall provide a statement of source and character of the proposed bituminous material which must be submitted and approved by the Engineer before any shipment of bituminous materials to the project.

The Contractor shall furnish the vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The tests 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 a basis for final acceptance.

603-3.5 FREIGHT AND WEIGH BILLS.

The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement 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

603-4.1 The bituminous material for tack 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

603.5-1 Payment shall be made at the contract unit price per gallon of bituminous material. This price shall be full compensation for furnishing all materials, for all preparation, delivery, and application of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-603-5.1 Bituminous Tack Coat - per gallon

MATERIAL REQUIREMENTS

ASTM D633	Standard Volume Correction Table for Road Tar
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
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 ITEM P-603

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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.

MATERIALS

605-2.1 JOINT SEALANTS.

Joint sealant materials shall meet the requirements of ASTM D5893.

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 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 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.

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, **14** days prior to use on the project.

a. Tractor-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 joints. 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.

b. 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.

c. Sandblasting equipment. Sandblasting is not allowed.

d. 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 (25 mm) 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 (kPa) at which the equipment is operating.

e. Hand tools. Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces.

f. 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 (32°C). 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 (37.8 to 189 L) per hour and through a range of application pressures from 50 to 1500 psi (345 kPa to 10.3 MPa) 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 **14** 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. 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 tractor-mounted routing equipment, concrete saw or waterblaster 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 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 (2 mm) 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 No separate measurement shall be made for sealing of joints in new pavement. 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.

BASIS OF PAYMENT

605-5.1 No separate payment shall be made for sealing of joints in new pavement. 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.

Payment will be made under:

TESTING REQUIREMENTS

ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
ASTM C509	Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
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 D5893	Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

END ITEM P-605

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ITEM P-610 STRUCTURAL PORTLAND CEMENT CONCRETE

DESCRIPTION

610-1.1 This item shall consist of **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.

Gradation For Coarse Aggregate

Sieve Designation (square openings)	Percentage by Weight Passing Sieves						
	2″ (50 mm)	1-1/2″ (38 mm)	1″ (25 mm)	3/4″ (19 mm)	1/2″ (12 mm)	3/8″ (9 mm)	No. 4
No. 4 to 1 in. (4.75-25 mm)	--	100	90-100	--	25-60	--	0-10

610-2.2.1 AGGREGATE SUSCEPTIBILITY TO DURABILITY (D) CRACKING.

Aggregates that have a history of D-cracking shall not be used.

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:

Gradation For Fine Aggregate

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
3/8 inch (9 mm)	100
No. 4 (4.75 mm)	95-100
No. 16 (1.18 mm)	45-80
No. 30 (0.60 mm)	25-55
No. 50 (0.30 mm)	10-30
No. 100 (0.15 mm)	2-10

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**.

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. Fly Ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of iginition, 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%.

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** conforming to the requirements of **ASTM A615.**

610-2.10 MATERIALS FOR CURING CONCRETE.

Curing materials shall conform to one or more of the following:

Waterproof paper	ASTM C171
Clear or white Polyethylene Sheeting	ASTM C171
White-pigmented Liquid Membrane-Forming Compound, Type 2, Class B	ASTM C309

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 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.

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 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.

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.

BASIS OF PAYMENT

610-5.1 Concrete and reinforcing steel for all 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.

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 C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregates (Accelerated Mortar-Bar Method)
ASTM E329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

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 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 C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM 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 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

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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**a**. Paint shall be furnished in **white – 37925, red – 31136, yellow – 33538 or 33655 and black - 37038** in accordance with Federal Standard No. 595.

a. Waterborne. Paint shall meet the requirements of Federal Specification TT-P-1952E, Type I **or** 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.

620-2.3 REFLECTIVE MEDIA.

Glass beads shall meet the requirements for **Type I, Gradation A**. 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.

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. Markings shall not be applied when the wind speed exceeds 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, shotblasting, grinding 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.

At least 24 hours prior to remarking existing markings, loose existing markings must be removed such that **90%** of the loose 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.

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:

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±1/2 inch (12 mm)
greater than 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
greater than 60 feet (18.3 m)	±3 inch (76 mm)

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted. A period of **2 weeks** shall elapse between placement of a bituminous surface course or seal coat and application of the paint.

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 cover no more than the maximum area prescribed in Table 1 (e.g., for 5 gallons (19 liters) of waterborne paint shall cover no more than 575 square feet (53.4 m^2).

Table 1. Application Rates For Paint And Glass Beads (See Note regarding Red and Pink Paint)

Paint Type	Paint Square feet per gallon, ft^2/gal (Sq m per liter, m^2/l)	Glass Beads, Type I, Gradation A Pounds per gallon of paint-lb/gal (Km per liter of paint-kg/l)	Glass Beads, Type III Pounds per gallon of paint-lb/gal (Km per liter of paint-kg/l)	Glass Beads, Type IV Pounds per gallon of paint-lb/gal (Km per liter of paint-kg/l)
Waterborne Type I or II	115 ft^2/gal max (2.8 m^2/l)	7 lb/gal min (0.85 kg/l)	--	--
*	*	*	*	*

It is recommended when using waterborne paints on previously unmarked asphalt or seal coat, that an initial paint coat at 50% of the permanent coverage rates 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. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment 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 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**.** 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	Yellow Markings (Reflective) - square foot
Item P-620-5.2	Black Markings (Non-Reflective) - square foot
Item P-620-5.3	Red Markings (Non-Reflective) - square foot
Item P-620-5.4	Surface Painted Signs – per each
Item P-620-5.5	Pavement Marking Removal - square foot

TESTING REQUIREMENTS

ASTM C371	Standard Test Method for Wire-Cloth Sieve Analysis of Nonplastic Ceramic Powders
ASTM D92	Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D711	Standard Test Method for No-Pick-Up Time of Traffic Paint
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1652	Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2074	Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method

ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D7585	Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments
ASTM E1710	Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
ASTM E2302	Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

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

29 CFR Part 1910.1200 Hazard Communication

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

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ITEM D-701 PIPE FOR STORM DRAINS AND CULVERTS

DESCRIPTION

701-1.1 This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

701-2.1 Materials shall meet the requirements shown on the plans and specified below.

-ASTM C76, Class III

701-2.2 PIPE.

The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

American Association of State Highway and Transportation Officials (AASHTO) M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter
ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Structural Steel Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

ASTM A849	Standard Specification for Post Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM F667	Standard Specification for 3 through 24 in Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

701-2.3 CONCRETE.

Concrete for pipe cradles shall have a minimum compressive strength of 2000 psi (13.8 MPa) at 28 days and conform to the requirements of ASTM C94.

701-2.4 RUBBER GASKETS.

Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the "RE" closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

701-2.5 JOINT MORTAR.

Pipe joint 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.

701-2.6 JOINT FILLERS.

Poured filler for joints shall conform to the requirements of ASTM D6690.

701-2.7 PLASTIC GASKETS.

Plastic gaskets shall conform to the requirements of AASHTO M198 (Type B).

701-2.8. CONTROLLED LOW-STRENGTH MATERIAL (CLSM).

Controlled low-strength material shall conform to the requirements of Item P-153. When CLSM is used all joints shall have gaskets.

CONSTRUCTION METHODS

701-3.1 EXCAVATION.

The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side. The trench walls shall be approximately vertical.

The Contractor shall comply with all current Federal, state and local rules and regulations governing the safety of men and materials during the excavation, installation and backfilling operations. Specifically, the Contractor shall observe that all requirements of the Occupational Safety and Health Administration (OSHA) relating to excavations, trenching and shoring are strictly adhered to. The width of the trench shall be sufficient to permit satisfactorily jointing of the pipe and thorough compaction of the bedding material under the pipe and backfill material around the pipe, but it shall not be greater than the widths shown on the plans trench detail. The trench bottom shall be shaped to fully and uniformly support the bottom quadrant of the pipe.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inch (200 mm) or 1/2 inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The excavation below grade 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.

The excavation for pipes placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

701-3.2 BEDDING.

The pipe bedding shall conform to the class specified on the plans. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe. When no bedding class is specified or detailed on the plans, the requirements for Class C bedding shall apply.

a. Rigid pipe. Class A bedding shall consist of a continuous concrete cradle conforming to the plan details.

Class B bedding shall consist of a bed of granular material having a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extending up around the pipe for a depth of not less than 30% of the pipe's vertical outside diameter. The layer of bedding material shall be shaped to fit the pipe for at least 10% of the pipe's vertical diameter and shall have recesses shaped to receive the bell of bell and spigot pipe. The bedding material shall be sand or select sandy soil with 100% passing a 3/8 inch (9 mm) sieve and not more than 10% passing a No. 200 (0.075 mm) sieve.

Class C bedding shall consist of bedding the pipe in its natural foundation material to a depth of not less than 10% of the pipe's vertical outside diameter. The bed shall be shaped to fit the pipe and shall have recesses shaped to receive the bell of bell and spigot pipe.

b. Flexible pipe. For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

Pipe Corrugation Depth		**Minimum Bedding Depth**	
inch	**mm**	**inch**	**mm**
1/2	12	1	25
1	25	2	50
2	50	3	75
2-1/2	60	3-1/2	90

c. PVC, polyethylene, and polypropylene pipe. For PVC, polyethylene, and polypropylene pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075 mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

701-3.3 LAYING PIPE.

The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of the pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

701-3.4 JOINING PIPE.

Joints shall be made with (1) Portland cement mortar, (2) Portland cement grout, (3) rubber gaskets, (4) plastic gaskets, or (5) coupling bands.

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

a. Concrete pipe. Concrete pipe may be either bell and spigot or tongue and groove. The method of joining pipe sections shall be so the ends are fully entered and the inner surfaces are reasonably flush and even. Joints shall be thoroughly wetted before applying mortar or grout.

b. Metal pipe. Metal pipe shall be firmly joined by form-fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M196 for aluminum pipe.

c. PVC, polyethylene and polypropylene pipe. Joints for PVC, Polyethylene, and Polypropylene pipe shall conform to the requirements of ASTM D3212 when water tight joints are required. Joints for PVC and Polyethylene pipe shall conform to the requirements of AASHTO M304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M252 or ASTM M294. Fittings for polypropylene pipe shall conform to ASTM F2881, ASTM F2736, or ASTM F2764.

701-3.5 BACKFILLING.

Pipes shall be inspected before any backfill is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense.

Material for backfill shall be fine, readily compatible soil or granular material shall meet the requirements of Item P-153**.** It shall not contain frozen lumps, stones that would be retained on a 2-inch (50 mm) sieve, chunks of highly plastic clay, or other objectionable material. Granular backfill material shall have 95% or more passing the a 1/2 inch (12 mm) sieve, with 95% or more being retained on the No. 4 (4.75 mm) sieve.

When the top of the pipe is even with or below the top of the trench, the backfill shall be compacted in layers not exceeding 6 inches (150 mm) on each side of the pipe and shall be brought up one foot (30 cm) above the top of the pipe or to natural ground level, whichever is greater. Thoroughly compact the backfill material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on each side of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the backfill shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. The width of backfill on each side of the pipe for the portion above the top of the trench shall be equal to twice the pipe's diameter or 12 feet (3.7 m), whichever is less.

For PVC, polyethylene, and polypropylene pipe, the backfill shall be placed in two stages; first to the top of the pipe and then at least 12 inches (300 mm) over the top of the pipe. The backfill material shall meet the requirements of paragraph 701-3.2c.

All backfill shall be compacted to the density required under Item P-152.

It shall be the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

METHOD OF MEASUREMENT

701-4.1 The length of pipe shall be measured in linear feet of pipe in place, completed, and approved. It shall be measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types and size shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipe being measured.

701-4.2 The volume of concrete for pipe cradles shall not be measured directly but shall be considered subsidiary to the structure in which it is placed.

701-4.3 The volume of rock shall not be measured directly but shall be considered subsidiary to the structure in which it is placed.

BASIS OF PAYMENT

701-5.1 Payment will be made at the contract unit price per linear foot for each kind of pipe of the type and size designated; no separate payment will be made for pipe cradles or rock, but shall be considered subsidiary to the structure in which they are placed.

These prices shall fully compensate the Contractor for furnishing all materials and for all preparation, excavation, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item D-701-5.1	24" ASTM C-76, Class III RCP – per linear foot

MATERIAL REQUIREMENTS

AASHTO M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M198	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter
ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

ASTM A849	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C94	Standard Specification for Ready Mixed Concrete
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe

ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

END ITEM D-701

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.

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.

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.

751-2.5 CORRUGATED METAL.

Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

751-2.6 FRAMES, COVERS, AND GRATES.

The castings shall conform to one of the following requirements:

- **a.** ASTM A48, Class 35B: Gray iron castings
- **b.** ASTM A47: Malleable iron castings
- **c.** ASTM A27: Steel castings
- **d.** ASTM A283, Grade D: Structural steel for grates and frames
- **e.** ASTM A536, Grade 65-45-12: Ductile iron castings
- **f.** ASTM A897:Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

751-2.7 STEPS.

The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of bituminous paint, when directed.

751-2.8 PRECAST INLET STRUCTURES.

Manufactured in accordance with and conforming to ASTM C1433.

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.

a. Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item P-610.

b. Laying brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it that can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved

joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and 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.

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.

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 (300 mm).

Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the 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 (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the 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.

METHOD OF MEASUREMENT

751-4.1 Manholes, catch basins, inlets, and inspection holes shall be measured by the unit.

BASIS OF PAYMENT

751-5.1 The accepted quantities of structures will be paid for at the contract unit price per each in place when completed. Removal of existing drainage structures, pipes, etc., as shown on the plans and as necessary to complete the work of this item, shall be considered subsidiary to the bid items listed in the Bid Form. The Contractor shall plug or replace any drainage structure tie-in where the Contractor is instructed to remove the pipe tying into the aforementioned drainage structure, as shown on the plans and as necessary to complete the work of this item, at no direct pay, so that the drainage structure to remain shall remain functional and structurally sound. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item D-751-5.1	2’ x 2’ Grate Inlet - 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)
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
AASHTO M36	Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

END OF ITEM D-751

ITEM D-752 CONCRETE CULVERTS, HEADWALLS, AND MISCELLANEOUS DRAINAGE STRUCTURES

DESCRIPTION

752-1.1 This item shall consist of reinforced concrete culverts, headwalls, and miscellaneous drainage structures constructed 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.

MATERIALS

752-2.1 CONCRETE.

Reinforced concrete shall meet the requirements of Item P-610.

CONSTRUCTION METHODS

752-3.1 UNCLASSIFIED EXCAVATION.

a. Trenches and foundation pits for structures or structure footings shall be excavated to the lines and grades and elevations shown on the plans. 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 approximate only; and the Engineer may approve, in writing, changes in dimensions or elevations of footings necessary to secure 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. When concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing steel is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to perform 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 excavation.

d. All bracing, sheathing, or shoring shall be removed by the Contractor after the completion of the structure. Removal shall be not disturb or damage the finished concrete. The cost of removal shall be included in the unit price bid for excavation.

e. After each excavation is completed, 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.

752-3.2 BACKFILLING.

a. After a structure has been completed, backfilling with approved material shall be accomplished by applying the fill in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted. The field density of the compacted material shall be at least 90% of the maximum

density for cohesive soils and 95% of the maximum density for noncohesive soils. The maximum density shall be determined in accordance with ASTM D698. The field density shall be determined in accordance with ASTM D1556.

b. No backfilling shall be placed against any structure until approved by the Engineer. For concrete, 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 or the placement methods.

c. Fill placed around concrete culverts shall be deposited on each side at the same time and to approximately the same elevation. All slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent wedge action against the structure.

d. Backfill will not be measured for direct payment. Performance of this work shall be considered as a subsidiary obligation of the Contractor, covered under the contract unit price for "unclassified excavation for structures."

752-3.3 WEEP HOLES.

Weep holes shall be constructed as shown on the plans.

752-3.4 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 embankment, 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.

METHOD OF MEASUREMENT

752-4.1 Drainage structures shall be measured on a per each basis for the size of structure as indicated. Measurement shall include excavation, forms, concrete, reinforcing steel, grates, covers, backfilling, and grading necessary to complete the item in accordance with the plans and specifications.

BASIS OF PAYMENT

752-5.1 Payment will be made at the contract unit price for the accepted quantities of each item completed and in place. No separate payment shall be made for removal of existing drainage structures, pipes, etc. Removal of existing drainage structures, pipes, etc., as shown on the plans and as necessary to complete the work of this item, shall be considered subsidiary to the bid items listed in the Bid Form. The Contractor shall plug or replace any drainage structure tie-in where the Contractor is instructed to remove the pipe tying into the aforementioned drainage structure, as shown on the plans and as necessary to complete the work of this item, at no direct pay, so that the drainage structure to remain shall remain functional and structurally sound. 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.

Payment will be made under:

Item D-752-5.1	Sloped End Treatment for X" Pipe – per Each
Item D-752-5.2	Sloped End Treatment for X" x X" Box Culvert – per Each

TESTING REQUIREMENTS

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

END OF ITEM D-752

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ITEM T-901 SEEDING

DESCRIPTION

901-1.1 This item shall consist of soil preparation, seeding and fertilizing the areas shown on the plans or as directed by the Engineer in accordance with these specifications.

MATERIALS

901-2.1 SEED.

The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the Engineer duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seed Mixture (Normal Application) shall be applied as follows:

Seed	Minimum Seed Purity	Minimum Germination	Rate of Application, lb/acre
Common Bermuda, Hulled	95%	85%	90

Normal application shall be performed during the period between **February 1** and **May 1** inclusive, unless otherwise approved by the Engineer.

Temporary Cool Weather Seed Mixture (For Installation if Requested by the Engineer) shall be applied as follows:

Seed	Minimum Seed Purity	Minimum Germination	Rate of Application, lb/acre
Wheat	95%	85%	50

Cool weather application shall be performed during the period between **September 1** and **November 30** inclusive, unless otherwise approved by the Engineer.

Temporary Warm Weather Seed Mixture (For Installation if Requested by the Engineer) shall be applied as follows:

Seed	Minimum Seed Purity	Minimum Germination	Rate of Application, lb/acre
Foxtail Millet	95%	85%	34

Warm weather application shall be performed during the period between **May 1** and **August 31** inclusive, unless otherwise approved by the Engineer.

Temporary cool or warm weather grasses must on compete with grasses sown later for permanent cover and shall be a quick-growing species suitable to the area providing a temporary cover. Selected grass species shall not create a wildlife attractant.

901-2.3 FERTILIZER.

Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;

b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or

c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be **16-20-0** commercial fertilizer and shall be spread at the rate of **400 pounds per acre**.

901-2.4 SOIL FOR REPAIRS.

The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the Engineer before being placed.

CONSTRUCTION METHODS

901-3.1 ADVANCE PREPARATION AND CLEANUP.

After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 DRY APPLICATION METHOD.

a. Fertilizing. Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity stated in paragraph 901-2.3.

b. Seeding. Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

c. Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

901-3.3 WET APPLICATION METHOD.

a. General. The Contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

b. Spraying equipment. The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons (190 liters) over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb / sq inches (690 kPa). The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch (16 mm) solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length shall be provided to which the nozzles may be connected.

c. Mixtures. Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds (100 kg) of lime shall be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds (100 kg) of these combined solids shall be added to and mixed with each 100 gallons (380 liters) of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. Brackish water shall not be used at any time. The Contractor shall identify to the Engineer all sources of water at least two (2) weeks prior to use. The Engineer may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor shall not use any water from any source that is disapproved by the Engineer following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

d. Spraying. Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches (75 mm), after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces that are to be mulched as indicated by the plans or designated by the Engineer, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

901-3.4 MAINTENANCE OF SEEDED AREAS.

The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the Engineer. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the Engineer. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded.

METHOD OF MEASUREMENT

901-4.1 The quantity of seeding to be paid for shall be the number of units per acre measured on the ground surface, completed and accepted.

BASIS OF PAYMENT

901-5.1 Payment shall be made at the contract unit price per acre or fraction thereof, which price and payment shall be full compensation for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed in this item.

Any areas disturbed by the Contractor's operations outside the grading limits shown on the plans (such as access roads, haul routes, and staging areas) shall not be measured for payment, but shall be seeded in accordance with this specification, at no additional cost to the Owner. Payment for this work along access roads, haul routes, and/or staging areas shall be considered subsidiary to the various bid items listed in the Bid Form.

Payment will be made at the contract unit price for the accepted quantities of each item completed and in place. These prices shall fully compensate the Contractor for furnishing and placing all material and for all labor, equipment, tools, and incidentals necessary to complete the work prescribed.

Payment will be made under:

Item T-901-5.1	Seeding - per acre

MATERIAL REQUIREMENTS

ASTM C602	Standard Specification for Agricultural Liming Materials
ASTM D977	Standard Specification for Emulsified Asphalt
FED SPEC	JJJ-S-181, Federal Specification, Seeds, Agricultural

END OF ITEM T-901

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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 6 inches (150 mm) in height shall be mowed to a height of 3 inches (75 mm) or less before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness not less than that stated in the special provisions.

904-2.3 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- **a.** A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- **b.** A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- **c.** A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be **16-20-0** commercial fertilizer and shall be spread at the rate of **400 pounds per acre**.

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 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 GROUND SURFACE.

After grading of areas has been completed and before applying fertilizer and limestone, areas to be sodded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris which might interfere with sodding, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes occurs after grading of areas and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage. This may include filling gullies, smoothing irregularities, and repairing other incidental damage.

904-3.3 APPLYING FERTILIZER AND GROUND LIMESTONE.

Following ground surface preparation, fertilizer shall be uniformly spread at a rate which will provide not less than the minimum quantity of each fertilizer ingredient, as stated in the special provisions. If use of ground limestone is required, it shall then be spread at a rate that will provide not less than the minimum quantity stated in the special provisions. These materials shall be incorporated into the soil to a depth of not less than 2 inches (50 mm) by discing, raking, or other suitable methods. Any stones larger than 2 inches (50 mm) in any diameter, large clods, roots, and other litter brought to the surface by this operation shall be removed.

904-3.4 OBTAINING AND DELIVERING SOD.

After inspection and approval of the source of sod by the 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.

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.

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.

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, and incidentals necessary to satisfactorily complete the items as specified.

Payment will be made under:

Item T-904-5.1	Sodding - per square yard

MATERIAL REQUIREMENTS

ASTM C602	Standard Specification for Agricultural Liming Materials

END OF ITEM T-904

ITEM T-905 TOPSOILING

DESCRIPTION

905-1.1 This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the Engineer.

MATERIALS

905-2.1 TOPSOIL.

Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (0.075 mm) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

905-2.2 INSPECTION AND TESTS.

Within 10 days following acceptance of the bid, the Engineer shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

CONSTRUCTION METHODS

905-3.1 GENERAL.

Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the Engineer before the various operations are started.

905-3.2 PREPARING THE GROUND SURFACE.

Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the Engineer, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

905-3.3 OBTAINING TOPSOIL.

Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the Engineer. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the Engineer. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the Engineer. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoiling purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the Engineer. The Contractor shall notify the Engineer sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

905-3.4 PLACING TOPSOIL.

The topsoil shall be evenly spread on the prepared areas to a uniform depth of inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. after spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the Engineer. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

METHOD OF MEASUREMENT

905-4.1 Topsoil obtained on the site shall be measured by the number of cubic yards of topsoil measured in its original position and stripped or excavated. Topsoil stockpiled by others and removed for topsoiling by the Contractor shall be measured by the number of cubic yards of topsoil measured in the stockpile. Topsoil shall be measured by volume in cubic yards computed by the method of end areas.

905-4.2 Topsoil obtained off the site shall be measured by the number of cubic yards of topsoil measured in its original position and stripped or excavated. Topsoil shall be measured by volume in cubic yards computed by the method of end areas.

BASIS OF PAYMENT

905-5.1 Payment will be made at the contract unit price per cubic yard for topsoiling (obtained on the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

905-5.2 Payment will be made at the contract unit price per cubic yard for topsoiling (obtained off the site). This price shall be full compensation for furnishing all materials and for all preparation, placing, and spreading of the materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item T-905-5.1	Topsoiling (Obtained on Site or Removed from Stockpile) - per cubic yard

TESTING MATERIALS

ASTM C117	Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing

END OF ITEM T-905

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ELECTRICAL: PROJECT SPECIFIC SPECIFICATIONS

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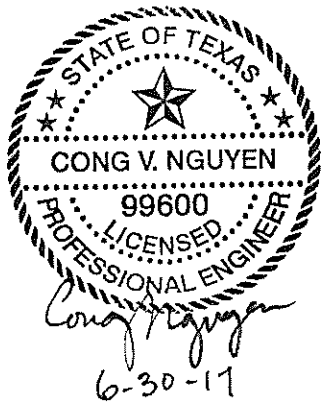
ELECTRICAL SPECIFICATIONS

L-108	UNDERGROUND POWER CABLE FOR AIRPORTS
L-110	AIRPORT UNDERGROUND ELECTRICAL DUCT BANKS AND CONDUITS
L-115	ELECTRICAL MANHOLES AND JUNCTION STRUCTURES
S-E100	GENERAL PROVISIONS – ELECTRICAL
S-E104	RECOMMENDED LOCKOUT PROCEDURE FOR AIRFIELD LIGHTING CIRCUIT
S-E105	ALTERATIONS, REMOVAL, AND DEMOLITION
S-E106	SUBMITTALS, RECORD DOCUMENTS, AND MAINTENANCE MANUALS
S-E111	AIRFIELD ELECTRICAL INSTALLATION AND TESTING
S-E125	INSTALLATION OF AIRPORT LIGHTING SYSTEM
S-E890	AIRFIELD LIGHTING CONTROL SYSTEM



TBPE Firm No. F-1356

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Item L-108 Underground Power Cable for Airports

DESCRIPTION

108-1.1 This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the Engineer. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities. Requirements and payment for trenching and backfilling for the installation of underground conduit and duct banks is in Item L-110, Airport Underground Electrical Duct Banks and Conduits.

EQUIPMENT AND MATERIALS

108-2.1 General.

a. Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.

b. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the Engineer.

c. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the Engineer) and replaced with materials that comply with these specifications at the Contractor's cost.

d. All materials and equipment used to construct this item shall be submitted to the Engineer for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

e. The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the plans and specifications. The Contractor's submittals shall be neatly bound in a properly sized 3-ring binder, tabbed by specification section. The Engineer reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's

discretion, with no additional cost to the Owner. The Contractor shall be responsible to maintain a minimum insulation resistance per AC 150/5340-26B, Maintenance Airport Visual aid Facilities, Table 5-1 and paragraph 5.1.3.1, with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period.

108-2.2 Cable. Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge AWG), L-824 Type C, 5,000 volts, nonshielded, with cross-linked polyethylene insulation. Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 Type C, 5,000 volts, nonshielded, cross-linked polyethylene insulation. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Federal Specification J-C-30 and shall be type THWN-2, 75°C. Conductors for parallel (voltage) circuits shall be sized and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 600 volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600 volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors, pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

108-2.3 Bare copper wire (counterpoise, bare copper wire ground and ground rods). Wire for counterpoise or ground installations for airfield lighting systems shall be No. 6 AWG bare solid copper wire for counterpoise and/or No. 6 AWG insulated stranded for ground wire per ASTM B3 and ASTM B8, and shall be bare copper wire per ASTM B33. See AC 150/5340-30 for additional details about counterpoise and ground wire types and installation. For voltage powered circuits, the equipment ground conductor shall be minimum No. 6 AWG, 600V rated, Type XHHW insulated, green color, stranded copper equipment ground conductor.

Ground rods shall be copper-clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 8 feet(2.54 m) long and 5/8 inch (16 mm) in diameter.

108-2.4 Cable connections. In-line connections or splices of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

a. The cast splice. A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M™ Company, "Scotchcast" Kit No. 82-B, or as manufactured by Hysol® Corporation, "Hyseal Epoxy Splice" Kit No. E1135, or an approved equivalent, used for potting the splice is acceptable.

b. The field-attached plug-in splice. Figure 3 of AC 150/5345-26, Specification for L-823 Plug and Receptacle, Cable Connectors, employing connector kits, is acceptable for field attachment to single conductor cable. It shall be the Contractor's responsibility to determine the outside diameter of the cable to be spliced and to furnish appropriately sized connector kits and/or adapters and heat shrink tubing with integral sealant.

c. The factory-molded plug-in splice. Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

d. The taped or heat-shrink splice. Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits that are designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made per the manufacturer's recommendations and listings.

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. See AC 150/5340-30 for additional information about methods of attaching a ground to a galvanized light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

108-2.5 Splicer qualifications. Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the Engineer proof of the qualifications of each proposed cable splicer for the airport cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splicing medium voltage cable.

108-2.6 Concrete. Concrete for cable markers shall be per Specification Item P-610, Structural Portland Cement Concrete.

108-2.7 Flowable backfill. Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

108-2.8 Cable identification tags. Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

108-2.9 Tape. Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

108-2.10 Electrical coating. Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

108-2.11 Existing circuits. Whenever the scope of work requires connection to an existing circuit, the circuit's insulation resistance shall be tested, in the presence of the Engineer. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the Engineer. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the Engineer. The Contractor shall record

the results on forms acceptable to the Engineer. 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 L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

108-2.12 Detectable warning tape. Plastic, detectable, American Wood Preservers Association (AWPA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend magnetic tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

CONSTRUCTION METHODS

108-3.1 General. The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Wherever possible, cable shall be run without splices, from connection to connection.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections unless otherwise authorized in writing by the Engineer or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed or at least once in each access point where L-823 connectors are not installed.

Provide not less than 3 feet (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the Engineer.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, hand holes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

108-3.2 Installation in duct banks or conduits. This item includes the installation of the cable in duct banks or conduit per the following paragraphs. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be per the latest version of the National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of

debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the Engineer of any blockage in the existing ducts.

The cable shall be installed in a manner that prevents harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended pulling tension values to the Engineer prior to any cable installation. If required by the Engineer, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the Engineer. Cable pull tensions shall be recorded by the Contractor and reviewed by the Engineer. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) shall apply. Cable installation, handling and storage shall be per manufacturer's recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the Engineer, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

108-3.3 Installation of direct-buried cable in trenches. Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S curves. Sharp bends or kinks in the cable shall not be permitted.

Where cables must cross over each other, a minimum of 3 inches (75 mm) vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

a. Trenching. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 inches (0.5 m) below finished grade per NEC Table 300.5, except as follows:

(1) When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches (91 cm) unless otherwise specified.

(2) Minimum cable depth when crossing under a railroad track, shall be 42 inches (1 m) unless otherwise specified.

Dewatering necessary for cable installation, erosion and turbidity control, per Federal, state, and local requirements is incidental to its respective pay items as part of Item L-108. The cost of all excavation regardless of type of material encountered, shall be included in the unit price bid for the L-108 Item.

The Contractor shall excavate all cable trenches to a width not less than 6 inches (150 mm). Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4 inch (6 mm) sieve. Flowable backfill material may alternatively be used. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All such rock removal shall be performed and paid for under Item P-152.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

(1) Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.

(2) Trenching, etc., in cable areas shall then proceed, with approval of the Engineer, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

b. Backfilling. After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall be 3 inches (75 mm) deep, loose measurement, and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4 inch (6 mm) sieve. This layer shall not be compacted. The second layer shall be 5 inches (125 mm) deep, loose measurement, and shall contain no particles that would be retained on a one inch (25 mm) sieve. The remaining third and subsequent layers of backfill shall not exceed 8 inches (20 cm) of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches (100 mm) maximum diameter.

The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent undisturbed soil, and to the satisfaction of the Engineer. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.

If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the compaction requirements per Item P-152 for that area shall be followed.

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turfing operation to be accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of per the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the Engineer. If not shown on the plans, the warning tape shall be located 6 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. A 4-6 inch (100 - 150 mm) wide polyethylene film detectable tape, with a metalized foil core, shall be installed above all direct buried cable or counterpoise. The tape shall be of the color and have a continuous legend as indicated on the plans. The tape shall be installed 8 inch (200 mm) minimum below finished grade.

c. Restoration. Following restoration of all trenching near airport movement surfaces, the Contractor shall visually inspect the area for foreign object debris (FOD) and remove any that is found. Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the sodding, topsoiling, fertilizing, liming, seeding, sprigging, and/or mulching as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration shall be equal to existing conditions and compaction shall meet the requirements of Item P-152. Restoration shall be considered incidental to the pay item of which it is a component part.

108-3.4 Cable markers for direct-buried cable. The location of direct buried circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4-6 inch (10 - 15 cm) thick, extending approximately one inch (25 mm) above the surface. Each cable run from a line of lights and signs to the equipment vault shall be marked at approximately every 200 feet (61 m) along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed directly above the cable. The Contractor shall impress the word "CABLE" and directional arrows on each cable marking slab. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep.

At the location of each underground cable connection, except at lighting units, or isolation transformers, or power a concrete marker slab must mark adapters placed above the connection. The Contractor shall impress the word "SPLICE" on each slab. The Contractor also shall impress additional circuit identification symbols on each slab as directed by the Engineer. All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete. After placement, all cable or splice markers shall be given one coat of high-visibility aviation orange paint as approved by the Engineer. Furnishing and installation of cable markers is incidental to the respective cable pay item.

108-3.5 Splicing. Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

a. Cast splices. These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured per the manufacturer's instructions and to the satisfaction of the Engineer.

b. Field-attached plug-in splices. These shall be assembled per the manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. In all cases the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint.

c. Factory-molded plug-in splices. These 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 rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint.

d. Taped or heat-shrink splices. A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. Throughout the rest of the splice less tension should be used. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer's instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminates prior to application.

Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

108-3.6 Bare counterpoise wire installation for lightning protection and grounding. If shown on the plans or included in the job specifications, bare solid **[** #6 AWG **]** copper counterpoise wire shall be installed for lightning protection of the underground cables. The Engineer shall select one of two methods of lightning protection for the airfield lighting circuit based on the frequency of local lightning:

a. Equipotential. – may be used by the Engineer for areas that have high rates of lightning strikes. This is where the counterpoise is bonded to the light base (edge lights included) and counterpoise size is determined by the Engineer.

b. Isolation – used in areas where lightning strikes are not common. The counterpoise is not bonded to edge light fixtures, in-pavement fixtures are boned to the counterpoise. Counterpoise size is selected by the Engineer.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables.

For edge light fixtures installed in turf (stabilized soils) and for raceways or cables adjacent to the full strength pavement edge, the counterpoise conductor shall be installed halfway between the pavement edge and the light base, mounting stake, raceway, or cable.

The counterpoise conductor shall be installed 8 inches (203 mm) minimum below grade.

Each light base or mounting stake shall be provided with a grounding electrode.

When a metallic light base is used, the grounding electrode shall be bonded to the metallic light base or mounting stake with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

When a nonmetallic light base is used, the grounding electrode shall be bonded to the metallic light fixture or metallic base plate with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

For raceways installed under pavement; for raceways and cables not installed adjacent to the full strength pavement edge; for fixtures installed in full strength pavement and shoulder pavement and for optional method of edge lights installed in turf (stabilized soils); and for raceways or cables adjacent to the full strength pavement edge, the counterpoise conductor shall be centered over the raceway or cable to be protected as described below.

The counterpoise conductor shall be installed no less than 8 inches (203 mm) above the raceway or cable to be protected, except as permitted below.

The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise conductor shall be installed no more than 12 inches (305 mm) above the raceway or cable to be protected.

The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection.

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

If shown on the plans or in the specifications, a separate equipment (safety) ground system shall be provided in addition to the counterpoise wire using one of the following methods:

c. A ground rod installed at and securely attached to each light fixture base, mounting stake, and to all metal surfaces at junction/access structures via #6 AWG wire.

d. For parallel voltage systems only, install a #6 AWG green insulated equipment ground conductor internal to the conduit system and securely attached it to each light fixture base internal grounding lug and to all metal surfaces at junction/access structures. Dedicated ground rods shall be installed and exothermically welded to the counterpoise wires at each end of a duct bank crossing under pavement.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

108-3.7 Counterpoise installation above multiple conduits and duct banks. Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete cone of protection measured 22-1/2 degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

108-3.8 Counterpoise installation at existing duct banks. When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

108-3.9 Exothermic bonding. Bonding of counterpoise wire shall be by the exothermic welding process. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the Engineer, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:

a. All slag shall be removed from welds.

b. Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See also AC 150/5340-30 for galvanized light base exception.

c. If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

108-3.10 Testing. The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the Engineer. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the Engineer. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

a. Earth resistance testing methods shall be submitted to the Engineer for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the Engineer. All such testing shall be at the sole expense of the Contractor.

b. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The Engineer shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

After installation, the Contractor shall test and demonstrate to the satisfaction of the Engineer the following:

c. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.

d. That all affected circuits (existing and new) are free from unspecified grounds.

e. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than 50 megohms.

f. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.

g. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.

h. That all affected circuits (existing and new) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.

i. That the impedance to ground of each ground rod does not exceed 25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the Engineer prior to performing the testing.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the Engineer. Where connecting new cable to existing cable, ground resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved "repair" procedures for items that have failed testing other than complete replacement.

METHOD OF MEASUREMENT

108-4.1 Trenching shall be measured by the linear feet (meters) of trench, including the excavation, backfill, and restoration, completed, measured as excavated, and accepted as satisfactory. When specified, separate measurement shall be made for trenches of various specified widths.

The cost of all excavation, backfill, dewatering and restoration regardless of the type of material encountered shall be included in the unit price bid for the work.

108-4.2 Cable or counterpoise wire installed in trench, duct bank or conduit shall be measured by the number of linear feet (meters) installed and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable or counterpoise wire installed in trench, duct bank or conduit. The measurement for this item shall include additional quantities required for slack.

108-4.3 Ground rods shall be measured by each 8-foot section installed complete.

BASIS OF PAYMENT

108-5.1 Payment will be made at the contract unit price for trenching, cable and bare counterpoise wire installed in trench (direct-buried), or cable and equipment ground installed in duct bank or conduit, in place by the Contractor and accepted by the Engineer. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals, including ground rods and ground connectors and trench marking tape, necessary to complete this item.

Payment will be made under:

Item L-108-5.1	No. 8 AWG, 5 KV, L-824, Type C Cable, Installed in Conduit – per linear foot
Item L-108-5.2	No. 6 AWG, Solid, Bare Counterpoise Wire, Installed in Trench, Including Ground Rods and Ground Connectors - per linear foot
Item L-108-5.3	Remove Existing No. 8 AWG, L-824C in 2" Conduit – per linear foot
Item L-108-5.4	Remove No. 6 AWG, Solid, Bare Counterpoise Wire, Installed in Trench, Including Ground Rods - per linear foot

MATERIAL REQUIREMENTS

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-53	Airport Lighting Equipment Certification Program
Commercial Item Description A-A-59544	Cable and Wire, Electrical (Power, Fixed Installation)
Commercial Item Description A-A-55809	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic
ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes
FED SPEC J-C-30	Cable and Wire, Electrical (Power, Fixed Installation)
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure Sensitive

REFERENCE DOCUMENTS

NFPA-70	National Electrical Code (NEC)
NFPA-780	Standard for the Installation of Lightning Protection Systems
MIL-S-23586F	Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical
ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

END OF ITEM L-108

Item L-110 Airport Underground Electrical Duct Banks and Conduits

DESCRIPTION

110-1.1 This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete or buried in sand) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits. It shall also include all turfing trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

EQUIPMENT AND MATERIALS

110-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

b. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the Engineer. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the Engineer and replaced with materials, that comply with these specifications, at the Contractor's cost.

c. All materials and equipment used to construct this item shall be submitted to the Engineer for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in project that accrue directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the plans and specifications. The Contractor's submittals shall be neatly bound in a properly sized 3-ring binder, tabbed by specification section. The Engineer reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

110-2.2 Steel conduit. Rigid galvanized steel (RGS) conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242. All RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments shall be painted with a 10 mil thick coat of asphaltum sealer or shall have a factory bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel shall be coated with 10 mil of asphaltum sealer. When using PVC coated RGS conduit, care shall be exercised not to damage the factory PVC coating. Damaged PVC coating shall be repaired per the manufacturer's written instructions.

110-2.3 Plastic conduit. Plastic conduit and fittings-shall conform to the following requirements:

- UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10.
- UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
- UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
- UL 651A covers W-C-1094-Rigid PVC Conduit and high density polyethylene (HDPE) Conduit type III and Class 4.

Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

a. Type I–Schedule 40 PVC suitable for underground use either direct-buried or encased in concrete.

b. Type II–Schedule 40 PVC suitable for either above ground or underground use.

c. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.

d. Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

110-2.4 Split conduit. Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

110-2.5 Conduit spacers. Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads, They shall be designed to accept No. 4 reinforcing bars installed vertically.

110-2.6 Concrete. Concrete shall conform to Item P-610, Structural Portland Cement Concrete, using 1 inch maximum size coarse aggregate with a minimum 28-day compressive strength of 4000 psi. Where reinforced duct banks are specified, reinforcing steel shall conform to ASTM A615 Grade 60. Concrete and reinforcing steel are incidental to the respective pay item of which they are a component part.

110-2.7 Flowable backfill. Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material. Fill shall be designed to achieve a 28-day compressive strength of 200 psi (1.4 MPa) under pavement.

110-2.8 Detectable warning tape. Plastic, detectable, American Wood Preservers Association (AWPA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

CONSTRUCTION METHODS

110-3.1 General. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The Engineer shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. No duct bank or underground conduit shall be less than 18 inches (0.5 m) below finished grade. Where under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade.

The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors IMMEDIATELY prior to pulling cable. Once cleaned and swabbed the light bases, manholes, pull boxes, etc., and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor's expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the Engineer of any blockage in the existing ducts.

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200 pound (90 kg) test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m).

Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4 inch (6 mm) sieve. Flowable backfill may alternatively be used The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All such rock removal shall be performed and paid for under Item P-152.

Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the Engineer. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet (60 cm).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the Engineer, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Alternatively, additional duct bank supports that are adequate and stable shall be installed, as approved by the Engineer.

All excavation shall be unclassified and shall be considered incidental to the respective L-110 pay item of which it is a component part. Dewatering necessary for duct installation, erosion and turbidity control, per Federal, state, and local requirements is incidental to its respective pay item as a part of Item L-110. The cost of all excavation regardless of type of material encountered, shall be included in the unit price bid for the L-110 Item.

Unless otherwise specified, excavated materials that are deemed by the Engineer to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

Any excess excavation shall be filled with suitable material approved by the Engineer and compacted per Item P-152.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables) cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

a. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred

b. Trenching, etc., in cable areas shall then proceed with approval of the Engineer, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.

110-3.2 Duct banks. Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (0.5 m) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (0.5 m) below finished grade where installed in unpaved areas.

Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (1 m) beyond the edges of the pavement or 3 feet (1 m) beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. The Contractor shall space the conduits not less than 3 inch (75 mm) apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals.

All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

Install a plastic, detectable, color as noted, 3 to 6 inches (75 to 150 mm) wide tape, 8 inches (200 mm) minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch (75-mm) wide tape only for single conduit runs. Utilize the 6-inch (150-mm) wide tape for multiple conduits and duct banks. For duct banks equal to or greater than 24 inches (600 mm) in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the Engineer shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the Engineer.

110-3.3 Conduits without concrete encasement. Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.

Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4 inch (6 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and lot less than 6 inches (150 mm) apart in a vertical direction.

Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

110-3.4 Markers. The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

The Contractor shall impress the word “DUCT” or “CONDUIT” on each marker slab. Impression of letters shall be done in a manner, approved by the Engineer, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the Engineer. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the Engineer. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

110-3.5 Backfilling for conduits. For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 “Excavation and Embankment” except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during back filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the Engineer.

110-3.6 Backfilling for duct banks. After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 “Excavation and Embankment” except that the material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter. In addition to the requirements of P-152, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet (76 m) of duct bank or one work period’s construction, whichever is less.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the Engineer.

110-3.7 Restoration. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include sodding, topsoiling, fertilizing, liming, seeding, sprigging, and/or mulching shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

METHOD OF MEASUREMENT

110-4.1 Underground conduits and duct banks shall be measured by the linear feet (meter) of conduits and duct banks installed, including encasement, locator tape, trenching and backfill with designated material, and for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

BASIS OF PAYMENT

110-5.1 Payment will be made at the contract unit price per linear foot for each type and size of conduit and duct bank completed and accepted, including trench and backfill with the designated material, and, for drain lines, the termination at the drainage structure. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item per the provisions and intent of the plans and specifications.

Payment will be made under:

Item L-110-5.1	Install 2” PVC Schedule 40 Conduit In Trench Including Excavation and Backfill – per linear foot
Item L-110-5.2	Install 2” HDPE SDR 11 Conduit Directional Boring Under Pavement – per linear foot
Item L-110-5.3	Remove Existing 2” Conduit – per linear foot

MATERIAL REQUIREMENTS

Advisory Circular (AC) 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2922	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
NFPA-70	National Electrical Code (NEC)

Underwriters Laboratories Standard 6
Electrical Rigid Metal Conduit - Steel

Underwriters Laboratories Standard 514B
Conduit, Tubing, and Cable Fittings

Underwriters Laboratories Standard 514C
Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

Underwriters Laboratories Standard 1242
Electrical Intermediate Metal Conduit Steel

Underwriters Laboratories Standard 651
Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

Underwriters Laboratories Standard 651A
Type EB and A Rigid PVC Conduit and HDPE Conduit

END OF ITEM L-110

Item L-115 Electrical Manholes and Junction Structures

DESCRIPTION

115-1.1 This item shall consist of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the Engineer. This item shall include the installation of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the Engineer.

EQUIPMENT AND MATERIALS

115-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the Engineer.

b. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the Engineer) and replaced with materials that comply with these specifications at the Contractor's cost.

c. All materials and equipment used to construct this item shall be submitted to the Engineer for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the plans and specifications. The Contractor's submittals shall be neatly bound in a properly sized 3-ring binder, tabbed by specification section. The Engineer reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

115-2.2 Concrete structures. Cast-in-place concrete structures shall be per the details and dimensions shown on the plans.

Provide precast concrete structures where shown on the plans. Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed

between all joints to make them watertight. The structure shall be designed to withstand aircraft loads, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

Threaded inserts and pulling eyes shall be cast in as shown.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the Engineer shall be submitted by the Contractor to allow for a full evaluation by the Engineer. The Engineer shall review per the process defined in the General Provisions.

115-2.3 Junction boxes. Junction boxes shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases that are encased in concrete. The light bases shall have a galvanized steel blank cover, gasket, and stainless steel or coated steel hardware per FAA Engineering Brief (EB) #83. Covers shall be 3/8-inch (9-mm) thickness for L-867 and 3/4-inch (19-mm) thickness for L-868.

115-2.4 Mortar. The mortar shall be composed of one part of Portland cement and two parts of mortar sand, by volume. The Portland cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C6. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

115-2.5 Concrete. All concrete used in structures shall conform to the requirements of Item P-610, Structural Portland Cement Concrete.

115-2.6 Frames and covers. The frames shall conform to one of the following requirements:

a. ASTM A48 Gray iron castings

b. ASTM A47 Malleable iron castings

c. ASTM A27 Steel castings

d. ASTM A283, Grade D Structural steel for grates and frames

e. ASTM A536 Ductile iron castings

f. ASTM A897 Austempered ductile iron castings

All castings specified shall withstand a maximum tire pressure of as detailed on the drawings and maximum load of as detailed on the drawings.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word “ELECTRIC” or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a “DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER” safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

115-2.7 Ladders. Ladders, if specified, shall be galvanized steel or as shown on the plans.

115-2.8 Reinforcing steel. All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

115-2.9 Bedding/special backfill. Bedding or special backfill shall be as shown on the plans.

115-2.10 Flowable backfill. Flowable material used to backfill shall conform to the requirements of Item P-153, Controlled Low Strength Material.

115-2.11 Cable trays. Cable trays shall be of galvanized steel, plastic, or aluminum. Cable trays shall be located as shown on the plans.

115-2.12 Plastic conduit. Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

115-2.13 Conduit terminators. Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

115-2.14 Pulling-in irons. Pulling-in irons shall be manufactured with 7/8 inch (22 mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2 inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

115-2.15 Ground rods. Ground rods shall be one piece copper clad**.** The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet (2.4 m) long nor less than 5/8 inch (16 mm) in diameter.

CONSTRUCTION METHODS

115-3.1 Unclassified excavation. It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the Engineer without additional expense to the Owner.

The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the 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.

All excavation shall be unclassified and shall be considered incidental to the respective L-115 pay item of which it is a component part. Dewatering necessary for L-115 structure installation, erosion and turbidity control, per Federal, state, and local requirements is incidental to its respective pay item as a part of Item L-115. The cost of all excavation regardless of type of material encountered, shall be included in the unit price bid for the L-115 Item.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the Engineer. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the Engineer. Structures shall be placed after the Engineer has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the Engineer as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

115-3.2 Concrete structures. Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the Engineer before the concrete is placed.

115-3.3 Precast unit installations. Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

115-3.4 Placement and treatment of castings, frames and fittings. All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the Engineer and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written permission is granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the Engineer and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor’s expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

115-3.5 Installation of ladders. Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.

115-3.6 Removal of sheeting and bracing. In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The Engineer may order the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

115-3.7 Backfilling. After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the Engineer.

Backfill shall not be placed against any structure until permission is given by the Engineer. In the case of concrete, such permission shall not be given until tests made by the laboratory under supervision of the Engineer establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the Engineer may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

115-3.8 Connection of duct banks. To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

115-3.9 Grounding. A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4 inch (100 mm) diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtails shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

115-3.10 Cleanup and repair. After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer’s recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

115-3.11 Restoration. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective L-115 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

115-3.12 Inspection. Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

115-3.13 Manhole elevation adjustments. The Contractor shall adjust the tops of existing manholes in areas designated in the Contract Documents to the new elevations shown. The Contractor shall be responsible for determining the exact height adjustment required to raise the top of each manhole to the new elevations. The existing top elevation of each manhole to be adjusted shall be determined in the field and subtracted/added from the proposed top elevation.

The Contractor shall remove/extend the existing top section or ring and cover on the manhole structure or manhole access. The Contractor shall then install precast concrete sections or grade rings of the required dimensions to adjust the manhole top to the new proposed elevation or shall cut the existing manhole walls to shorten the existing structure, as required by final grades. Finally, the Contractor shall reinstall the manhole top section or ring and cover on top and check the new top elevation.

The Contractor shall construct a concrete slab around the top of adjusted structures located in graded areas that are not to be paved. The concrete slab shall conform to the dimensions shown on the plans.

115-3.14 Duct extension to existing ducts. Where existing concrete encased ducts are to be extended, the duct extension shall be concrete encased plastic conduit. The fittings to connect the ducts together shall be standard manufactured connectors designed and approved for the purpose. The duct extensions shall be installed according to the concrete encased duct detail and as shown on the plans.

METHOD OF MEASUREMENT

115-4.1 Electrical manholes and junction structures shall be measured by each unit completed in place and accepted. The following additional items are specifically included in each unit:

- All Required Excavation, Dewatering
- Sheeting and Bracing
- All Required Backfilling with On-Site Materials
- Restoration of All Surfaces and Finished Grading, Sodding
- All Required Connections
- Dewatering If Required
- Temporary Cables and Connections
- Ground Rod Testing

115-4.2 Manhole elevation adjustments shall be measured by the completed unit installed, in place, completed, and accepted. Separate measurement shall not be made for the various types and sizes.

BASIS OF PAYMENT

115-5.1 The accepted quantity of electrical manholes and junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to

complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.

115-5.2 Payment shall be made at the contract unit price for manhole elevation adjustments. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary, including but not limited to, spacers, concrete, rebar, dewatering, excavating, backfill, topsoil, sodding and pavement restoration, where required, to complete this item as shown in the plans and to the satisfaction of the Engineer.

Payment will be made under:

Item L-115-5.1	Install L-867E Electrical Handhole –Per Each
Item L-115-5.2	Remove Existing Handhole –Per Each

MATERIAL REQUIREMENTS

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
Advisory Circular (AC) 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program
Commercial Item Description A-A 59544	Cable and Wire, Electrical (Power, Fixed Installation)
ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C206	Standard Specification for Finishing Hydrated Lime
FAA EB #83	In Pavement Light Fixture Bolts

MIL-P-21035	Paint High Zinc Dust Content, Galvanizing Repair
NFPA-70	National Electrical Code (NEC)

END OF ITEM L-115

Item S-E100 General Provisions – Electrical

DESCRIPTION

S-E100-1.1 General: This item is intended to supplement the specifications for the Airfield Electrical, Signs, and 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.

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.

QUALITY ASSURANCE

S-E100-2.1 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.

Institute of Electrical and Electronic Engineers (IEEE)
American National Standards Institute (ANSI) American Society for Testing and Materials (ASTM) Insulated Power Cable Engineers Association (ICEA)
National Bureau of Standards (NBS)
National Electrical Contractors Association (NECA)
National Electrical Manufacturers Association (NEMA)
National Fire Protection Association (NFPA)
Underwriter's Laboratories, Inc. (UL)
National Electrical Safety Code (NESC)

S-E100-2.2 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.

S-E100-2.3 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 State of Texas. The Airport Building Official will recognize the credentials of Master Electricians with valid current licenses from Texas. Credentials will be recognized of Journeyman Electricians with valid current licenses from Texas 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 of one (1) licensed Apprentice 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.

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. 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. If the electrical contractor fails to furnish any of the above to the satisfaction of the engineer and owner, then the owner has the authority to reject the contractor from work on this project.

k. Electrical contractor qualifications shall be based on previous work experience as follows:

1. Perform construction activities within an active AOA.
2. Provide airfield lighting, signage and infrastructure installation of similar size and complexity within past 2 years.

S-E100-2.4 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.

S-E100-2.5 Submittals

a. Submit manufacturer's data or shop drawings following Item S-E106 – Submittals, Record Documents and Maintenance Manuals.

S-E100-2.6 Inspection and Testing

a. All work performed by the Contractor shall be subject to periodic inspections by the 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 Item S-E111 Airfield Electrical Installation and Testing. Test results shall be evaluated by the Engineer 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 Item S-E111
Airfield Electrical Installation and Testing 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 Item S-E111 Airfield Electrical Installation and Testing.

CONSTRUCTION PROVISIONS

S-E100-3.1 AOA Area Installation Provisions

a. To enhance personnel safety and avoid contractual problems, the Contractor shall comply with the provisions indicated below

S-E100-3.2 Electrical Work Provisions

a. Existing Underground Utilities.

1. 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.

2. Also at least forty-eight (48) hours prior to beginning any excavation within the AOA, the contractor shall request the airport 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.

3. 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.

4. Contractor shall hand excavate in areas of Airport underground electrical lines to avoid disturbing circuits such as FAA, telecom and NAVAIDS.

5. Repair of underground lines damaged by the Contractor shall be the sole responsibility of the Contractor.

b. Lockout Procedure: Contractor shall adhere to requirements of Item S-E104 Recommended Lockout Procedure for Airfield Lighting Circuit.

S-E100-3.3 Temporary and Bypass Circuit Provisions

a. 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.

b. General Requirements.

1. 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.

c. Equipment and Materials.

1. Temporary/bypass wiring shall meet the requirements of Item L-108 Underground Power Cable for Airport, 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.

d. Installation.

1. 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.

2. 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.

3. 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.

S-E100-3.4 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.

S-E100-3.5 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.

S-E100-3.6 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 Engineer at all times. Refer to Item S-E106 Submittals, Record Documents and Maintenance Manuals for additional requirements.

b. Airfield wiring verification diagrams shall be maintained throughout the project and later submitted to the airport manager 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 as applicable to the construction documents. Refer to Item S-E106 Submittals, Record Documents and Maintenance Manuals for additional requirements.

MEASUREMENT AND PAYMENT

S-E100-4.1 Method of Measurement and Payment

a. There will be no measurement or payment for this section. All work will be considered incidental for complete installation of the work to which it is related.

END OF ITEM S-E100

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Item S-E104 Recommended Lockout Procedure for Airfield Lighting Circuit

DESCRIPTION

S-E104-1.1 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 RPR. Airfield lighting circuits can be locked out only with the approval of the airport manager. 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.

a. In order to gain access to the circuit power source, the Contractor will contact his RPR 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.

b. The RPR will then contact the Airport Manager 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 Airport Manager 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, (0530 to 2230), will require special notice. In this case the Airport Manager must be notified a minimum of two regular working days in advance of the lockout occurrence. The Contractor, the RPR, and the Airport Manager, 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 Airport Manager's Authorized Representative will de-energize the circuit. The Contractor will install his lock on the scissor clip, locking out the disconnect.

c. The Contractor will insulate between the field contact of the S-1 switch of all series circuits to be locked out prior to megging. The insulating piece(s) will remain in place until all circuits are meggered for release of lockout. The Contractor will megger the circuit in the presence of the Airport Manager's Authorized Representative. The megger 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 room. The RPR will notify the Airport Manager to report the circuit lockout time and the megger reading.

d. 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.

e. 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 RPR, who will in turn notify the Airport Manager that the circuit is ready to be re-energized. The Contractor, the Airport Manager's Authorized Representative and the RPR will meet at the vault to re-test the circuit.

f. The Contractor will megger the circuit for five minutes in the presence of the Airport Manager's Authorized Representative and the RPR 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 Airport Manager's Authorized Representative and the RPR, 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 RPR must notify the Airport Manager with detailed information concerning the outage. Some outages will require continued work to re-energize circuits.

g. Under no circumstance will the Circuit Disconnect Switch be turned back on by anyone other than the Airport Manager or their Representative. The RPR will notify the Airport Manager to report the time the circuit was released and the megger reading.

PRODUCTS (NOT USED)

EXECUTION (NOT USED)

MEASUREMENT AND PAYMENT

S-E104-4.1 There will no separate measurement for 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 ITEM S-E104

Item S-E105 Alterations, Removal and Demolition

DESCRIPTION

S-E105-1.1 Definitions. 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.

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.

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 unrepairable 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.

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.

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.

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.

S-E105-1.2 Condition of Existing Facilities. 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.

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.

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 Item S-E106, Submittals, Record Documents and Maintenance Manuals.

S-E105-1.3 Occupancy and Use of Existing Facilities. 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.

S-E105-1.4 Vacating Occupied Areas. The Owner will remove all portable items of furniture, equipment, and fixtures prior to the start of work.

S-E105-1.5 Safety Requirements. 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.

S-E105-1.6 Classification of Removed/Demolished Items. 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.

Reusable salvaged items:

a. Salvaged materials and equipment shall be reused in the work as described on the contract drawings, unless noted otherwise.

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.

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.

S-E105-1.7 Temporary Protection. The Contractor shall provide and maintain the following requirements.

Protection of persons and property shall be provided throughout the progress of the work in accordance with these specifications.

Provide temporary enclosures and partitions prior to starting alterations and removal of work. Such items shall protect existing materials, equipment, and other remaining building or system components from damage by weather and construction operations.

Provide temporary enclosures to isolate space utilized by equipment during construction, from dirt, dust, noise, and unauthorized entry.

Provide temporary exits, entrances, and protected passages where work prevents the use of existing facilities. Provide weathertight temporary enclosures over and around openings to be made in existing

exterior construction prior to the start of work. The Contractor shall maintain such temporary enclosures until new construction will protect the interior of existing facilities from the elements.

Provide temporary exterior wall construction which will be designed and fabricated to resist an applied horizontal wind pressure of not less than 130 mph.

Provide temporary exterior roof construction which will be capable of supporting an applied vertical live load of not less than 200 psf, uniformly distributed over the entire roof area.

Design and fabricate temporary enclosures to maintain temperatures inside the existing facilities within a range of plus-or-minus 5 degrees F of normal operating conditions.

Provide temporary jet blast structures which will withstand the jet blast with a safety factor of 2.

EXECUTION

S-E105-2.1 Disconnecting Utilities. 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 Item S-E104 Recommended Lockout Procedures for Airfield Lighting Circuits.

S-E105-2.2 Temporary Utility Services. 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.

S-E105-2.3 Removal Work. 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.

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.

S-E105-2.4 Salvageable Materials and Equipment. The Contractor shall remove all salvageable materials and equipment in a manner that will cause the least possible damage thereto. The equipment shall be properly supported during the removal operation to prevent damage. Removed items which are to be retained by the Owner shall be carefully handled, stored, and protected.

The Contractor shall provide identification tags on all items boxed or placed in containers, indicating the type, size, and quantity of materials.

S-E105-2.5 Buildings and Structures. The Contractor shall perform removal operations in existing buildings as indicated and as otherwise required to complete the work.

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.

The Contractor shall dismantle steel components at field connections and in a manner that will prevent bending or damage.

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.

S-E105-2.6 Electrical Equipment and Fixtures. Wiring systems and components shall be salvaged. Loose items shall be boxed and tagged for identification.

All unused conduit not removed shall have a pull string installed and shall be noted on the record drawings.

Primary, secondary, control, communication, and signal circuits shall be disconnected at the point of attachment to their distribution system.

The Contractor shall remove and salvage electrical fixtures. Incandescent lamps, mercury-vapor lamps, and fluorescent lamps shall be salvaged, boxed and tagged for identification, and protected from breakage.

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.

The Contractor shall remove and dispose of conductors and conduits not used in the finished work and shown to be demolished on the plans.

DEMOLITION

S-E105-3.1 Demolition Operations. 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.

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.

S-E105-3.2 Maintaining Traffic. 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.

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.

S-E105-3.3 Reference Standards Requirements. Demolition operations shall be conducted to ensure the safety of persons in accordance with ANSI A 10.6 Safety Requirements for Demolition.

Demolition shall be conducted in accordance with OSHA, State and local requirements.

DISPOSAL OF DEMOLISHED MATERIALS

S-E105-4.1 General. 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.

S-E105-4.2 Removal from Owner Property. 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.

ALTERATION WORK

S-E105-5.1 General. Cutting, patching, repairing, and other alteration work shall be done by tradesman skilled in the particular trade or work required.

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.

Salvaged items for reuse shall be as approved by the Engineer and Owner.

METHOD OF MEASUREMENT

S-E105-6.1 Removal of the airfield navigational equipment will be measured by each item removed. This item includes all materials, labor, transportation incidentals and services required for the airfield nav-aid demolition as shown on the plans. It is the intent of the demolition pay item that all equipment, devices, fixtures, boxes, stakes, materials, systems and appurtenances, etc. which are no longer required as a result of the project to be removed shall be measured by each item removed. Removal of the item shall include the associated foundation, base can or box, concrete encasement, stakes, isolation transformers, mounting structures, disconnect of the wiring, removal of existing interconnecting and control cables between nav-aid units, repair of the disturbed area to match surrounds, seeding, etc for a complete removal of the item and its components. Furthermore, this item shall include storage when item is planned to be re-installed, or disposal as directed by owner or as noted on the contract drawings. Separate measurement will be made for each nav-aid type only. There is no separate measurement for installed location, nav-aid size variations, etc.

S-E105-6.3 Removal of the airfield electrical infrastructure shall be measured by the lineal footage. This item includes all materials, labor, transportation incidentals and services required for the airfield electrical infrastructure demolition as shown on the plans. This item includes all cables and conduits that are no longer used as a result of this project. It is the intent of this demolition pay item that all cable noted for demolition installed in conduit or boxes is to be removed. Demolition of conduit or direct buried cables is limited to areas requiring excavation for construction of pavement or new utilities or associated infrastructure. It is not the intent of this item to provide additional excavation for the sole purpose of electrical infrastructure removal. Incidental to this item are all associated duct markers, ground rods. Where a conductor is no longer in use but cannot be demolished, the cable ends shall be tagged and labeled at each end and at all accessible areas of the cable. For 600V cables, measurement is for the complete circuit including all conductors

BASIS OF PAYMENT

S-E105-7.1 Payment will be made at the contract price for the required airfield nav-aid demolition. This price shall be full compensation for furnishing all material, equipment and for all preparation, removal of the salvageable materials or debris and equipment and for all labor, equipment, tools and incidentals necessary to complete this item. This item includes any temporary wiring, fixtures, etc. required to maintain the existing airfield lighting systems to the satisfaction of the Owner and Engineer. Separate payment will be made for each Nav-Aid type.

S-E105-7.4 Payment will be made at the contract price for required airfield electrical infrastructure demolition. This item includes all materials, labor, transportation, incidentals and services required for the demolition as shown on the plans. This item includes any temporary wiring, fixtures, etc. required to maintain the existing airfield lighting systems to the satisfaction of the Owner and Engineer. It is the intent of the demolition pay item that all conduit, conductors and counterpoise no longer required as a result of the project be removed.

Payment will be made under:

Item L-108-5.3	Remove Existing No. 8 AWG, L-824C in 2" Conduit – per linear foot
Item L-108-5.4	Remove No. 6 AWG, Solid, Bare Counterpoise Wire, Installed in Trench, Including Ground Rods - per linear foot
Item L-110-5.3	Remove Existing 2” Conduit – per linear foot
Item S-E125-5.4	Remove Existing Can-Mount Elevated MITL/MIRL including Transformer, Base Can, and Concrete Pad - per each
Item S-E125-5.5	Remove Base Mounted Sign L-858, Size 2 and Concrete Pad - per each
Item S-E890-5.2	Remove Existing Airfield Lighting Control and Monitoring System - Per Lump Sum

END OF ITEM S-E105

Item S-E106 Submittals, Record Documents and Maintenance Manuals

DESCRIPTION

S-E106-1.1 General. The items described in this section are applicable to all electrical work by the Contractor. Where the contract special conditions or general provisions also apply, the stricter of the documents shall apply.

S-E106-1.2 Scope. This section includes the requirements for submittals, record documents operation and maintenance (O&M) manuals. All submittals and O & M Manuals shall be submitted in book form as described in this item.

SHOW DRAWINGS AND SAMPLES

S-E106-2.1 Requirements for Shop Drawings and Samples. Shop drawings are drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Contractor or any subcontractor, manufacturer, supplier or distributor, and which illustrate some portion of the work.

Submittal data for electrical materials and equipment shall consist of shop drawings and/or catalog cuts showing technical data as necessary to evaluate the material or equipment, to include dimensions, wiring diagrams, performance curves, ratings, control sequence and other descriptive data necessary to describe fully the item proposed and its operating characteristics.

Samples are physical examples furnished by the Contractor to illustrate materials, equipment or workmanship, and to establish standards by which the work will be judged. Each sample shall be accompanied by the manufacturer's instructions regarding installation, operation and maintenance and shall be identified by item number, and specification.

The Contractor shall review, stamp with his approval and submit to the Engineer, one (1) reproducible and six (6) prints of shop drawings, six (6) copies of submittal books and three (3) sets of samples where required, as described in this item, within fifteen (15) days of notice to proceed.

If the Contractor desires to deviate from the requirements of the contract documents, the Contractor shall separately submit all deviations from the requirements of the contract documents in shop drawings or samples. The submission shall direct in writing the specific attention of the Engineer to the deviations, and shall contain all required data and supporting documentation necessary for an evaluation of the proposed deviation. Any submission or deviation not identified as heretofore mentioned shall be rejected and require resubmission. Separate written approval of all deviations by the Engineer for all design related deviations and by the Owner for all other deviations is required before the Contractor may perform the work covered by such deviation. By requesting a deviation, the Contractor makes the representations contained in this section.

If approval is given, the Contractor will not be excused from producing work in conformity with contract requirements. If a trial use establishes the work does not meet the contract requirements, the Contractor shall take such action as the Engineer determines necessary to meet the contract requirements. No change in contract time will be made as a result of changes made under this subparagraph. By requesting a deviation, the Contractor makes the representations contained in this section.

S-E106-2.2 Substitutions after Bid Date. Substitutions will only be considered after bid date only if the following conditions are met and allowed by other sections of these specifications.

a. Request for substitution is submitted no later than 15 days after notice to proceed for construction is awarded to the Contractor.

b. Request for substitution includes appropriate credit to the project cost. This credit must be submitted with request for substitution in order for substitution to receive any consideration.

c. Samples are to be submitted for all substituted light fixtures, wiring devices and other items deemed necessary by the Engineer to determine that the substituted item meets all specifications and requirements before approval of substitutions can be made.

d. Samples shall be submitted within 15 days after the notice to proceed of the contract.

e. Request for substitution shall include the name of the material or equipment for which it is to be substituted, drawings, cuts, performance and that data or any other data or information necessary for the Engineer to determine that the equipment meets all specifications and requirements.

f. Where permitted and approved, the substitution must conform to space requirements. Substitutions that cannot meet space requirements, which is the substitution installer's responsibility whether approved or not, shall be replaced at the Contractor's expense. Any substitution modifications of related systems, as a result of the substitution, shall be made at the Contractor's expense.

g. The Contractor represents that it has personally investigated the proposed substitution and determined that the proposed substitution is equal or superior in all respects to the specified method or equipment.

h. The Contractor represents that it will provide a warranty for the substitution identical in all respects to the warranty for the specified method or equipment.

i. The Contractor represents that it will coordinate the installation of the accepted substitute, making changes as may be required for the work to be complete in all respects at no additional costs to the Owner.

j. The Engineer shall be the sole judge of whether the proposed "or equal" is suitable for use in the work.

S-E106-2.3 Substitutions Prior to Bid Date. Substitutions will be considered prior to bid date only if all the following conditions are met:

a. A written request has been submitted to the Engineer for approval not less than 7 days prior to the bid date.

b. Substitution samples are to be submitted for all substituted light fixtures, wiring devices and other items deemed necessary by the Engineer to determine that the substituted item meets all specifications and requirements before approval of substitutions can be made.

c. Substitution samples shall be submitted not less than 7 days prior to the receipt of bids.

d. Request for substitution shall include the name of the material or equipment for which it is to be substituted, drawings, cuts, performance and that data or any other data or information necessary for the Engineer to determine that the equipment meets all specifications and requirements.

e. Substitution is approved and included in an addendum.

f. By approving and submitting shop drawings and samples, the Contractor thereby represents that he/she has determined and verified all field measurements, field construction criteria, materials, catalog numbers and similar data and that the Contractor, has checked and coordinated each shop drawing and sample with the requirements of the work of the contract documents.

g. Unless otherwise stated in the contract documents, the Engineer will review and approve shop drawings and samples within fifteen (15) days after receipt, but only for conformance with the design concept of the project and with the information given in the contract documents. The Engineer's approval of a separate item shall not indicate approval of an assembly in which the item functions.

h. The Contractor shall make any corrections required by the Engineer and shall resubmit the required number of corrected shop drawings or new samples until approved. The Contractor shall direct specific attention in writing or on resubmitted shop drawings to revisions other than the corrections requested by the Engineer on previous submissions.

i. The Engineer's approval of shop drawings or samples shall not relieve the Contractor of responsibility for any deviation from the requirements of the contract documents unless the Contractor has informed the Engineer in writing of such deviation at the time of submission and the Engineer has given written approval to the specific deviation. **The Engineer's approval shall not relieve the Contractor from responsibility for errors or omissions in the shop drawings or samples.**

j. The submittals will be reviewed for design intent and general compliance with the information contained in the drawings and specifications. The Contractor is responsible for dimensions, quantities, fabrication processes and methods of construction, coordination of the Contractor’s work with that of all trades. The Contractor shall be responsible for satisfactory performance of his work and supplying a complete and operational system.

k. No portion of the work requiring a shop drawing or sample submission shall be commenced until the submission has been approved by the Engineer. All such portions of the work shall be in accordance with approved shop drawings and samples.

l. Samples, upon request, shall be submitted after written notice of acceptance and approval has been made of each substitution. The Engineer reserves the right to reject the sample should the sample not meet the requirement of the contract documents.

S-E106-2.4 Submittal Books. Submittal books shall consist of a hard cover, view type, 3-ring binder sized to hold 8-1/2-inch x 11-inch sheets.

a. Each binder is to be adequately sized to comfortably hold required submittals. Minimum spline

size to be 1-inch, maximum spline size to be 3-inches (provide additional binders if 3-inch size is not sufficient to properly hold submittals). Each binder shall be adequately sized to hold the submittal information plus an additional 25% of the submittal sheet count.

b. Binder covers to have outer clear vinyl pocket on front and back cover (to hold 8-1/2-inch x 11-inch sheet) and on spline (to hold spline width x 11-inch sheet). Binders shall be Wilson Jones Standard Locking D-Ring View Binders or approved equal. Provide correct designation of project in each pocket. See "EXAMPLES" Appendix A, Figures 1 and 2 included at the end of this section. Description sheet is to be white with black letters, maximum sheet height of 11-inches high and full width of pocket. Description is to describe project and match project drawing/specification description. Description to include submittal type. One (1) for the Airfield Lighting System materials (black) and one (1) for the Airfield Lighting Control System (blue)

S-E106-2.5 Submittal Book Contents. Submittal books to include:

a. First sheet(s) in book shall be a photocopy of the cover sheet. See Appendix A, Figure 1.

b. The second sheet shall be a table of contents.

c. Third sheet shall be prepared and filled out by the Contractor and shall list project addresses. See Appendix A, Figure 3.

d. Fourth sheet shall also be filled out by Contractor and list project information for project, Appendix A, Figure 4.

e. Provide Wilson Jones, reinforced clear, ring binder indexes, 5 tab No. WJ-54125 or approved equal with the appropriate specification section number, and a typed index for each section.

f. Submittals consisting of marked catalog sheets or shop drawings shall be inserted in the binder in proper order. Submittal data shall be presented in a clear and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify pertinent products or models applicable to this project. Markings shall be boldly and clearly made with arrows or circles (highlighting is not acceptable). Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be boldly and clearly made with arrows or circles (highlighting is not acceptable).

g. Shop Drawings: Drawings to include identification of project and name of Engineer, Contractor, subcontractors and suppliers, data, number sequentially and indicate the following:

1. Fabrication and erection dimensions.
2. Arrangements and sectional views.
3. Necessary details, including complete information for making connections with other work.
4. Kinds of materials and finishes.
5. Descriptive names of equipment.
6. Modifications and options to standard equipment required by the work.

7. Leave blank area, size approximately 4-inches x 2-1/2-inches, near title block (Engineer's stamp imprint).
8. Point-to-point wiring diagrams.
9. Conduit/raceway rough-in drawings.
10. See specific sections of specifications for further requirements.

S-E106-2.6 Submittal Books Product Data. Technical data is required for all items as called for in the specifications regardless if item furnished is as specified.

a. Submit technical data verifying that the item submitted complies with the requirements of the specifications. Technical data shall include manufacturer's name and model number, dimensions, weights, electrical characteristics, and clearances required. Indicate all optional equipment and changes from the standard item as called for in the specifications. Furnish drawings or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.

b. In order to facilitate review of product data, insofar as practicable, they shall be noted, indicating by cross reference the contract drawings, note, and/or specification paragraph numbers where item(s) occur in the contract documents. At the end of each section insert a copy of the applicable specification.

c. See specific sections of specifications for further requirements.

S-E106-2.7 Processing Submittals.

a. Submit a minimum of six (6) submittal books with separate tag marking on each copy for the Owner (1), Engineer (4), Contractor and Subcontractor (See other sections of these specifications for additional quantity requirements.)

b. The Contractor shall review the submittal books before submitting to the Engineer. No request for payment will be considered until the submittal book has been reviewed, submitted for approval and approved.

c. Submit under provisions of the Special Conditions, Section 1 and this section of the specifications, whichever is the most strict.

d. Product Data: For standard manufactured materials, products and items, submit six (6) copies or sets of data. If submittal is rejected, resubmittal shall contain same quantity of new data.

e. Shop Drawings: For custom fabricated items and systems shop drawings, initially submit a transparency (suitable for reproduction) together with six (6) prints made therefrom. When submittal is acceptable, furnish one (1) print per book made from the accepted transparency.

f. Acceptance: When returned to Contractor, the front of each submittal section will be marked with the Engineers stamp. If box marked "Submit Specified Item", or "Rejected" or "Revise and Resubmit" is checked, submittal is not accepted and Contractor is to correct and resubmit as noted. Contractor is to comply with notation making necessary corrections on submittal and resubmit for final record. If submittal is marked "Approved", Approved as Noted" or "Returned Without Action", Contractor may begin construction utilizing the submitted item with corrections made. However, the corrected submittal must be resubmitted

for record keeping purposes. Contractor is to comply with notation making necessary corrections on submittal and resubmit for final record.

g. If the submittal is marked "Returned Without Action" the Engineer took no exceptions to the submitted.

h. If the submittal is marked "See Transmittal Letter Comments", the Contractor shall make or note any corrections or requirements identified in the comments. Corrections or comments made on the shop drawings during this review do not relieve the Contractor from compliance with requirements of the drawings and specifications. This check is only for review of the general conformance with the design concept of the project and general compliance with the information given in the contract documents. The Contractor is responsible for; confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his or her work with that of all other trades and performing all work in a safe and satisfactory manner.

i. Note that the approval of shop drawings or other information submitted in accordance with the requirements herein before specified, does not assure that the Engineer, or any other Owner's authorized representative, attests to the dimensional accuracy or dimensional suitability of the material or equipment involved, the ability of the material or equipment involved or the mechanical/electrical performance of equipment. Approval of shop drawings does not invalidate the plans and specifications, if in conflict, unless a letter requesting such a change is submitted and approved on the Engineer's letterhead.

S-E106-2.8 Delays. The Contractor is responsible for delays in project time accruing directly or indirectly from late submissions or resubmissions of shop drawings, or product data.

S-E106-2.9 Re-Submittals. The Engineer shall be reimbursed the cost to review resubmittals subsequent to the second submittal. The cost of review of submittals after the second submittal will be determined and the cost shall be withheld from the Contractor's earnings each month permanently.

RECORD DOCUMENTS

S-E106-3.1 Progress and Record Drawings. Keep one set of blue line prints on the job and neatly mark up design drawings each day as components are installed. Different colored pencils shall be used to differentiate each system of electrical work. All items on progress drawings shall be shown in actual location installed. Drawings shall be inspected weekly for compliance and accuracy. Progress payments shall be withheld if the marked-up drawings are not current.

All underground ducts, conduits, drains, ground grids, force mains, etc., (all underground utilities) installed by the Contractor or located by the Contractor during the construction of this project shall be surveyed. The data shall be sufficient to accurately relocate the utility at a later date. The data shall include North-South and East-West coordinates and an elevation. This data shall be recorded on the as- built drawings.

All manholes and other structures installed by the Contractor shall be surveyed. The center of the structure shall be located by a North-South and East-West coordinate and an elevation. This data shall be recorded on the as-built drawings.

Change the equipment schedules to agree with items actually furnished. At the end of the project, all changes shall be transferred to a set of reproducible transparencies of the design drawings marked "As Built" and dated and stamped by the Contractor.

Prior to request for final payment, furnish a set of "As Built" sepia originals and four sets of prints along with the marked set defined above to the Engineer for approval. The final sepia originals shall be professionally drafted to indicate "As Built" conditions to the Engineer. The prints shall be stamped "As-Built", signed and dated by the electrical contractor.

The Contractor's failure to produce representative "As Built" drawings in accordance with requirements specified herein, shall be cause for the Engineer to produce such "As-built" drawings and the Contractor shall reimburse the Engineer for all costs to produce a set of "Record" drawings to the Owner's satisfaction.

Complete and sign the Progress and Record Document Certification Form in Appendix A, Figure 5 and submit with the Operation and Maintenance Manuals. Submit one form for each Contractor/Subcontractor providing as-built information and include a copy of each form in the O & M Manuals.

S-E106-3.2 Requirements for Display Drawings. An "as built" control and field wiring diagram shall be displayed in the vault. Size D minimum framed and installed. In addition to the wiring diagram (showing actual connections between the system components), a "schematic" diagram shall be provided. A schematic diagram to show the electrical interrelation among the different systems components in the simplest way possible without being cluttered with actual wiring. It should show the path of the signal flow or the power flow. These drawings shall be submitted to the Engineer for approval. The Contractor shall coordinate the requirements with the Owner or his authorized representative and provide the above at no additional cost to the Owner.

OPERATION AND MAINTENANCE MANUALS

S-E106-4.1 Requirements for operation and Maintenance Manuals. Within each major division of work, each specification section in the contract documents which require submission of O & M information shall be individually identified by a typed index tab. The Contractor shall provide four (4) copies of manufacturer's manuals for all installed equipment. As a minimum, it shall contain the following:

a. Safety precautions used while maintaining the equipment.

b. Theory of circuit and system operation.

c. Complete schematic and interconnecting wiring diagrams

d. Complete parts list with each circuit component keyed to designations assigned on schematics and wiring diagrams. Complete information shall be given for each part to permit ordering for replacement purposes. This information shall include the components rating, name of manufacturer and the manufacturer's part number in addition to the following:

e. Recommended preventive maintenance, including care, cleaning, lubrication, service schedules, etc.

f. Troubleshooting procedures.

g. Physical characteristics (weight, size, mounting dimensions, etc.).

h. Installation instructions.

i. Operating instructions.

j. Recommended spare parts and usage for a 1 year period.

k. Submit for checking purposes a specific set of written operating instructions on each item which requires instructions to operate. After approval, provide one copy for insertion in each Operation and Maintenance Manual.

l. Submit for approval maintenance information consisting of manufacturer's printed instructions and parts list for each major item of equipment. After approval, insert information in each Operations and Maintenance Manual. Detailed schematic diagrams shall be furnished for all electrical/electronic equipment.

m. Bill of materials.

n. Physical layout plans.

o. Equipment supplier list.

p. Panel schedules shall be submitted with the respective panel data.

q. Special instructions.

r. Service maintenance contracts including the name, address and 24 hour phone number and contact of manufacturers authorized repair company.

s. There shall be no "Black Boxes" for which there are no schematic/wiring diagrams.

S-E106-4.2 Operation and Maintenance Manuals. O & M Manuals shall consist of hard cover, view type, 3-ring binders sized to hold 8-1/2-inch x 11-inch sheets.

Each binder is to be adequately sized to comfortably hold required submittals. Minimum spline size to be 1-inch, maximum spline size to be 3-inch (provide additional binders if 3-inch size is not sufficient to properly hold submittals). Each binder shall be adequately sized to hold the submittal information plus an additional 25% of the submittal sheet count.

Binder covers to have outer clear vinyl pocket on front and back cover (to hold 8-1/2-inch x 11-inch sheet) and on spline (to hold spline width x 11-inch sheet). Binders shall be Wilson Jones Standard Locking D-Ring View Binders or approved equivalent. Provide correct designation of project in each pocket, see "EXAMPLES" Appendix A, Figures 6 and 7 included at the end of this section. Description sheet is to be white with black letters, maximum sheet height of 11-inch high and full width of pocket. Description is to describe project and match pocket drawing/specification description. Description to include submittal type. One (1) for Airfield Lighting System Materials (black) and one (1) for the Airfield Lighting Control System (blue).

S-E106-4.3 Operation and Maintenance manual Contents. O & M Manuals to include:

a. First sheet in binder shall be a photocopy of the cover sheet see Appendix A, Figure 6.

b. The second sheet shall be a table of contents.

c. The third sheet shall be filled out by the Contractor and shall list project addresses, see Appendix A, Figure 3.

d. The fourth sheet shall also be filled out by the Contractor and list project information for project, see Appendix A, Figure 4.

e. Provide Wilson Jones, reinforced, clear, ring binder indexes, 5 tab No. WJ-54125 or approved equal with the appropriate specification section number, and typed index for each section.

f. Shop Drawings: Shop drawings shall be a copy of the final and approved shop drawings submitted as required in Item S-E106-2, Shop Drawings and Samples. These shall be inserted in the binder in proper order. Each catalog sheet shall clearly identify where the product is used and the drawing identification for equipment. Clear vinyl pockets shall be provided for insertion of shop drawings.

g. Product data and/or catalog sheets shall be a copy of the final and approved submittal submitted as required in Item S-E106-2, Shop Drawings and Samples. These shall be inserted in the binder proper order. Each catalog sheet shall clearly identify where the product is used and the drawing identification for equipment.

h. Warranty/Guarantee: Provide a copy of the warranty/guarantee and letters of certification, in respective locations in the O & M Manual binder. Original warranty/guarantee is to be incorporated into a separate project warranty book with warranty/guarantees provided for other sections of the specifications and submitted for Engineer approval.

i. Performance Verification and Demonstration to Owner.

j. Tabulated Data (as required in S-E111, Airfield Electrical Installation and Testing).

k. Required Check-Out Memos.

l. Progress and Record Drawing Certification.

m. Ground Test Information.

S-E106-4.4 Processing O & M Manuals. Submit four (4) sets of O & M Manuals. The Contractor shall review the manuals before submitting them to the Engineer.

S-E106-4.5 Delays. The Contractor is responsible for delays in project time accruing directly or indirectly from late submissions or resubmissions of the Operation and Maintenance Manuals.

S-E106-4.6 Re-Submittals. The Engineer shall be reimbursed the cost to review Operation and Maintenance Manuals, re-submittals subsequent to the second submittal. The cost of review of Operation

and Maintenance Manuals after the second submittal will be determined and the cost shall be withheld from the Contractor's earnings each month permanently.

METHOD OF MEASUREMENT

S-E106-5.1 The items described in this section are incidental to other sections and not shall be measured for payment.

BASIS OF PAYMENT

S-E106-6.1 No direct payment shall be made for the work described in this section. The work described in this section is incidental to other items and shall be paid for in the respective bid item of which it is a component part.

"EXAMPLE"

AIRPORT OWNER
AIRPORT LOCATION

AIRPORT NAME

PROJECT NAME

AIRFIELD LIGHTING SUBMITTAL BOOK

APPENDIX A - FIGURE 1

"EXAMPLE"

AIRPORT OWNER
AIRPORT LOCATION

PROJECT NAME
AIRPORT NAME

AIRFIELD LIGHTING SUBMITTAL BOOK

APPENDIX A - FIGURE 2

PROJECT ADDRESSES

OWNER:_____ PHONES:_____

CONSULTING ENGINEER:_____

GENERAL CONTRACTOR:_____

SUBCONTRACTORS:_____

SUPPLIERS:_____

APPENDIX A - FIGURE 3

PROJECT INFORMATION

Contractor shall fill in the blanks below and insert in the Submittal Books and the Operating and Maintenance Manuals. Submit one (1) sheet for each major division of Work.

Project Name:_____

Specification Division Number & Name:_____

Subcontractor:_____

Contact:_____ Phone Number:_____

Date Project Bid:_____

Project Start Date:_____

Days Allowed for Construction:_____

Target Completion:_____

Substantial Completion:_____

Certification Date:_____

	DATE SUBMITTED	DATE SUBMITTED
Closeout Documentation Manual:	_____	_____
Operating & Maintenance Manual:	_____	_____
Owner Performance Verification and Demonstrations:	_____	_____
Manufacturer's Performance Verification Memos:	_____	_____
Manufacturer's Test Data:	_____	_____
Record Documents:	_____	_____

APPENDIX A - FIGURE 4

PROGRESS AND RECORD DRAWING CERTIFICATION

This form shall be completed and submitted with the Record Documents. Submit one form for each Contractor/Subcontractor providing as-built information. Include a copy of this form in the Closeout Documentation Manual.

Project Name:_____

Specification Division Number & Name:_____

The Contractor's and Subcontractor's signatures below certify that the attached drawings and specifications were marked and revised as items were installed/changed, during the course of construction, and that these documents represent an accurate "Record-As Built" condition of the work as actually installed.

(Name of General Contractor)

(Signature, Title, Date)

(Name of Subcontractor)

(Signature, Title, Date)

APPENDIX A - FIGURE 5

"EXAMPLE"

AIRPORT OWNER
AIRPORT LOCATION

AIRPORT NAME

PROJECT NAME

AIRFIELD LIGHTING OPERATION AND MAINTENANCE MANUALS

APPENDIX A - FIGURE 6

"EXAMPLE"

AIRPORT OWNER
AIRPORT LOCATION

AIRPORT NAME

PROJECT NAME

OPERATION AND MAINTENANCE MANUAL

APPENDIX A - FIGURE 7

ELECTRICAL MATERIALS SUBMITTAL LIST

Spec. Section Number	Submittal Description	Date Received	Date Returned	Status
S-E100	Certification of Electrical Contractor's Experience. Submit proof of experience for airfield projects of similar size and complexity completed in past 5 years. Copy of Electrical Contractor's State Electrical License Copy of Master Electrician's License Certification of Electrical Superintendent's Experience Electrical Superintendent's resume' and copy of Journeyman Electrician License Electrical Superintendent's References, Airport Name, Contact and phone number Copy of each Journeyman Electrician's License Complete list of licensed Journeyman Electricians planned for work on this project. Complete list of Apprentice Electricians planned for work on this project. Certificate of Splicer Training Completion for all personnel used for splicing on this project.			
S-E104	Submit Lock-Out procedures			
S-E105	Insulation Resistance tests on existing circuits to be modified by Contractor Existing cable protection plan			
L-108	L-824C 5KV Cable with color coding noted #6 AWG bare solid copper counterpoise wire #6 AWG strand copper insulated ground wire L-823 Connector Kits Cable Identification Tags Pull ropes Cable pulling lubricant Detectable marker tape with message and color Wire/cable markers 5/8" diameter by 8' long copper clad steel sectional ground rod Exothermic connections and welding			

L-110	2” Schedule 40 PVC conduits, end bells, fittings, elbows, terminations, cleaner and solvent cement PVC Glue PVC Spacer 2” Schedule 40 PVC duct spacers and duct plugs Duct markers 2” HDPE SDR 11 conduits, fittings, elbows, cleaner, and solvent cement, 2” HDPE SDR 11 to 2” schedule 40 PVC transition couplings			
S-E111	Submit all materials, test equipment, written procedures, equipment calibration certificates for performing the following tests: Calibration Lab Qualifications Megger Tester including Certificate of Calibration Ground Resistance Tester Earth resistance testing Ground continuity/resistance testing Exothermic weld tests			
L-115	L-867E Base can use as handholes			

S-E125	Light bases including hardware, gasket, ground lugs, drain, anti-rotational fins, spacer rings. Lock washers, SS bolting hardware including anti-seize compound **L-861T (LED) Medium Intensity Taxiway Elevated Edge Light** - including as applicable: encased concrete, concrete maintenance pad, light bases (base cans), covers, gaskets, ground lugs, load rings, spacer rings, concrete rings, adapter rings, SS bolting hardware, L-830 isolation transformers, frangible couplings, lamps, installation detail, all components, accessories and incidentals. **L-861 Medium Intensity Runway Elevated Edge Light** - including as applicable: encased concrete, concrete maintenance pad, light bases (base cans), extensions and top sections, covers, gaskets, ground lugs, load rings, spacer rings, concrete rings, adapter rings, SS bolting hardware, L-830 isolation transformers, frangible couplings, lamps, installation detail, all components, accessories and incidentals. **L-861T (LED) Medium Intensity Taxiway Elevated In-Pavement Light** – including as applicable: encased concrete, light bases (base cans), extensions and top sections, covers, gaskets, ground lugs, load rings, spacer rings, concrete rings, adapter rings, SS bolting hardware, L-830 isolation transformers, frangible couplings, lamps, installation detail, all components, accessories and incidentals. **L-858 Y, R, L Internally Lighted Sign** - including as applicable: light bases (base cans), extensions and top sections, covers, gaskets, ground lugs, load rings, anti-rotational fins, spacer rings, concrete rings, sign tethers, SS anchor bolts, SS bolting hardware, L-830 isolation transformers, frangible couplings, lamps, installation detail, panel legend, module quantity, style, size, all components, accessories and incidentals. Epoxy bonding compound including pavement compatibility statement Reinforcing Steel Concrete			

END OF ITEM S-106

Item S-E111 Airfield Electrical Installation and Testing

DESCRIPTION

S-E111-1.1 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.

S-E111-1.2 Related Sections

a. Item S-E104- Recommended Lockout Procedure For Airfield Lighting Circuit

b. Item L-108 - Underground Power Cable for Airports

c. Item S-E125 – Installation of Airport Lighting Systems

EQUIPMENT AND MATERIALS

S-E111-2.1 General. 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.

CONSTRUCTION METHODS

S-E111-3.1 General. The Contractor shall furnish all necessary equipment and appliances for testing installations as indicated below.

S-E111-3.2 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 10 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.

S-E111-3.3 Airfield Lighting Circuits Testing.

a. The Contractor shall notify the Construction Manager and Airport Manager 4-hours prior to cable testing. All testing shall be conducted in the presence of the Construction Manager and Airport Manager's Authorized Representative. All test results shall be simultaneously recorded by the Contractor and the Airport Manager's Authorized Representative. Contractor shall provide test report information to the Construction Manager and the Airport Manager's Authorized Representative for approval. Test procedures for the following required tests, including field test report forms, shall be submitted to the Construction Manager 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 Engineer 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 1000-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 Construction Manager, as requested.
  - **3)** Test Procedures. Refer to Item S-E104 for Lock-Out Procedure requirements. Test procedures for the required tests, including field test report forms, shall be submitted to the Construction Manager 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 Airport Manager's Authorized Representative 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 the FAA criteria listed in the 150/5340-26, latest edition, 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 Construction Manager. 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 Airport Manager's Authorized Representative 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 TO PRODUCT DESCRIPTION
TEMP. MEASURE EQUIP. NO.	HUMID. MEASURE EQUIP. NO.
CALIBRATION DUE DATE	AMBIENT TEMPERATURE
RELATIVE HUMIDITY	

S-E111-3.7 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.

METHOD OF MEASUREMENT AND PAYMENT

S-E111-4.1 There will no separate measurement for 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 ITEM S-111

Item S-E125 Installation of Airport Lighting System

DESCRIPTION

S-E125-1.1 General: This section shall consist of all lighting systems furnished and installed following the project plans and specifications and the applicable advisory circulars including all edge lights, lighted signs, and associated base cans, transformers, base plates, mounting assemblies, connections, lamps, testing of the installed system and all incidentals and appurtenances necessary to place the systems in operation as completed units to the satisfaction of the engineers.

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 Engineer shall be transmitted by the Contractor through the CM to the 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 Item S-E100 General Provisions – Electrical.

S-E125-1.2 FAA References: 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) 150/5345-53, Airport Lighting Equipment Certification Program.

a. All Advisory Circulars referenced in this specification shall be the edition indicated or the latest edition.

b. Additional details pertaining to specific systems covered in this specification are contained in the latest editions of the FAA Advisory Circulars listed below.

150/5340-1	Standards for Airport Markings
150/5340-18	Standards for Airport Sign Systems
150/5340-26	Maintenance of Airport Visual Aid Facilities
150/5340-30	Design and Installation Details for Airport Visual Aids
150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
150/5345-26	FAA Specification for L-823 Plug and Receptacle, Cable Connectors
150/5345-39	FAA Specification L-853, Runway and Taxiway Centerline Retro reflective Markers
150/5345-42	Specification for Airport Light Bases, Transformer Houses, Junction Boxes and Accessories
150/5345-46	Specification for Runway and Taxiway Light Fixtures
150/5345-47	Isolation Transformers for Airport Lighting Systems
150/5345-51	Specifications for Discharge Type Flashing Light Equipment
150/5345-53	Airport Lighting Equipment Certification Program

S-E125-1.3 FAA Specifications: Products covered by FAA specifications shall be as specified by reference number Item L-108 - Underground Power Cable for Airports; reference is made to Item L-110 - Airport Underground Electrical Duct Banks and Conduits.

PRODUCTS

S-E125-2.1 General: Airport lighting 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, latest edition.

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 and the applicable specification sections to the Engineer for approval before the equipment and material are ordered.

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.

All items required per this section are for use on a 6.6 amp primary series circuit unless specifically noted otherwise.

S-E125-2.2 Submittals: 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 materials 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.

S-E125-2.3 Light Fixtures: Light fixtures and lamps specified shall be low wattage and energy efficient, unless noted otherwise.

a. 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.

b. The lighting fixtures shall be Airport Lighting Company.

S-E125-2.4 Products Common to all Systems:

a. Primary Cable. Primary L-824 cable shall as specified in Item L-108.

b. Counterpoise Wire. Counterpoise wire shall as specified in Item L-108.

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-867 and L-868, 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. Coordinate bolt hole patterns for bases with fixtures to be installed. Reference bolt circle dimensions on fixture schedule noted on plans.
4. Furnish all bases with an internal and external ground lug to accept a No. 6 AWG ground cable and threaded hubs for conduit entrance.
5. Coordinate bolt hole patterns for bases with fixtures to be installed. In general, to match fixtures, bolt hole pattern for bases off concrete pavement shall be 10-1/4 inch diameter and 11-1/4 inch diameter bolt hole pattern for bases in concrete pavement.

e. Connectors. L-823 connectors used to splice the L-824 primary cables shall be as specified in Item L-108. 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 Item L-110.

g. Concrete. Concrete shall adhere to requirements of Item P-610 Structural Portland Cement Concrete. Reinforcing steel shall conform to provisions of Item P-610. Precast base cans are not approved for use.

h. Sealer Products. Products used shall conform to applicable requirements of Item P-605 Joint Sealing Filler. Submit materials with satisfactory adhesive and waterproofing qualities for approval of the CM.

i. Joints. Use joint sealing material conforming to Item P-606 and Item P-605 Joint Sealing Filler 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.

j. Fixture Hold Down Bolts. Fixture hold down bolts and installations shall adhere to the following requirements.

1. Bolts shall be all-thread, 18-8, Type 304 stainless steel.
2. Bolts information shall be submitted for approval of the CM. Submittal shall be specifically identify, as a minimum, the bolt material, dimensions and threading.
3. 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 Engineer.
4. 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.
5. Bolts shall receive anti-seize compound (Ideal “Noalox” or approved equivalent) prior to the final turn.
6. 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 1 spacer ring will be allowed per fixture base. Owner to retain additional spacers as spare parts.

S-E125-2.5 Frangible Couplings: 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.

S-E125-2.6 Equipment and Materials for Taxiway Edge 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.

1. Taxiway elevated edge light fixtures shall be L-861T (LED). Fixtures shall be furnished with blue color lens indicated on construction plans. Fixture lamps shall be a LED lamp.
2. Fixtures shall be provided with connecting leads for power connections, optical system, lamp and mounting assembly.
3. The lighting fixtures shall be Airport Lighting Company, Catalog number ALC-861L-BB-14-2.

b. Isolation Transformer. Transformers shall be L-830, 10/15 watt isolation transformers complying with requirements of AC 150/5345-47A for 6.6 ampere series circuits for quartz lamps.

c. Light Base and Transformer Housing. Fixtures shall be installed on new L-867 or L-868 base complying with requirements of AC 150/5345-42.

1. Bases shall house isolation transformer and are 12 inch diameter. Base shall be provided with 1, 2 or more factory installed cable entrance hubs or grommets. Contractor to field verify entrances.
2. Taxiway elevated edge light fixtures shall be L-867B, one-piece bases with factory installed anti-rotation tabs. Coordinate bolt hole patterns for bases with fixtures to be installed.
3. Furnish all elevated edge lights installed in shoulder pavement with telescoping base cans. Furnish all elevated edge lights installed in earth with one-piece base can.
4. Fixtures bases installed in pavement shall be type L-868B. Provide L-868, Class I, two-piece bases with factory installed anti-rotation tabs. Coordinate bolt hole patterns for bases with fixtures to be installed.

d. Additional requirements for LED fixtures

1. LED fixtures shall comply to the FAA EB-67, Light Sources Other Than Incandescent and Xenon For Airport and Obstruction Lighting Fixtures, October 2005.
2. 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.
3. 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 AC150/5345-10F 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.

4. 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.
5. LED Fixture Tolerance to nominal current steps—Since the tolerance for the circuit current is +/- 0.1 amps (for a 6.6 amp circuit) for each nominal step, (from AC 150/5345-10F) the fixture shall operate at the prescribed steps with a greater input current tolerance to provide appropriate operating margin of the circuit.
6. 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
7. Fixture Step Support-- The LED fixture shall support both 3 and 5 step brightness levels as specified in AC 150/5345-10F.

S-E125-2.7 Equipment and Materials for Runway Edge 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.

1. Runway elevated edge light fixtures shall be medium intensity L-861. Fixtures shall be bi-directional with clear/clear or clear/yellow color lenses, unless otherwise indicated on the plans as indicated on construction plans. Light fixture shall consist of an optical system as shown on plans, lamp holder mounted in a suitable housing and mounting assembly.
2. Fixtures shall be provided with connecting leads for power connections.
3. To avoid inadvertent rotation of the fixture, the breakable coupling shall be secured to the base plate by a locking ring.

b. Isolation Transformer. Transformers shall be L-830, isolation transformers complying with requirements of AC 150/5345-47A for 6.6 ampere series circuits. Transformer wattage rating shall be as indicated below.

1. Runway elevated edge light fixture, L-861: 30/45W

c. Light Base and Transformer Housing. Fixtures bases are type L-867 base complying with requirements of AC 150/5345-42.

1. Bases shall house isolating transformer and consist of a cylindrical body with a top flange having a bolt circle as indicated below. Bases are provided with one, two or more factory installed cable entrance hubs. Verify number and direction in field.
2. Runway elevated edge light fixtures shall be L-867B, one-piece base. Coordinate bolt hole patterns for bases with fixtures to be installed.

S-125-2.7 Airfield Guidance Signs.

a. The signs shall be L-858 B, Y, R, and L and shall be internally lighted as indicated on the plans. The size of the units shall be as noted on the sign schedule. The signs shall be furnished

with quartz lamps installed. The L-858 B, Y, R, L units shall be Style 2 as required by the circuit the respective sign is connected to and noted on the sign schedule. All units shall be Class 1. All signs shall be furnished with tethers on a minimum of two legs per module. The tethers shall be fabricated from 3/16" stainless steel aircraft cable with a formed eye on both ends and shall be of ample length to attach the sign (min. of 6" of slack) to the flange plate and allow the frangible coupling and disconnect plug to function properly. The bolting pattern, method of anchoring, etc., shall be per the sign manufacturer's recommendation. The sign manufacturer shall submit to the Engineer calculations showing the sign and anchoring methods will withstand a 200 MPH jet blast in accordance with Paragraph 4.1.2 of AC 150/5345-44, latest edition. The signs shall be supplied with the messages as shown on the sign schedule.

b. Each sign shall be furnished with an on-off toggle switch with weatherproof cover. The switch shall be used by maintenance personnel to de-energize the sign so maintenance work can be performed. The switch shall be located immediately adjacent to the load side of the L-823 disconnect plug. The weatherproof cover shall provide protection from driving rain and shall have a spring operated closing device. The weatherproof cover shall also provide physical protection for the switch handle.

e. The nameplate required by 150/5345-44 shall be made of metal with the data stamped into the metal nameplate.

f. Provide 3-M Scotch-Lite or approved equivalent 6 inch high, die cut labels for each sign, labels shall be reflective film, with pressure-sensitive adhesive backing, suitable for exterior applications. Labels shall be UV resistant. Labels shall be yellow for installation on black surface, black for installation on other surfaces. Text shall be: number and letter style; Helvetica medium, upper case, 6” in height.

g. The quantity of sign modules is based on two (2) characters per module. Payment shall be made on the basis of a module consisting of two characters, regardless of the manufacturing methods or techniques.

h. Each sign shall be furnished with an on-off toggle switch with weatherproof cover. The switch shall be used by maintenance personnel to de-energize the sign so maintenance work can be performed. The weatherproof cover shall provide protection from driving rain and shall have a spring operated closing device. The weatherproof cover shall also provide physical protection for the switch handle.

i. Lighted Sign shall be by Airfield Guidance sign Manufacturers, Inc. (AGM).

125-2.10 SIGN LEGENDS.

a. Furnish sign legends to be installed on existing airfield signs. Legends shall be compatible with existing sign manufacturers.

b. The new legends shall not affect the lumen output of the existing sign. New legends shall secure to existing signs in the same manner as the original legends. Legend text size and style shall be in accordance with FAA Advisory Circular 150/5345-44, latest edition.

c. Legends provided for existing signs that are to remain shall be by original manufacturer of those signs. Provide letter of certification from the manufacturer that the legend replacement does not change any of the performance parameters under which the sign was FAA certified.

d. Sign legend panels shall include all incidentals required for a complete and operational unit to the satisfaction of the Engineer. Each replacement sign panel shall be one or two characters in length.

CONSTRUCTION METHODS

S-E125-3.1 General: 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.

a. Install and mount the products to comply with the requirements of the National Electric Code, Item L-111 and Section L-108.

b. 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 Item L-108. 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 L-108.
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.

c. 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 Item L-110.

d. 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. Light bases shall be set level. Leveling jig shall be required as specified and as directed by the CM. Turn leveling tool over to owner for spare parts.
4. Install reinforcement in the concrete encasement consisting of No. 4 bar tie bar cage. Base can encasement shall be cast-in-place.
5. 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, sealtight steel conduit can be installed at the connection point to fixture base cans, only where rigid conduit connections cannot be made. Any flexible, sealtight 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.

6 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. The cable entrance hubs shall be oriented in the proper direction so as to align with the connecting conduit.

7. Stub-in conduit connections into existing light bases shall be Meyers Hub installation, where required on the plans and as noted on plan details.

8. Furnish base with a 1" drain where noted on the contract drawings.

9. Furnish a light base ground consisting of a #6 AWG bare copper wire jumper banded to the external ground lug on the base to a ground rod installed adjacent to the base.

10. Furnish a light fixture bonding conductor consisting of a (minimum 6' length) #6 AWG stranded copper wire rated for 600V with green XHHW insulation. Connect conductor from internal ground lug on base can to light fixture base plate following light fixture manufacturer's recommendations.

11. When existing light fixtures are removed for the purpose of installing new conductors, lock washers shall be re-installed using new 18-8, Type 304 stainless steel hold down bolts and bolts shall extend 1 inch below flange into base can. Submit bolts information for approval.

12. 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 Engineer.

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 Engineer shall be used.

e) All broken bolts shall be replaced with 3/8"-16 stainless steel 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.

e. 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 Item L-108. 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 L-108.

S-E125-3.2 Light Fixture Installation in Unpaved Areas:

a. Light Base Installation Requirements. Install light fixture bases as per general requirements noted in paragraph S-E125-3.1 and as noted below.

1. Concrete shall be placed under and around the outside of the base. Reference detail drawings for fixture base installation requirements.
2. Provide each fixture with an identification number following the plans by impressing numbers of a 1/4-inch minimum height on a 3 inch brass or aluminum concrete marker disk imbedded in the concrete encasement.

b. Light Fixtures. Assemble the light fixture following the manufacturer's instructions.

1. Connect the secondary leads of the transformer to the fixture leads with a disconnecting plug and receptacle conforming to AC 150/5345-26 without taping the joint. Install a lamp of the proper rating in the fixture.
2. Do not extend the shearing groove of the breakable coupling more than 3-1/2 inches above finished grade. Level each fixture as recommended by the manufacturer to within 1 degree.

c. Cable, Duct and Conduit. Install as per general requirements as specified herein.

S-E125-3.3 Light Fixture Installations in Pavement Areas

a. Light Base Installation Requirements for Class I Bases. Install light fixture bases as per general requirements noted in paragraph S-E125-3.1, details shown on the drawings, and 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 owner.

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.

b. 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. Turn over the light fixture leveling tool to the airport manager at the end of the contract

S-E125-3.4 Demolition and Salvage: At locations noted on plans, the following shall be required:

a. 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.

MEASUREMENT AND PAYMENT

S-E125-4.1 Method of Measurement

a. The number of edge lights with new base can installed to be paid for shall be measured per each per location, installed and accepted by the Engineer. This item will include the light unit, lenses, isolation transformer, fixture leveling tool, splice kits, heat shrinks, base can, tag, concrete encasement collar, ground rod terminations with test reports and all items necessary to complete installation and accepted by the Engineer. Separate measurement will be made for each fixture type.

b. The number of airfield signs shall be measured per each per location, installed and accepted by the Engineer. This item will include the sign structure, panels, lamps, replacement lamps, concrete foundation with L-867D, 24" deep base can with galvanized steel cover plate with hub, gasket, L-830 isolation transformer, L-823 connector, stainless-steel bolting hardware, ground rod with test report, identification tag, tether and all incidentals required to provide a complete and operational system. Separate measurement will be made for the various sign module quantities and module size. There will be separate measurement for single or double sided signs, sign size, and sign style.

BASIS OF PAYMENT

S-E125-5.1 Payment

a. The edge light installation 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.

b. The signage 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 connection, complete in place in accordance with the plans and specifications.

Payment will be made under:

Item	S-E125-5.1	Install Concrete Encased Can-mounted Elevated MITL/MIRL, Transformer, Base Can and Concrete Maintenance Pad - per each
Item	S-E125-5.2	Install In-Pavement Elevated MITL, Transformer, Base Can in Existing PCC Pavement - per each
Item	S-E125-5.3	Install Base Mounted Sign L-858, Size 2 with Sign Legends per Details on Drawings, all in place – per each
Item	S-E125-5.4	Remove Existing Can-Mount Elevated MITL/MIRL including Transformer, Concrete Encased Base Can and Concrete Maintenance Pad - per each
Item	S-E125-5.5	Remove Existing Base Mounted Sign L-858, Size 2 and Concrete Pad– per each

END OF ITEM S-E125

Item S-E890 Airfield Lighting Control System

DESCRIPTION

S-E890-1.1 Scope of Work

a. Provide all labor, materials, tools and equipment, whether or not directly specified in this section or shown on the plans, required for the design, supply, installation, testing, training and commissioning of a complete, functioning of a latest release Airfield Lighting Control and Monitoring System (ALCMS) at the San Angelo Regional Airport.

b. The ALCMS described in this specification and associated drawings shall replace the existing ALCMS in the tower and vault. The removal of the existing ALCMS and changeover to the new ALCMS is included in the scope of work.

c. Supply all ALCMS materials, components, and programming including, but not limited to, ATCT (Air Traffic Control Tower) and vault computer hardware, software, touch screens, interfacing devices, interconnecting cables, networking components, miscellaneous hardware, and components. The cabinets, fiber patch panels, and main fiber cable from vault to tower shall remain and reuse.

d. Supervise the installation of all components of the ALCMS described above. Provide final connection of all communication cables to the ALCMS as shown on drawings.

e. Work directly with San Angelo Regional Airport ATCT personnel to develop an operator control interface that is acceptable to the ATCT personnel.

g. Commission the ALCMS including systematic electrical and mechanical checkout and proving the systems under actual or simulated operating conditions. Verify that all monitored and/or controlled points are accurately depicted and functional on all applicable tower and maintenance graphic screens. Verify that all alarm conditions are accurately displayed on the tower and maintenance graphic screens as required.

h. Provide training for San Angelo Regional Airport personnel in the operation and maintenance of the systems including the provision of complete documentation, classroom instruction, and field training.

S-E890-1.2 References

a. Federal Aviation Administration (FAA), Advisory Circular 150/5345-53, latest edition, Airport Lighting Equipment Certification Program.

b. Federal Aviation Administration (FAA), Advisory Circular 150/5345-49, latest edition, L-854 Radio Control Equipment

c. Federal Aviation Administration (FAA), Advisory Circular 150/5345-56, latest edition, L-890 Airfield Lighting Control and Monitoring System

d. Federal Aviation Administration (FAA), Advisory Circular 150/5345-10, latest edition, Constant Current Regulators and Regulator Monitors

e. National Fire Protection Association (NFPA), NFPA 70, National Electrical Code.

f. National Electrical Manufacturer's Association (NEMA), ICS-1-Industrial Control and Systems General Requirements.

S-E890-1.3 Definitions. The following words and abbreviations have particular meaning and relevance to the work of this Section:

ALCMS	Airfield Lighting Control and Monitoring System
ATC	Air Traffic Control
ATCT	Air Traffic Control Tower
ATS	Automatic Transfer System
CCR	Constant Current Regulator
CGR	Commercial Grade Computer
CSR	Current Sensing Relay
CPU	Central Processing Unit
CRT	Cathode Ray Tube
DCME	Distributed Control and Monitoring Equipment
EMI	Electro-magnetic Inteferference
LCD	Liquid Crystal Display
EEPROM	Electrical Erasable Programmable Read-Only Memory
FAA	Federal Aviation Administration
GUI	Graphical User Interface
HMI	Human Machine Interface
IGC	Industrial Grade Computer
I/O	Input/Output
IRM	Insulation Resistance Monitoring
LED	Light Emitting Diode
LIU	Line Interface Unit
NEMA	National Electrical Manufacturer's Association
NFPA	National Fire Protection Association
PC	Personal Computer, Commercial Grade Computer
RAM	Random Access Memory
RWY	Runway
TWY	Taxiway
UPS	Uninterruptible power supplies

S-E890-1.5 System Description

a. The ALCMS shall meet the requirements of FAA AC 150-5345-56, Specification for L-890, Airfield Lighting Control and Monitoring System Type C (Advanced Monitoring) and Failsafe Type B (Last State-Latching).

b. The requirements for L-890 shall be considered as general minimum requirements to be met. The ALCMS shall also fully comply with the requirements in this specification S-E890, which includes the specific requirements of this airport.

c. ALCMS System Overview

1. Refer to the drawings sheets to view the overall topology of the system. The primary function of the ALCMS is to provide the remote control capability of the equipment in the airfield lighting vault, vault generator, beacon, and air-to-ground (Pilot Control Radio

Control). The primary location for user interface to the system is at the cab of the air traffic control tower. Secondary control for the system, protected by an authentication process, is from the airfield lighting electrical vault.

2. The ALCMS shall be a state-of-the-art system, PC-based and software-controlled, able to operate as a stand-alone system and to be expandable to add more items to be controlled and if required monitored. All hardware or software changes required in the future as a result of airport expansions or changes must be possible without contacting the original equipment manufacturer or supplier. The equipment and software supplied shall be upgradeable by San Angelo Regional Airport personnel, consultants or other systems integrators.
3. The system shall be configured and installed in such a manner as to facilitate and minimize impact to a future upgrade process.
4. The major elements of the ALCMS are as specified in the contract drawings.

S-E890-1.6 System Requirements. The ALCMS design criteria to meet the minimum general, operational, and equipment functional requirements are as follows.

a. General Requirements

1. The ALCMS shall provide remote control and monitoring of the designated airfield lighting equipment in the vault, the generator, radio controlled equipment, and the beacon under all present visibility operating conditions, as applicable.
2. The ALCMS shall be based on an "open architecture" concept to allow simple integration and interfacing of all system components. All components shall be of industrial grade and extended temperature ranges and have high mean time between failure (MTBF) ratings.
3. Customized system and graphics software for operational and maintenance operations.
4. The ALCMS supplier shall coordinate software and programming development with the control tower operations personnel San Angelo Regional Airport, and the airport owner to ensure that user-operated control and maintenance functional requirements are provided.
5. All other specifications and requirements in the design package shall be supported by the ALCMS. Functionality requirements from the CCRs shall be integrated into the ALCMS, to meet the specified operational, functional and maintainability requirements.
6. All equipment indoors shall have an operating temperature range 0°C to +50°C ambient, with relative humidity, 10% to 90%, non-condensing.

b. Control Software

1. All software required to operate, maintain, analyze, and trouble-shoot the system, including source code, shall be provided as part of this contract. All control and monitoring software packages shall be off-the-shelf, non-proprietary.
2. All interlocking, monitoring and control logic shall be programmed reside in the computer provided. A failure of a tower, or vault touch screens that displays the airfield graphics shall not affect the computer operation and the operation of the rest of the system.
3. The software contained in the graphics engines of the touch screens shall consist solely of graphic generation, touch-screen operator input, configuration utilities and remote access software. All light control logic shall be performed in the ALCMS control engine.
4. The graphics on the touch screens that depict the airport for the purposes of ALCMS control, shall represent graphically the movement area of the airport with taxiways and runways clearly labeled. The graphic of the airport shall reflect the actual shapes of the

movement area as viewed from the ATCT. Coordinate the graphics design with the ATCT personnel.

5. System functions and display information shall be configurable on-line by maintenance personnel. This provides the ability to change the configurable items of the system without the need to make any program changes. These configuration changes shall be made simply by selecting a checkbox or by entering data into a configuration screen. The following features shall be provided:
   a) Enable control capability from each location including electrical vault touch screen. In normal operation, control shall both be assigned and accepted, or shall be requested and granted. In the event control is needed and there personnel are not present in the location under control, an additional step shall be provided to override and take control.
   b) Independently enable or disable alarming of each monitoring function for viewing by tower, or electrical vault. This allows the site to specify which alarms are viewable at each different location.
   c) Configure all preset custom pushbuttons allowing the site to easily change presets.
   d) Enable ability to cancel user's pushbutton's selections after a pre-determined time of inactivity and the SEND button has not been pressed to initiate the commands. The time limit shall also be configurable by site.
6. All original program files and source code necessary to make any changes must be provided as part of this contract.
7. Access to all software shall be provided with suitable security measures to prevent inadvertent access to maintenance features, configuration screens and settings. Any ability to make changes to the software must be protected using appropriate passwords and security features. These passwords shall be provided to airport personnel to allow them to make future modifications and additions. Security features shall include the following:
   a) Site assignable usernames with different security levels, allowing individuals access to different system capabilities (i.e. view only, lighting control only, control and monitoring, configuration).

S-E890-1.7 Maintenance Requirements.

a. The ALCMS shall include the capability to diagnose and locate system faults from a touch screen by maintenance authorized. All system software on system computers shall be loaded by CDs or suitable mass storage media, provided by the supplier. The system shall not require any special configuration or file management by maintenance personnel to restore the system software. A restore of the image to the current system revision level, shall be accomplished by CDs, using a laptop and proper loading software shall be provided.

b. It shall be possible for failed replaceable components to the diagnosed by maintenance personnel using the training supplied

S-E890-1.8 Operational Requirements. The ALCMS supplier shall obtain the current operational requirements that define the operation of the control system as used by the Air Traffic Control Personnel. These items are subject to change and additional customization as required by San Angelo Regional Airport and FAA tower personnel. Any additions or changes shall be part of the scope of this contract.

S-E890-1.9 ALCMS Functional Requirements. The proposed ALCMS functional requirements shall duplicate the functional requirements of the current ALCMS system.

S-E890-1.10 Equipment Requirements. Refer to the contract drawings for the equipment requirement.

S-E890-1.11 Maintenance Screens. The proposed ALCMS maintenance screens shall duplicate the maintenance screens requirements of the current ALCMS system.

S-E890-1.12 Submittals

a. Design Submittal. All significant equipment to be supplied shall be listed followed by descriptive data sheets. The equipment list shall include each component name, supplier, model number, a description of the operation, quantity supplied and any special setup, operation and maintenance characteristics.

b. The submittal shall include a description, by specification paragraph number, of how each of the requirements in the specification will be met.

c. Software submittals shall provide a complete description of the system on a functional level.

d. All submittal items shall be subject to approval of the Engineer. Materials and methods identified and described not meeting the requirements of this specification or, in the opinion of the engineer, are not suitable for the intended application, may be rejected, in whole or in part. The supplier shall be required to modify the submittal including changes to materials and methods to the satisfaction of the engineer.

e. Shop Drawings and Product Data

1. Provide drawings showing mounting details of Control Tower touch-screen display, general arrangement of control panels, identification and location of device and panel, "bill of materials". For control panels, provide as a minimum a plan view and a front view with doors removed. Show overall dimensions and component mounting details, cable routings, connections, and terminations.

2. Provide detailed power schematics of computer, showing incoming power supplies, circuit breakers, cooling fan and control, battery charger and control.

3. Provide detailed control schematic and wiring diagrams including all control, monitoring, and communications interconnections and terminations between ALCMS components and airfield lighting control and monitoring points and terminals; computer interconnections, fiber optic communication connections, computer to touch-screen video display monitor interconnections. Provide control and monitoring schematic diagrams.

4. Provide preliminary and final touch-screen display monitor "page" layouts. Include graphic displays, touch, "pushbuttons," status displays (brightness level, on/off, alarm); graphic display representation for each field lighting element, and, for pushbuttons (back-indication from computer to acknowledge operator input; back-indication from computer to confirm action taken; alarm).

5. Submit 3 copies of all drawings and data to the Engineer for review.

f. Operation and Maintenance Manuals

1. Provide 3 copies of Operations and Maintenance Manuals.

2. Provide a detailed description of the ALCMS operation principles and information on troubleshooting, servicing, and maintenance of the equipment, including computers, touch-screen video display monitors, computers, and related equipment, and the actions required in the event of faults.

3. Manuals shall be in full color including color photographs of all equipment at site and full color screen captures of all ALCMS operator and maintenance graphic screens

4. Provide a typical step-by-step procedure describing use and systematic troubleshooting of the system. Maintenance manuals shall describe in detail specifically how ALCMS symptoms are diagnosed, isolated and repaired.
5. Provide individual manuals for specific equipment as appropriate. Provide identified tabs and sections in master manuals for individual equipment data/manuals.
6. Include schematics and detailed power and control/monitoring diagrams for all equipment supplied.
7. Provide full and complete system software and associated source codes. Software shall be complete so that the owner can modify or change the program or graphics as required without the need to contact the ALCMS manufacturer.
8. Include detailed material lists with parts numbers.

S-E890-1.13 Project Record Documents.

a. All drawings, materials lists, and software documentation shall be updated to as built condition to include any factory assembly modifications and field installation modifications.

S-E890-1.14 Quality Assurance

a. Airport lighting equipment and materials covered by FAA specifications shall have prior approval of the Federal Aviation Administration, Airports Service, Washington, D.C. 20591, and shall be listed in Advisory Circular 150/5345-53, latest edition, Airport Lighting Equipment Certification Program. All items that are FAA approved at the time of bidding, that meet the project specifications, are acceptable.

b. All hardware and software proposed must be commercially available off-the-shelf products and must be available from various suppliers.

c. Systems of the type and configuration proposed must have been operational at other airports for at least a period of 5 (five) years.

S-E890-1.15 Qualifications

a. Manufacturers must have a minimum of five (5) PC-based airfield lighting control systems installed and fully operational.

b. Submit a detailed experience list for approval by the owner including the following information: location, date of final acceptance, and a description of the hardware and software used in the control system.

S-E890-1.17 Regulatory Requirements

a. Conform to requirements of NFPA 70.

b. Perform all work in conformance with guidelines established by the FAA for an ALCMS.

S-E890-1.18 Delivery, Storage, and Handling

a. Deliver, store, protect, and handling of products to site shall be coordinated with the construction manager.

b. Accept products on site in factory containers. Inspect for damage.

S-E890-1.19 Warranty

a. Provide written warranty that the ALCMS equipment and components supplied and installed are warranted against defects and malfunction for a period of 12 months from date of completion of commissioning.

S-E890-1.20 Spare Parts

a. Spare parts shall be delivered as part of the system and included as part of the bid to the contractor.
b. At a minimum, the following spare parts shall be included as part of the project.

1. (One) Touchscreen Panel Computer
2. (One) Computer, Industrial, to match industrial hardware supplied.
3. (Two) Distributed Control and Monitoring Equipment (DCME) Assembly
4. (Two) Current/Voltage Module (CVM)
5. (Two) Insulation Resistance Module (CVM)
6. (Two) Ethernet Fiber Optic Transceiver
7. (Two) Fiber Optic Transceiver
8. (Two) Network Interfacing Card (NIC)

PRODUCTS

S-E890-2.1 ALCMS Equipment Refer to the contract drawings for the equipment requirement.

S-E890-2.2 Wireless Roaming Maintenance Computer – Wireless Service

a. A wireless maintenance computer shall be provided to allow for remote connection to the ALCMS system from a maintenance vehicle or other remote location.
b. The maintenance computer shall be a notebook computer with docking station to allow the unit to be docked and re-charged.
c. The computer shall provide real-time control and monitoring of the airfield lighting system when in range of the wireless coverage.
d. The wireless computer shall use wireless Ethernet to provide wireless roaming access to the ALCMS system.
e. The ALCMS manufacturer shall provide all peripherals, computer cards and wireless equipment required to configure the computer to work with the Ethernet network.

S-E890-2.3 Roaming Maintenance Laptop Computer Technical Specifications

A. All roaming maintenance computers in the ALCMS system shall have the following technical specifications:

ID	Options	Description
a)	Type	Laptop
b)	Processor Type	Intel Core I3 or better
c)	Processor Clock Rate	2.5 GHz or better
d)	Memory Capacity	4 GBytes RAM
e)	Hard Disk Drive	500 Mbytes or larger
f)	Floppy Diskette Drive	1.44 MB, 3.5” (As required by the ALCMS manufacturer)
g)	2 X USB Ports	2 USB Ports minimum

h)	Cache Memory	2M
i)	CD-ROM	52X
j)	Video (Integrated)	SVGA, 8MB VRAM, minimum support 1280 x 1024
k)	LCD Screen	12” diagonal viewing area or greater
l)	Operating System	Window 10 (Or as required by ALCMS manufacturer)

S-E890-2.3 Wiring Methods and Practices

a. General

1. Conductors: install copper conductors not smaller than #12 AWG for 120 V power circuits and #16 AWG for control wiring.
2. Insulation: rated 600 V, 90ºC.

b. Color Code
1. AC power circuits: black
2. AC control circuits: red
3. DC control circuits: blue
4. Interlock circuits energized from an external source: yellow
5. Ground conductors: green
6. Current-carrying grounded conductors: white

c. Terminal Blocks

1. Provide terminal blocks rated 600 V for both power and control wiring.
2. Locate terminal blocks so that connections are readily accessible.
3. Provide minimum 15% spare terminals for future use.
4. Group power and control terminals separately. Identify all terminals using clear indelible markings.

d. Device Nameplates

1. Identify all power, control, and communications devices by means of labels or lamacoid nameplates. Label backplate mounted devices in a visible location adjacent to the device.
2. Lamacoid nameplates: 3-mm thick, white face, black lettering, 5-mm high letter, minimum.
3. All ALCMS cables must be labeled at both ends as to the signal name
4. Provide a network diagram laminated in plastic showing all network connections. This should be placed in the each cabinet of the ALCMS for wiring at that location.

e. Panel Wiring

1. Contained in noncombustible plastic wiring duct with removable covers and filled to no more than 60% capacity.
2. Where the use of wiring ducts is impractical, wires shall be neatly bundled and mechanically supported.
3. All installed I/O points shall be wired to terminal blocks including points installed but left as spare.

f. Grounding

1. Ground controls enclosure and individual components.
2. Observe grounding procedures in accordance with the manufacturer's Assembly and Installation Manual.
3. Provide separate bond to ground for enclosure door with electrical devices mounted thereon.
4. Provide a bolted ground lug at the bottom of the enclosure and connect to building ground bus using insulated ground wire.

S-E890-2.4 Source Quality Control

a. Factory tests of all equipment covered by these specifications shall be documented by the manufacturer and a report submitted to the engineer. .

b. Perform a complete examination of the system to determine compliance with the specifications and drawings with respect to materials, workmanship, dimensions and marking.

c. Conduct a complete review of all graphic screens to determine compliance with air traffic control and maintenance requirements prior to shipment.

d. Verify sequence of operations to ensure complete functionality and performance of system. Perform complete testing of fiber optic communication systems.

EXECUTION

S-E890-3.1 Removal of the Existing Lighting Control System.

a. The existing ALMCS components in the vault and all associated cables shall be removed by the contractor. Return removed items to the airport, unless noted otherwise.

b. The existing ALMCS components in the Tower and all associated cables shall be removed return to the airport, unless noted otherwise.

c. Where equipment is remove from walls or other surfaces, these surfaces shall be painted to match surrounding areas, with repairs made to the remaining areas. Equipment shall be disposed of by the contractor, unless otherwise noted. Reconnect any items that will not be controlled by the new ALCMS but will still require power to operate.

d. The Removal of the existing ALMCS shall be coordinated with the Owner and ATCT personnel so that the control of the lights can be maintained.

S-E890-3.2 Installation

a. Installation of the new ALCMS and removal of the old system shall be coordinated with the ATCT personnel and airport maintenance personnel as follows:

1. The changeover period shall be coordinated with the FAA and the airport and shall only occur during the windows agreed upon.
2. During the changeover, provision shall be made for local operation from the regulator vaults.

3. Refer to phasing plans for staging of ALCMS work.
4. Install Tower equipment. Connect to supply.
5. Terminate fiber optic cable into Tower ALCMS cabinet.
6. Install touch-screens, cables as required.
7. Install the new PC-Based computer in vault.
8. Terminate fiber optic cable into ALCMS Enclosure.
9. Install and wire all regulator, circuit selector, and other monitoring kits.
10. Install and connect all control and monitoring wiring as required between the regulators and the computer controls cabinet.

S-E890-3.3 Testing and Commissioning

a. Prepare and submit a proposed testing and commissioning procedure for the ALCMS. Prepare these documents listing the testing and commissioning procedures and expected test results. As a minimum, tests shall include the following:

1. Point-to-point wiring continuity tests.
2. Insulation and grounding tests.
3. Fiber-optic communications tests.
4. Verification of all remote control functions for each controllable element.
5. Touch-screen monitor operations, screen display sections, command select acknowledgment, action confirmed representations, and alarm indications.

b. Acceptance testing. Following final installation and calibration of the ALCMS, the supplier shall perform a demonstration of system performance to the satisfaction of the Engineer. An acceptance test shall be conducted to determine if the system meets the functional and performance requirements of the specification. Satisfactory performance of control functions, monitoring and display functions, alarming, and reporting functions shall be demonstrated. All performance requirements in this specification are subject to testing and verification. If the system does not meet the performance requirements of this specification, the supplier shall make modifications so that the requirements can be met.

S-E890-3.4 Training

a. Provide a qualified factory-trained service engineer to conduct on-site familiarization, operation, and maintenance training program for the ALCMS. Training will be for the Airport's Control Tower and the Maintenance personnel and shall be conducted after the system is fully commissioned.

1. Provide 1 set of 4 hours of on-site training for Air Traffic Control personnel covering operational procedures including allowance for shift work periods.
2. Provide 1 set of 4 hours of on-site training for maintenance personnel covering operational, maintenance and troubleshooting procedures.
3. Provide 1 set of 4 hours of on-site training for maintenance personnel covering software and system configuration of lighting components.
4. As a minimum, training shall include the following:
   a) Familiarization with the Operation and Maintenance Manuals.
   b) Review of schematic drawings - how to read them and how to use them to troubleshoot system function and control problems.
   c) Review of software documentation.
   d) Physical check-over of equipment, noting device locations and relationships to schematics.
   e) Equipment functional tests and checks.

f) Equipment operating instructions.
g) Equipment routine service requirements.
h) Equipment troubleshooting instructions and procedures - review equipment self-diagnostic features and indications, define most likely problems, symptoms and corrective actions.
i) Trouble shooting shall include causing simulated faults throughout the system so that they can be diagnosed by maintenance personnel.

MEASUREMENT AND PAYMENT

S-E890-4.1 Unit Prices

a. Payment for items covered in this section and subsidiary items shall be paid for per lump sum shown below and shall be full compensation for furnishing all products and for preparation, assembly and installation of these products, removal of existing items as specified, and for all labor, equipment, tools, and incidentals necessary to complete these items. Payment designing providing shipping installation and testing of the ALCMS and associated components and connections to the ALCMS, as per construction documents shall be included in the lump sum for providing a complete ALCMS system.

S-E890-4.2 Method of Measurement

a. Measurement for the ALCMS shall include all work and materials required by this specification and plan details and shall include the removal and disposal of the existing airfield lighting control system components, and the supply and installation of the new airfield lighting control system components including, tower and vault touch screens, computer and industrial hardware, distributed control and monitoring equipment, current/voltage modules, insulation resistance module, but not limited to the associated power supply, ethernet switches, fiber media converters, battery backup, etc, and all associated power and control cables and associated interior and exterior conduits and all mounting hardware, terminations, programming, configuration and testing for a complete ALCMS system, approved by the Engineer. Also includes installation and all submittals, training, operation manuals, testing, tools and incidentals to provide a complete and working system.

BASIS OF PAYMENT

S-E890-5.1 Payment

a. Payment for the ALCMS shall include all work and materials required by this specification and plan details This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with the provisions and intent of the plans and specifications.

Payment will be made under:

S-E890-5.1	Install Airfield Lighting Control and Monitoring System (ALCMS) - Lump Sum
S-E890-5.2	Remove Existing Airfield Lighting Control and Monitoring System - Lump Sum

S-E890-5.3 Install a Wireless WIFI Bridge Network System for the ALCMS – Lump Sum

ENDS OF ITEM S-E890

ATTACHMENT A

GEOTECHNICAL INVESTIGATION

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Rodriguez Engineering Laboratories

Construction Materials Engineering Testing

Geotechnical Investigation for San Angelo Regional Airport "Cross-Taxiways Reconfiguration" San Angelo, Texas

Submitted to:

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KSA Engineers, Inc.
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Final
March 30, 2016

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Rodriguez Engineering Laboratories, LLC

Geotechnical Investigation For San Angelo Regional Airport

"Cross-Taxiways Reconfiguration"

San Angelo, Texas

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KSA Engineers, Inc
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Submitted by:

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Final
March 30, 2016

Jose Melendez, P.E.

Geotechnical Investigation for San Angelo Regional Airport "Cross-Taxiways Reconfiguration" San Angelo, Texas

Table of Contents

Geotechnical Investigation For
San Angelo Regional Airport
San Angelo, Texas

INTRODUCTION

Rodriguez Engineering Laboratories (REL) was retained by KSA Engineers, Inc. to perform a geotechnical investigation at San Angelo Regional Airport located in San Angelo, Texas.

PURPOSE OF STUDY

The purpose of this investigation is to determine the engineering properties of the in-situ subsurface soils for the proposed pavement construction of the Cross-Taxiways at the San Angelo Regional Airport. The scope of work for the field geotechnical investigation includes drilling boreholes and collecting representative soil samples to perform the appropriate laboratory tests. The objective is to submit a summary of the laboratory test results, provide soil stabilization, and pavement section recommendations. The results of this geotechnical investigation are summarized and recommendations are provided in this report.

SUBSURFACE INVESTIGATION

The subsurface investigation was performed under the supervision of Jose Melendez, P.E. The field inspection, drilling and logging was performed by Tim Sutherland. Six borings were drilled to depths ranging from 3 to 10 feet depth below existing grade in location selected by KSA Engineers, Inc. Appendix C contains a map of the borehole locations. Appendix A contains the information on each borehole along with the laboratory results for Moisture Content, Atterberg Limits, Sieve Analysis and Unified Soil Classification. The borings were drilled with a Giddings trailer mounted drill rig with a six-(6) inch diameter flight auger at the selected locations.

LABORATORY TESTING

The soil samples obtained during the exploration were sealed at the site and transported to the laboratory. A testing program was conducted on the sealed samples to aid in classification and evaluation of the engineering properties required for analysis. The laboratory tests were performed by experienced laboratory technicians and monitored by the geotechnical engineer. The parameters were determined by the following laboratory tests:

- Potential volumetric shrinkage characteristics of the cohesive soils were determined by the Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D 4318).

- Material gradation for soil classification was determined by the Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D 2487).

- Material moisture content was determined by the Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (ASTM D 2216).

- Field description of the material was determined by the Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM D 2488).

The data can be found in Appendix A.

- The Moisture-Density relationship of the natural subgrade soils was determined by the standard test method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3)) (ASTM D 698).

- An index of strength and deflection characteristics of the natural subgrade soils was determined by performing the standard test method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils (ASTM D 1883).

The data can be found in Appendix B.

- The Stabilization of Subgrade was determined by the Standard Specification for Determining Stabilization Ability of Lime by Soil pH (Tex-121-E, Part III).

The data can be found in Appendix E.

- The pH of soils in an aqueous solution was determined by the Standard Test Method for Determining Soil pH (Tex-128-E).

- The Soluble Sulfate Content was determined for the purpose of insuring that these would not be any potential adverse sulfate-lime reaction in the event lime stabilization is recommended by Standard Test Method for Sulfate Content in Soils Colorimetric Method (Tex-145-E).

The data can be found on CBR table of this report.

SITE AND SUBSURFACE CONDITIONS

Site Conditions

The San Angelo Regional Airport is located off FM 584 in San Angelo, Texas, at approximately 7 nautical miles southwest from downtown. The topography in the area is generally flat.

The Geologic Atlas of Texas (San Angelo Sheet) published by the Bureau of Economic Geology at the University of Texas at Austin indicates that the general geology of the area is Quaternary with Caliche Deposits (Qc) from the Recent (Holocene) and Pleistocene Period. Forms partly alleviated flats, above the level of fluviatile terraces, partly stream cut, mostly soil covered; thickness up to 15 feet.

Appendix C includes a geological map of the area as well as a site map of the boring locations.

Subsurface Conditions

Borings to depth were generally advanced with ease; the material sampled varied from medium-to-high plasticity Clays. The particular subsurface stratigraphy, as determined by the exploration, is shown in detail in the boring logs.

No groundwater was encountered during drilling operations. However, the short-term field observations generally do not permit an accurate evaluation of the subsurface water levels. Any ground water elevation information provided is representative of conditions existing on the day and for the specific location where the information was taken. The actual groundwater elevation may fluctuate due to time, climatic conditions, and/or construction activities.

SUMMARY OF TEST RESULTS

The following is a summary of test results obtained from the field borings information and laboratory tests of the representative soil samples.

Laboratory CBR Value, Subgrade

The following laboratory CBR values were based on a 95% maximum dry density (ASTM D 698) compaction level and a soaking period of 96 hr.

CBR No.	Sample Location	Laboratory Compacted – Soaked CBR	Maximum Dry Density (PCF)	Optimum Moisture (%)	Average Percent Swell Measured
1	Proposed Cross-Taxiway (Near to Boring No. 1)	4.5	102.3	19.3	0.8
2	Proposed Cross-Taxiway (Near to Boring No. 5)	3.6	98.2	19.8	1.0

The soil classification for the subgrade materials used on CBR tests are:

CBR No.	Soil Classification	Atterberg Limits		Moisture Content (%)	Material Passing (%)			Soluble Sulfate Content	
		LL	PI		#4	#40	#200	mg/Kg	%
1	Dark Gray, Sandy Lean Clay (CL)	38	19	16.4	91.6	83.7	69.4	300	0.030
2	Brown, Lean Clay with Sand (CL)	40	22	19.9	95.8	86.6	70.7	<100	<0.010

Summary of Soil Testing

The following is a summary of the laboratory tests results of the soil samples obtained.

Boring No.	Depth (ft)	Soil Classification	Moisture Content (%)	Atterberg Limits		Sieve Analysis Percent Passing		
				LL	PI	#4	#40	# 200
1	0 - 2.5	Dark Gray, Lean Clay with Sand (CL)	16.5	48	30	97.0	92.8	81.2
	2.5 - 5	Brown, Lean Clay with Sand (CL)	16.3	35	17	97.2	89.9	81.4
	5 - 7.5	Yellowish Brown, Lean Clay (CL)	16.3	41	23	99.7	98.5	92.5
	7.5 - 10	Yellowish Brown, Lean Clay (CL)	22.6	41	23	98.8	97.5	92.0
2	0 - 2.5	Pale Brown, Lean Clay w/Sand (CL)	19.9	35	18	98.8	94.2	84.9
	2.5 - 5	Yellowish Brown, Clayey Sand with Gravel (SC)	18.1	30	14	82.0	54.8	40.8
	5 - 7.5	Yellowish Brown, Clayey Sand (SC)	18.8	32	13	89.7	56.6	40.2
	7.5 - 10	Yellowish Brown, Sandy Lean Clay (CL)	22.5	32	17	95.5	77.2	62.9

Summary of Existing Pavement Structure

The following is a summary of the existing pavement structure and soil classification of the encountered base material:

Boring No.	Location	Pavement Thickness		Properties of Existing Base			
		HMAC (in)	BASE (in)	Soil Group Symbol	Soil Classification	LL	PI
2	Existing Cross-Taxiway	10	9.5	SW-SM	Gray, Well Graded Sand with Silt and Gravel	Non-Plastic	
3	Existing Cross-Taxiway	6	19	SC	Grayish Brown, Clayey Sand with Gravel	34	15
4	Existing Cross-Taxiway	9	6	SW-SC	Grayish Brown, Well Graded Sand with Clay and Gravel	31	10
6	Existing Cross-Taxiway	11	11	SC	Light Gray, Clayey Sand	32	11

Above base samples were obtained by drilling method, drilling with an auger through the base layer might cause degradation of the coarse aggregate; therefore, gradation and plasticity test results of base samples obtained from the borings by drilling may vary from in-place base material.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based upon the data obtained from the field and laboratory testing of the soil samples, the project information provided to us by KSA Engineers, Inc. and experience with similar soils and site conditions.

Pavement Design Parameters

Based on information provided by KSA Engineers, Inc., we understand that flexible and rigid pavement section recommendations are desired for the proposed pavement at the Cross-Taxiways.

The Resilient Modulus of the Subgrade (E_{SG} Value) and the Foundation Modulus of the Subgrade (K Value) were obtained using a CBR Value of 3.5 and the following correlations shown in the FAA Advisory Circular 150/5320-6E. As recommended on FAA Advisory Circular 150/5320-6E, one standard deviation below the mean of the subgrade CBR test results was used as the CBR design value.

$E_{SG} = 1500 * CBR$
$E_{SG} = 26 * K^{(1.284)}$

- Design CBR value: 3.5
- Design E_{SG} value: 5,250 psi
- Design K value: 62 pci
- Concrete Flexural Strength: 650 psi

Cross-Taxiway Reconfiguration					
No.	Aircraft Type	Gear Type	Gross Weight (lbs)	Annual Departures	% Annual Growth
1	Dual Whl - 50	DW	50,000	2,903	2.5
2	Beechjet 400	DW	15,500	1,450	2.5
3	Gulfstream V	DW	90,900	450	2.5
4	Airbus 319	DW	141,978	450	2.5
5	Sngl Whl - 3	SW	3,000	10,613	2.5
6	Dual Whl – 10	DW	12,500	1,728	2.5
7	Sngl Whl - 15	SW	15,000	24,299	2.5
8	Sngl Whl - 5	SW	5,000	2,680	2.5

HMAC Pavement Section Recommendation

The FAA's Airport Pavement Design and Evaluation (FAA Advisory Circular 150/5320-6E) and the FAARFIELD software has been used as basis for our recommendations along with a CBR value of 3.5 and the above aircraft information that was provided by KSA Engineers, Inc. The annual departures and type of aircraft notably influence the section thickness. A new pavement analysis should be performed if modifications are made to the design parameters shown above.

Flexible Pavement Section

The new pavement section should consist of 5" HMAC over 10.4" CTB and 5" HMAC over 11.07" HMAC Base (Appendix D1 & D2). However, the following options may be utilized:

Option 1
5" FAA Item P-401 Bituminous Surface Course
10.5" FAA Item P-304 Cement Treated Base Course
8" FAA Item P-155 Lime Treated Subgrade

Option 1A
5" FAA Item P-401 Bituminous Surface Course
11" FAA Item P-401/P-403 Bituminous Base Course
8" FAA Item P-155 Lime Treated Subgrade

Rigid Pavement Section

The new pavement section should consist of 14.82" PCC over 6" CTB and 14.89" PCC over 6" HMAC Base (Appendix D3 & D4). However, the following options may be utilized:

Option 2
15" FAA Item P-501 PCC Pavement
Bond-breaker
6" FAA Item P-304 Cement Treated Base Course
8" FAA Item P-155 Lime Treated Subgrade

Option 2A
15" FAA Item P-501 PCC Pavement
6" FAA Item P-401/P-403 Bituminous Base Course
8" FAA Item P-155 Lime Treated Subgrade

In the event that any changes on the design parameters used above are made, the pavement sections recommended in this report shall be reviewed and analyzed by us and a revised report should be issued. The pavement sections presented above were based on the laboratory and engineering analysis of the soil samples taken. If any subsurface conditions other than those described here are encountered, Rodriguez Engineering Laboratories should be immediately notified so that further investigations and supplemental recommendations can be provided.

The recommended pavement sections do not take the Potential Vertical Rise (PVR) into consideration; if PVR is desired as part of the design parameters, the geotechnical investigation will need to be expanded. Deeper borings and additional testing will be required to determine the PVR value. The above pavement sections are based on percent swell calculations using ASTM D-1883 method and FAA-AC150/5320-6E pavement design manual.

General Pavement Recommendations

Areas containing unsuitable materials (with vegetable or organic matter) should be removed to avoid differential settlements due to decomposition of these materials. Unsuitable materials shall be disposed to authorized areas or if approved, used for embankment slope to support vegetation.

All undercut and grading of existing subgrade shall comply with the requirements of FAA Item P-152. The excavated areas may be refilled with suitable material obtained from the grading operations or borrow areas and compacted to a minimum of 95% of Modified Proctor Density ASTM D1557 and the moisture content of the material during placement shall be within ±2% of the optimum moisture content.

If embankment is utilized for lower areas, it should comply with the requirements of FAA Item P-152. Compact the material to a minimum of 95% of Modified Proctor Density ASTM D1557 and the moisture content of the material during placement shall be within ±2% of the optimum moisture content. For non-cohesive material, the top 6 inches of the embankment should be compacted to 100% maximum density. The material should be placed in successive horizontal layers of 8 inches or less (measured un-compacted) for the entire width of the cross section.

Compaction of side slopes should be parallel to the long direction of the side slopes. Pieces larger than 4 inches will not be allowed on the upper 6 inch course. Embankment should extend 5 feet from the pavement edge.

Subgrade preparation shall comply with the requirements of FAA Item P-152. Compact non-cohesive material to 100% or cohesive material to 95% of Modified Proctor Density ASTM D1557 and the moisture content of the material during placement shall be within ±2% of the optimum moisture content.

Samples containing clay were analyzed for Sulfate Content. The sulfate content was found to be less than 0.04 percent by weight of dry soil. This is well below the 0.2 percent indicated by Dallas N. Little* as the level at or above which expansion problems may occur with lime. Although the sulfate content during our investigation was relatively low, the soil should be periodically analyzed for sulfate content during construction. If it is determined that the sulfate content of the soil is higher than what was determined during the geotechnical investigation, REL should be notified in order to re-evaluate the changed conditions.

Subgrade material having a plasticity index (PI) exceeding 20 should be stabilized with lime slurry at eight (8) inch minimum-compacted thickness.

If lime stabilization is used, it shall comply with the requirements of FAA Item P-155. The percentage (based on the dry weight of the soil) of lime slurry required to stabilize the existing subgrade is approximately 6%; however, if during construction, after cut/fill operations, other types of subgrade materials are encountered, additional testing should be performed to determine the lime required to stabilize the final subgrade material. Compact the material to a minimum of 95% of Standard Proctor Density (ASTM D-698) and the moisture content of the mixture at the start of the compaction shall not be below nor more than2% of the optimum moisture. Lime-treated subgrade should extend at least 5 feet from the pavement edge.

If bituminous base course is used, it shall comply with the requirements of FAA specification Item P-401 or P-403 (Plant Mix Bituminous Pavements) for 1" maximum nominal size aggregate, 75-blow compaction. Mix complying with this specification has sufficient asphalt to better resist oxidation and age hardening to which pavements receiving intermittent traffic are susceptible.

If cement treated base course is used, it shall comply with the requirements of FAA Item P-304. The moisture content of the material during placing operations shall not be below, nor more than 2 percentage points above the optimum moisture content and compacted to a minimum of 98% of the maximum dry density as determined by the Soil-Cement Mixtures Proctor Density (ASTM D-558).

Base material should extend 2 feet from the pavement edge. Topsoil should be placed over the base extension to protect base from excess water penetration and erosion from runoff.

If flexible pavement is used for surface, it should comply with the requirements of FAA specification Item P-401 (Plant Mix Bituminous Pavements) for 3/4" maximum nominal size aggregate, 75-blow compaction. Mix complying with this specification has sufficient asphalt to better resist oxidation and age hardening to which pavements receiving intermittent traffic are susceptible.

If rigid pavement is used, it shall comply with the requirements of FAA Item P-501 Specification (Portland Cement Concrete Pavement). It is important to saw cut the joints as soon as possible to minimize random cracking. Insure that the concrete has attained sufficient strength to withstand equipment loads.

Care should be taken to slope the site to prevent water ponding around or on the pavement structure during and after construction. Once completed, the ground surface should slope away from the pavement and have enough topsoil to grow vegetative cover to prevent erosion.

It was also determined that the topsoil encountered during our investigation can be excavated using conventional earth moving equipment (ripper, trencher, backhoe). However, if bedrock is encountered, rock hammers or possibly blasting may be required.

* *Handbook for Stabilization of Pavement Subgrades and Base Courses with Lime, by Dallas N. Little, Kendall / Hunt Publishing Co., 1995. Pp. 51 & 52*

LIMITATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the exclusive use of KSA Engineers, Inc. in the preparation of the pavement design, construction, drawings, and specifications for the proposed cross-taxiways at the San Angelo Regional Airport. Verification of subsurface conditions for purposes of determining difficulty of excavation, dewatering, trafficability, etc., is the responsibility of others specializing in those areas. Our geotechnical scope of work for this site did not include an environmental assessment or chemical testing and analysis of the property's air, water, and subsurface soils. This report is not intended for use in determining construction means and methods and may therefore be misleading if used for that purpose. In the event that any changes in the nature, design or locations of these structures are made from those assumed herein, the conditions and recommendations contained in this report shall not be considered valid until the changes are reviewed and the conclusions are verified in writing.

Appendix A:

Bore Log Data

Rodriguez Engineering Laboratories

Bore Log Data
Boring No. 1

Project: San Angelo Regional Airport
Location: New Cross Taxiway (31°21'43.7"N, 100°29'58.0"W)
Date Drilled: 1/21/2016

Boring Depth: 10 ft.
Water Level: N / A
Drilling Method: A = Auger

Depth (ft)	Soil Symbol	Sample No.	Laboratory Classification		Drilling Method	Moisture Content (%)	Atterberg Limits		Sieve Analysis, Percent Passing								Depth (ft)
			Material Description	Group Symbol			LL	PI	3"	7/8"	3/4"	3/8"	No.4	No.10	No.40	No.200	
		NS	Topsoil with Vegetation.		A												
1.0		1-1	Dark Gray, Lean CLAY with Sand.	CL	A	16.5	48	30	100.0	100.0	100.0	99.1	97.0	95.2	92.8	81.2	1.0
2.0																	2.0
3.0		1-2	Brown, Lean CLAY with Sand.	CL	A	16.3	35	17	100.0	100.0	100.0	98.7	97.2	95.0	89.9	81.4	3.0
4.0																	4.0
5.0																	5.0
6.0		1-3	Yellowish Brown, Lean CLAY.	CL	A	16.3	41	23	100.0	100.0	100.0	100.0	99.7	99.2	98.5	92.5	6.0
7.0																	7.0
8.0		1-4	Yellowish Brown, Lean CLAY.	CL	A	22.6	41	23	100.0	100.0	100.0	99.5	98.8	98.3	97.5	92.0	8.0
9.0																	9.0
10.0																	10.0

Boring terminated at 10 ft. No groundwater was encountered.

Rodriguez Engineering Laboratories

Bore Log Data
Boring No. 2

Project: San Angelo Regional Airport
Location: Existing Cross Taxiway (31°21'37.3"N, 100°29'58.5"W)
Date Drilled: 1/21/2016

Boring Depth: 3 ft.
Water Level: N / A
Drilling Method: A = Auger

Depth (ft)	Soil Symbol	Sample No.	Laboratory Classification: Material Description	Laboratory Classification: Group Symbol	Drilling Method	Moisture Content (%)	Atterberg Limits: LL	Atterberg Limits: PI	Sieve Analysis, Percent Passing: 3"	7/8"	3/4"	3/8"	No.4	No.10	No.40	No.200	Depth (ft)
0.5		2-1	10" HMAC Pavement.		A												0.5
1.0		2-2	9.5" BASE. Gray, Well Graded SAND with Silt and Gravel.	SW-SM	A	4.6	Non-Plastic		100.0	100.0	98.6	88.8	71.9	53.4	25.7	8.7	1.0
1.5																	1.5
2.0		2-3	Brown, Clayey SAND.	SC	A	19.9	44	25	100.0	100.0	100.0	92.7	88.0	80.9	65.5	46.3	2.0
2.5																	2.5
3.0																	3.0
			Boring terminated at 3 ft. No groundwater was encountered.														
3.5																	3.5
4.0																	4.0
4.5																	4.5
5.0																	5.0

Rodriguez Engineering Laboratories

Bore Log Data
Boring No. 3

Project: San Angelo Regional Airport
Location: Existing Cross Taxiway (31°21'36.1"N, 100°30'00.4"W)
Date Drilled: 1/21/2016

Boring Depth: 3 ft.
Water Level: N / A
Drilling Method: A = Auger

Depth (ft)	Soil Symbol	Sample No.	Laboratory Classification: Material Description	Laboratory Classification: Group Symbol	Drilling Method	Moisture Content (%)	Atterberg Limits: LL	Atterberg Limits: PI	Sieve Analysis, Percent Passing: 3"	7/8"	3/4"	3/8"	No.4	No.10	No.40	No.200	Depth (ft)
0.5		3-1	6" HMAC Pavement.		A												0.5
1.0		3-2	19" BASE. Grayish Brown, Clayey SAND with Gravel.	SC	A	8.8	34	15	100.0	100.0	97.0	81.0	58.2	42.1	24.9	12.7	1.0
1.5																	1.5
2.0																	2.0
2.5		3-3	Brown, Clayey SAND.	SC	A	18.9	48	29	100.0	100.0	100.0	97.5	94.5	87.4	66.9	42.0	2.5
3.0																	3.0
			Boring terminated at 3 ft. No groundwater was encountered.														
3.5																	3.5
4.0																	4.0
4.5																	4.5
5.0																	5.0

Rodriguez Engineering Laboratories

Bore Log Data
Boring No. 4

Project: San Angelo Regional Airport
Location: Existing Cross Taxiway (31°21'14.4"N, 100°30'01.6"W)
Date Drilled: 1/21/2016

Boring Depth: 3 ft.
Water Level: N / A
Drilling Method: A = Auger

Depth (ft)	Soil Symbol	Sample No.	Laboratory Classification: Material Description	Laboratory Classification: Group Symbol	Drilling Method	Moisture Content (%)	Atterberg Limits: LL	Atterberg Limits: PI	Sieve Analysis, Percent Passing: 3"	7/8"	3/4"	3/8"	No.4	No.10	No.40	No.200	Depth (ft)
0.5		4-1	9" HMAC Pavement.		A												0.5
1.0		4-2	6" BASE. Grayish Brown, Well Graded SAND with Clay and Gravel.	SW-SC	A	7.5	31	10	100.0	100.0	98.5	91.3	75.0	54.5	27.1	10.7	1.0
1.5		4-3	Brown, Clayey SAND.	SC	A	20.0	38	19	100.0	100.0	100.0	96.5	91.6	83.4	67.4	49.5	1.5
2.0																	2.0
2.5																	2.5
3.0																	3.0
3.5			Boring terminated at 3 ft. No groundwater was encountered.														3.5
4.0																	4.0
4.5																	4.5
5.0																	5.0

Rodriguez Engineering Laboratories

Bore Log Data
Boring No. 5

Project: San Angelo Regional Airport
Location: New Cross Taxiway (31°21'12.5"N, 100°30'01.5"W)
Date Drilled: 1/21/2016

Boring Depth: 10 ft.
Water Level: N / A
Drilling Method: A = Auger

Depth (ft)	Soil Symbol	Sample No.	Laboratory Classification: Material Description	Laboratory Classification: Group Symbol	Drilling Method	Moisture Content (%)	Atterberg Limits: LL	Atterberg Limits: PI	Sieve Analysis, Percent Passing: 3"	7/8"	3/4"	3/8"	No.4	No.10	No.40	No.200	Depth (ft)
		NS	Topsoil with Vegetation.		A												
1.0		5-1	Pale Brown, Lean CLAY with Sand.	CL	A	19.9	35	18	100.0	100.0	100.0	99.7	98.8	97.9	94.2	84.9	1.0
2.0																	2.0
3.0		5-2	Yellowish Brown, Clayey SAND with Gravel.	SC	A	18.1	30	14	100.0	97.1	97.1	90.1	82.0	71.5	54.8	40.8	3.0
4.0																	4.0
5.0																	5.0
6.0		5-3	Yellowish Brown, Clayey SAND.	SC	A	18.8	32	13	100.0	100.0	100.0	97.1	89.7	78.7	56.6	40.2	6.0
7.0																	7.0
8.0		5-4	Yellowish Brown, Sandy Lean CLAY.	CL	A	22.5	32	17	100.0	100.0	100.0	100.0	95.5	90.2	77.2	62.9	8.0
9.0																	9.0
10.0																	10.0

Boring terminated at 10 ft. No groundwater was encountered.

Rodriguez Engineering Laboratories

Bore Log Data
Boring No. 6

Project: San Angelo Regional Airport
Location: Existing Cross Taxiway (31°21'12.6"N, 100°30'03.9"W)
Date Drilled: 1/21/2016

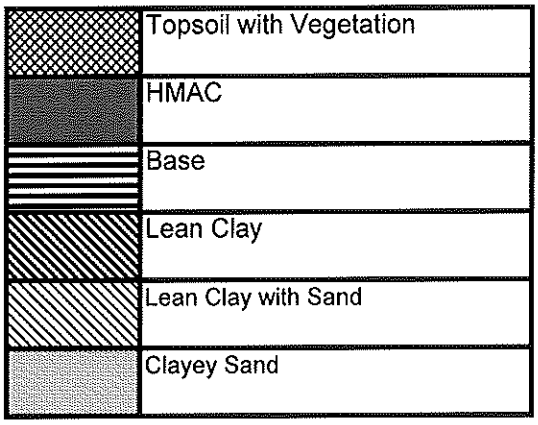
Boring Depth: 3 ft.
Water Level: N / A
Drilling Method: A = Auger

Depth (ft)	Soil Symbol	Sample No.	Laboratory Classification: Material Description	Laboratory Classification: Group Symbol	Drilling Method	Moisture Content (%)	Atterberg Limits: LL	Atterberg Limits: PI	Sieve Analysis, Percent Passing: 3"	7/8"	3/4"	3/8"	No.4	No.10	No.40	No.200	Depth (ft)
0.5		6-1	11" HMAC Pavement.		A												0.5
1.0		6-2	11" BASE. Light Gray, Clayey SAND.	SC	A	8.3	32	11	100.0	100.0	100.0	97.8	91.4	75.9	42.3	18.0	1.0
1.5																	1.5
2.0		6-3	Yellowish Brown, Sandy Lean CLAY.	CL	A	18.2	40	20	100.0	100.0	100.0	99.5	96.2	91.1	80.4	64.1	2.0
2.5																	2.5
3.0																	3.0
			Boring terminated at 3 ft. No groundwater was encountered.														
3.5																	3.5
4.0																	4.0
4.5																	4.5
5.0																	5.0

LEGEND OF TERMINOLOGY

GRAVELS More than half of Coarse fraction is LARGER than No. 4 Sieve	**Clean Gravels** Little or no Fines	**GW**	Well-Graded, gravel-sand mixtures, mixtures, little or no fines
		GP	Poorly-Graded gravels, gravel-sand mixtures, little or no fines
	Gravels with Fines Appreciable Amount of fines	**GM**	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay Mixtures
SANDS More than half of Coarse fraction is SMALLER than No. 4 Sieve	**Clean Sands** Little or no Fines	**SW**	Well-Graded sands, gravely sands, little or no fines
		SP	Poorly-Graded sands, gravely sands little or no fines
	Sands with Fines Appreciable Amount of fines	**SM**	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
SILTS and CLAYS Liquid Limit LESS than 50		**ML**	Inorganic silts & very fine sands, rock flour, silty or clayey fine sands or clayey silts w/slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays
		OL	Organic silts & organic silty clays of low plasticity
SILTS and CLAYS Liquid Limit GREATER than 50		**MH**	Inorganic silts, micoceous or diatomaceous fine sand or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silts
Highly ORGANIC Soils		**PI**	Peat & other highly organic soils

Legend of Symbols



Appendix B:

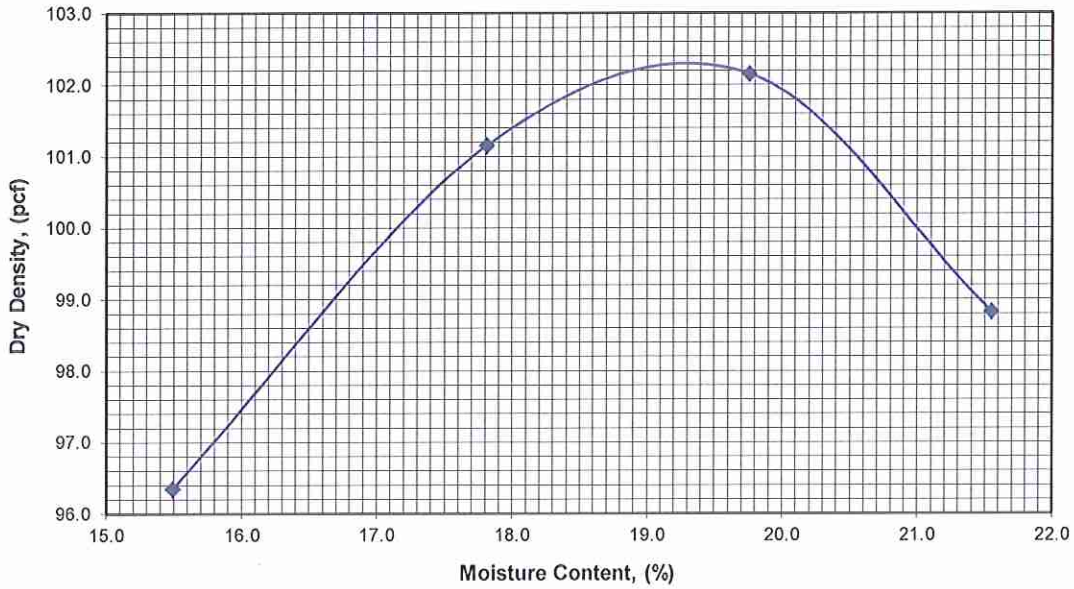
Subgrade Proctor and CBR Data

San Angelo Regional Airport
San Angelo, Texas
Proctor Chart for CBR Sample No. 1

Laboratory No:	RE16-0157-1	**Compactive Effort:**	ASTM D698-C
Material Type:	Subgrade	**Maximum Density** (pcf)**:**	**102.3**
Sample Location:	New Cross-Taxiway, Boring 1	**Optimum Moisture** (%)**:**	**19.3**

Specimen No.	1	2	3	4	5
% Water Added	4.0	6.0	8.0	10.0	--
Net Wt. Of Specimen & Mold (g)	6426.8	6720.4	6828.0	6752.6	--
Tare Wt. Of Mold (g)	2641.5	2666.4	2666.4	2666.4	--
Wet Wt. Of Specimen (lb)	8.345	8.937	9.175	9.008	--
Volume of Specimen (ft^3)	0.0750	0.0750	0.0750	0.0750	--
Wet Density of Specimen (pcf)	111.3	119.2	122.3	120.1	--
Guesstimated Dry Density (pcf)	107.0	112.4	113.3	109.2	--
Wet Wt. Of Specimen & Pan (g)	4987.7	5175.0	5085.2	5239.8	--
Dry Wt. Of Specimen & Pan (g)	4482.0	4575.0	4416.6	4531.6	--
Tare Wt. Of Pan (g)	1216.9	1206.3	1032.0	1244.5	--
Wt. Of Water (g)	505.7	600.0	668.6	708.2	--
Dry Wt. Of Material (g)	3265.1	3368.7	3384.6	3287.1	--
Total % Moisture of Specimen	**15.5**	**17.8**	**19.8**	**21.5**	--
Dry Density of Specimen (pcf)	**96.3**	**101.2**	**102.1**	**98.8**	--

Dry Density vs. Moisture Content



San Angelo Regional Airport
San Angelo, Texas
Proctor Chart for CBR Sample No. 1

Laboratory No: RE16-0157-1
Material Type: Subgrade
Sample Location: New Cross-Taxiway, Boring 1

Compactive Effort: ASTM D698-C
Maximum Density (pcf): 102.3
Optimum Moisture (%): 19.3

Specimen No.	1	2	3
No. of Blows	10 Blows	25 Blows	56 Blows
Net Wt. Of Spec.& Mold (g)	7709.0	8029.1	8298.1
Tare Wt. Of Mold (g)	4222.5	4210.6	4205.6
Wet Wt. Of Specimen (lb)	7.686	8.418	9.022
Volume of Specimen (ft^3)	0.0750	0.0750	0.0750
Wet Density of Spec.(pcf)	102.5	112.2	120.3
Wet Wt. of Spec.& Pan (g)	1278.4	1278.4	1278.4
Dry Wt. Of Spec. & Pan (g)	1156.3	1156.3	1156.3
Tare Wt. Of Pan (g)	494.0	494.0	494.0
Wt. Of Water (g)	122.1	122.1	122.1
Dry Wt. Of Material (g)	662.3	662.3	662.3
Total % Moisture of Spec.	18.4	18.4	18.4
Target % Moisture of Spec.	19.3	19.3	19.3
Dry Density of Spec. (pcf)	86.5	94.8	101.6
Initial Measurement (Div.)	133	532	308
Final Measurement (Div.)	180	570	332
Percentage of Swelling	1.0	0.8	0.5

10 blows/lift

Penetration (in)	Load (lb)	Stress (psi)
0.025	0.0	0.0
0.050	2.8	0.9
0.075	6.8	2.3
0.100	9.4	3.1
0.125	11.4	3.8
0.150	14.6	4.9
0.175	16.0	5.3
0.200	20.0	6.7
0.300	24.6	8.2
0.400	31.3	10.4
0.500	36.3	12.1

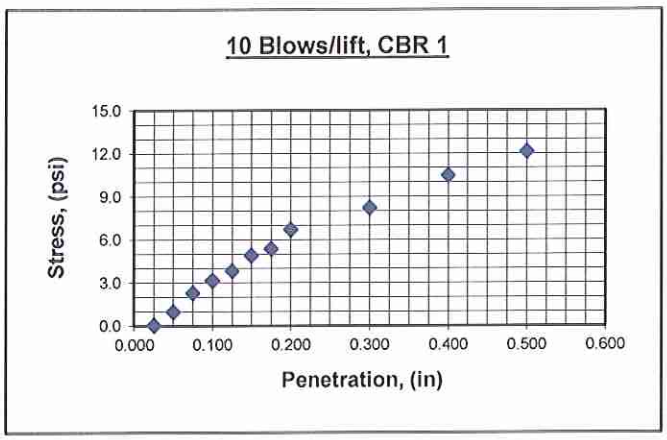
25 blows/lift

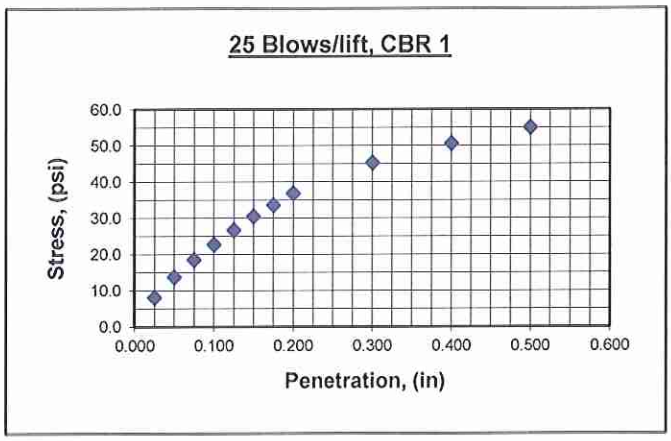
Penetration (in)	Load (lb)	Stress (psi)
0.025	23.9	8.0
0.050	40.9	13.6
0.075	55.2	18.4
0.100	68.0	22.7
0.125	80.0	26.7
0.150	91.3	30.4
0.175	100.6	33.5
0.200	110.4	36.8
0.300	135.5	45.2
0.400	151.6	50.5
0.500	164.8	54.9

56 blows/lift

Penetration (in)	Load (lb)	Stress (psi)
0.025	120.1	40.0
0.050	183.1	61.0
0.075	217.9	72.6
0.100	244.7	81.6
0.125	266.5	88.8
0.150	285.9	95.3
0.175	303.1	101.0
0.200	313.5	104.5
0.300	358.4	119.5
0.400	394.8	131.6
0.500	430.0	143.3

San Angelo Regional Airport
San Angelo, Texas
Proctor Chart for CBR Sample No. 1





Dry Density @ 10 Blows/lift (pcf) = 86.5

$CBR_{0.100}$ = (3.1 /1000) x 100 = 0.31

$CBR_{0.200}$ = (6.7 /1500) x 100 = 0.44

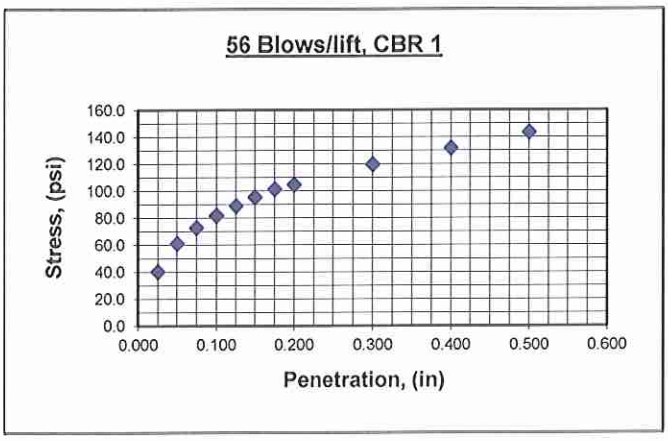
Use CBR = 0.44

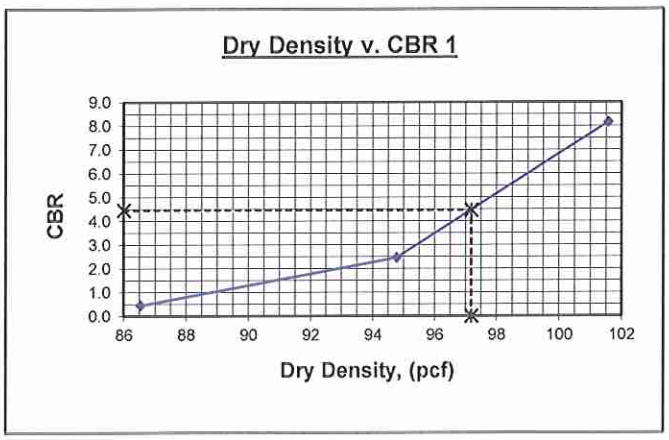
Dry Density @ 25 Blows/lift (pcf) = 94.8

$CBR_{0.100}$ = (22.7 /1000) x 100 = 2.27

$CBR_{0.200}$ = (36.8 /1500) x 100 = 2.45

Use CBR = 2.45





Dry Density @ 56 Blows/lift (pcf) = 101.6

$CBR_{0.100}$ = (81.6 /1000) x 100 = 8.16

$CBR_{0.200}$ = (104.5 /1500) x 100 = 6.97

Use CBR = 8.16

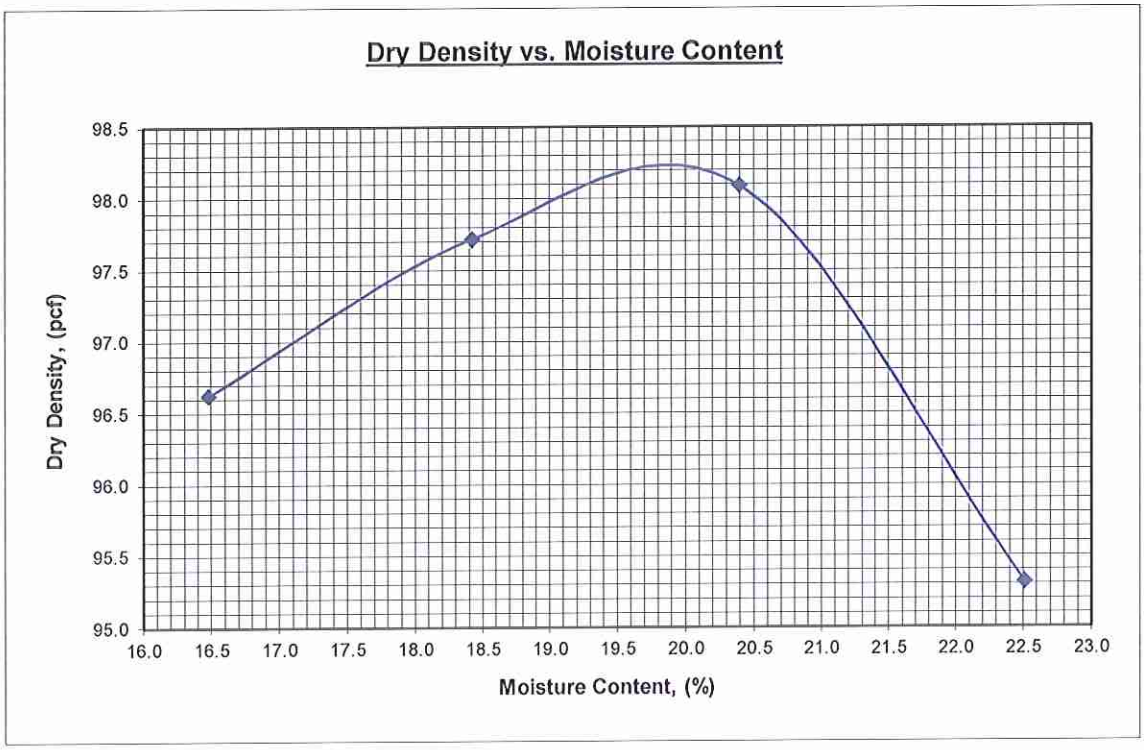
Design CBR @ 95 % Max. Dry Density = 4.5

Design CBR @ 100% Max. Dry Density = 8.2

San Angelo Regional Airport
San Angelo, Texas
Proctor Chart for CBR Sample No. 2

Laboratory No:	RE16-0157-2	**Compactive Effort:**	ASTM D698-C
Material Type:	Subgrade	**Maximum Density** (pcf):	**98.2**
Sample Location:	New Cross-Taxiway, Boring 5	**Optimum Moisture** (%):	**19.8**

Specimen No.	1	2	3	4	5
% Water Added	4.0	6.0	8.0	10.0	--
Net Wt. Of Specimen & Mold (g)	6467.4	6575.2	6655.9	6611.1	--
Tare Wt. Of Mold (g)	2638.6	2638.6	2638.6	2638.6	--
Wet Wt. Of Specimen (lb)	8.441	8.679	8.857	8.758	--
Volume of Specimen (ft^3)	0.0750	0.0750	0.0750	0.0750	--
Wet Density of Specimen (pcf)	112.5	115.7	118.1	116.8	--
Guesstimated Dry Density (pcf)	108.2	109.2	109.3	106.2	--
Wet Wt. Of Specimen & Pan (g)	5101.1	5165.1	5247.7	5253.2	--
Dry Wt. Of Specimen & Pan (g)	4560.9	4554.7	4569.8	4517.1	--
Tare Wt. Of Pan (g)	1283.2	1241.2	1245.6	1247.0	--
Wt. Of Water (g)	540.2	610.4	677.9	736.1	--
Dry Wt. Of Material (g)	3277.7	3313.5	3324.2	3270.1	--
Total % Moisture of Specimen	**16.5**	**18.4**	**20.4**	**22.5**	--
Dry Density of Specimen (pcf)	**96.6**	**97.7**	**98.1**	**95.3**	--



San Angelo Regional Airport
San Angelo, Texas
Proctor Chart for CBR Sample No. 2

Laboratory No: RE16-0157-2
Material Type: Subgrade
Sample Location: New Cross-Taxiway, Boring 5

Compactive Effort: ASTM D698-C
Maximum Density (pcf)**:** **98.2**
Optimum Moisture (%)**:** **19.8**

Specimen No.	1	2	3
No. of Blows	**10 Blows**	**25 Blows**	**56 Blows**
Net Wt. Of Spec.& Mold (g)	7485.5	7739.4	8195.4
Tare Wt. Of Mold (g)	4226.2	4203.0	4179.8
Wet Wt. Of Specimen (lb)	7.185	7.796	8.853
Volume of Specimen (ft^3)	0.0750	0.0750	0.0750
Wet Density of Spec.(pcf)	95.8	104.0	118.0
Wet Wt. of Spec.& Pan (g)	1276.0	1276.0	1276.0
Dry Wt. Of Spec. & Pan (g)	1155.5	1155.5	1155.5
Tare Wt. Of Pan (g)	490.5	490.5	490.5
Wt. Of Water (g)	120.5	120.5	120.5
Dry Wt. Of Material (g)	665.0	665.0	665.0
Total % Moisture of Spec.	**18.1**	**18.1**	**18.1**
Target % Moisture of Spec.	**19.8**	**19.8**	**19.8**
Dry Density of Spec. (pcf)	**81.1**	**88.0**	**99.9**
Initial Measurement (Div.)	795	113	202
Final Measurement (Div.)	840	167	239
Percentage of Swelling	**1.0**	**1.2**	**0.8**

10 blows/lift

Penetration (in)	Load (lb)	Stress (psi)
0.025	0.0	0.0
0.050	1.0	0.3
0.075	3.1	1.0
0.100	4.1	1.4
0.125	4.7	1.6
0.150	6.3	2.1
0.175	8.7	2.9
0.200	9.6	3.2
0.300	11.4	3.8
0.400	15.7	5.2
0.500	20.2	6.7

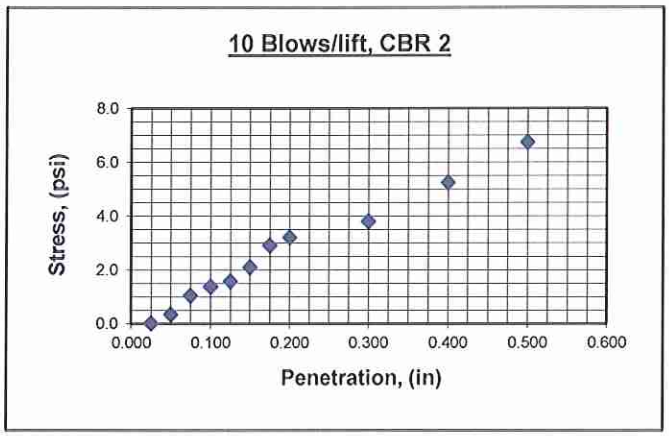
25 blows/lift

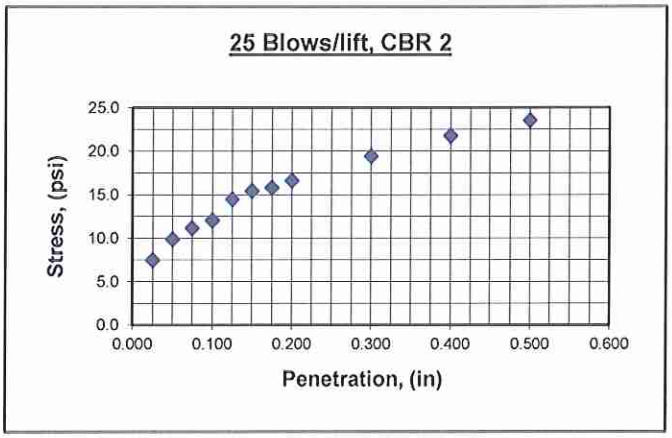
Penetration (in)	Load (lb)	Stress (psi)
0.025	22.3	7.4
0.050	29.5	9.8
0.075	33.4	11.1
0.100	36.1	12.0
0.125	43.4	14.5
0.150	46.2	15.4
0.175	47.3	15.8
0.200	49.8	16.6
0.300	58.2	19.4
0.400	65.2	21.7
0.500	70.5	23.5

56 blows/lift

Penetration (in)	Load (lb)	Stress (psi)
0.025	109.0	36.3
0.050	118.2	39.4
0.075	158.0	52.7
0.100	193.8	64.6
0.125	222.5	74.2
0.150	245.1	81.7
0.175	266.4	88.8
0.200	285.3	95.1
0.300	337.4	112.5
0.400	385.0	128.3
0.500	427.5	142.5

San Angelo Regional Airport
San Angelo, Texas
Proctor Chart for CBR Sample No. 2





Dry Density @ 10 Blows/lift (pcf) = 81.1

$CBR_{0.100}$ = (1.4 /1000) x 100 = 0.14

$CBR_{0.200}$ = (3.2 /1500) x 100 = 0.21

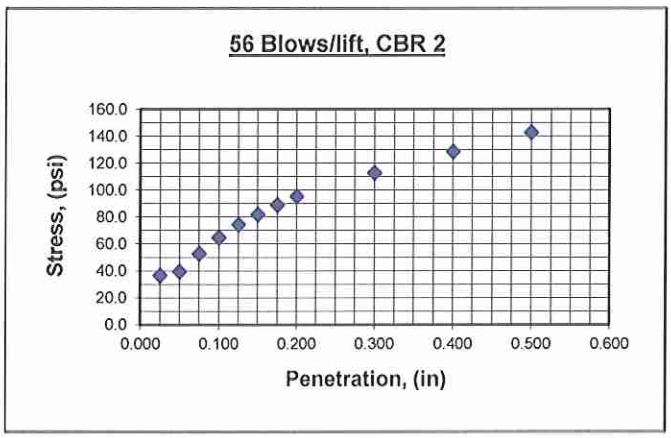
Use CBR = 0.21

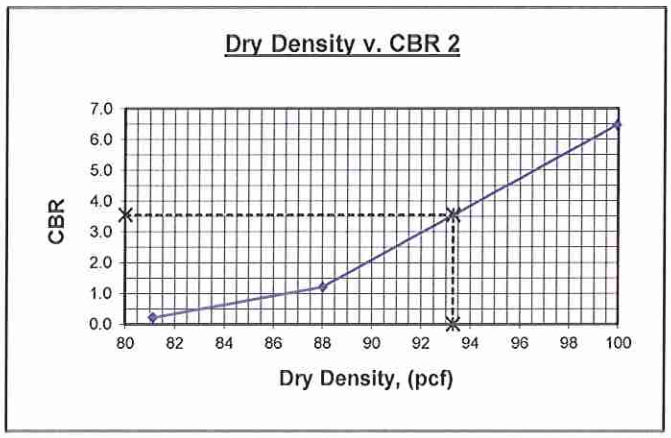
Dry Density @ 25 Blows/lift (pcf) = 88.0

$CBR_{0.100}$ = (12.0 /1000) x 100 = 1.20

$CBR_{0.200}$ = (16.6 /1500) x 100 = 1.11

Use CBR = 1.20





Dry Density @ 56 Blows/lift (pcf) = 99.9

$CBR_{0.100}$ = (64.6 /1000) x 100 = 6.46

$CBR_{0.200}$ = (95.1 /1500) x 100 = 6.34

Use CBR = 6.46

Design CBR @ 95 % Max. Dry Density = 3.6

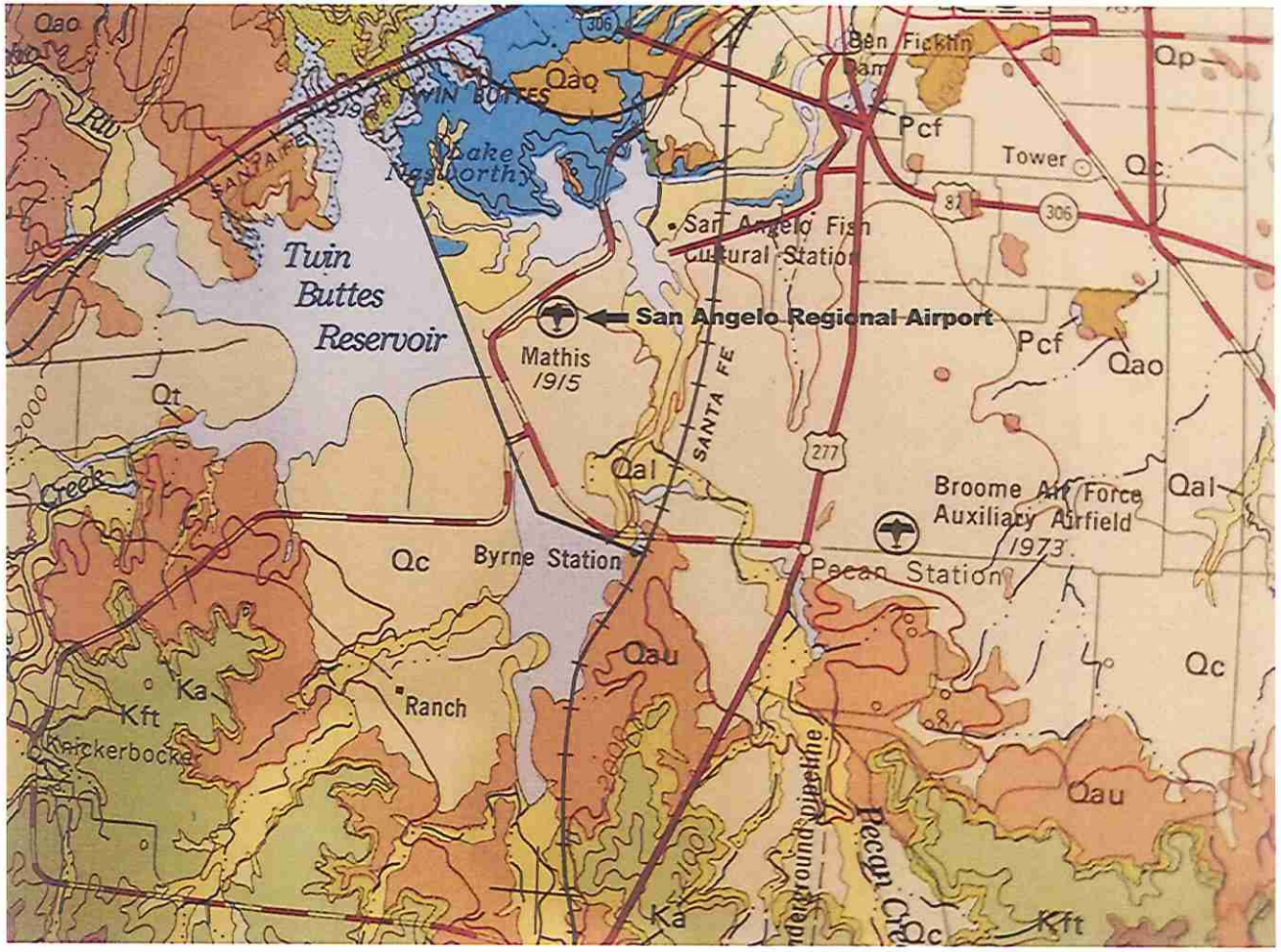
Design CBR @ 100% Max. Dry Density = 6.5

Appendix C:

University of Texas, Bureau of Economic Geology Map
and
Map of Borehole Locations

San Angelo Regional Airport

San Angelo, Texas



The University of Texas at Austin, Bureau of Economic Geology,
Geological Atlas of Texas, San Angelo Sheet, Second Printing, 1976

Map of Borehole Locations
San Angelo Regional Airport
San Angelo, Texas

NOTE: Boring locations are approximate.

Boring No.	Latitude	Longitude
1	31°21'43.7"N	100°29'58.0"W
2	31°21'37.3"N	100°29'58.5"W
3	31°21'36.1"N	100°30'00.4"W
4	31°21'14.4"N	100°30'01.6"W
5	31°21'12.5"N	100°30'01.5"W
6	31°21'12.6"N	100°30'03.9"W

Appendix D:

HMAC Pavement Sections

San Angelo Regional Airport
San Angelo, Texas

Flexible Pavement Section
Option 1

FAARFIELD - Airport Pavement Design (V 1.305, 9/28/10 64-bit)

Section HMAC in Job SanAngelAp_2-16.
Working directory is C:\Program Files (x86)\FAA\FAARFIELD\

The structure is New Flexible. Asphalt CDF was not computed.
Design Life = 20 years.
A design for this section was completed on 02/23/16 at 18:08:37.

Pavement Structure Information by Layer, Top First

No.	Type	Thickness in	Modulus psi	Poisson's Ratio	Strength R,psi
1	P-401/ P-403 HMA Surface	5.00	200,000	0.35	0
2	P-304 CTB	10.40	500,000	0.20	0
3	Subgrade	0.00	5,250	0.35	0

Total thickness to the top of the subgrade = 15.40 in

Airplane Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth
1	Dual Whl-50	50,000	2,903	2.50
2	BeechJet-400	15,500	1,450	2.50
3	Gulfstream-G-V	90,900	450	2.50
4	A319-100 std	141,978	450	2.50
5	Sngl Whl-3	3,000	10,613	2.50
6	Dual Whl-10	12,500	1,728	2.50
7	Sngl Whl-15	15,000	24,299	2.50
8	Sngl Whl-5	5,000	2,680	2.50

Additional Airplane Information

Subgrade CDF

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	Dual Whl-50	0.00	0.00	0.00
2	BeechJet-400	0.00	0.00	0.00
3	Gulfstream-G-V	0.00	0.00	0.00
4	A319-100 std	0.00	0.00	0.00
5	Sngl Whl-3	0.00	0.00	0.00
6	Dual Whl-10	0.00	0.00	0.00
7	Sngl Whl-15	0.00	0.00	0.00
8	Sngl Whl-5	0.00	0.00	0.00

San Angelo Regional Airport
San Angelo, Texas

Flexible Pavement Section
Option 1A

FAARFIELD - Airport Pavement Design (V 1.305, 9/28/10 64-bit)

Section HMAC-HMAC in Job SanAngelAp_2-16.
Working directory is C:\Program Files (x86)\FAA\FAARFIELD\

The structure is New Flexible. Asphalt CDF was not computed.
Design Life = 20 years.
A design for this section was completed on 02/24/16 at 13:57:22.

Pavement Structure Information by Layer, Top First

No.	Type	Thickness in	Modulus psi	Poisson's Ratio	Strength R,psi
1	P-401/ P-403 HMA Surface	5.00	200,000	0.35	0
2	P-401/ P-403 St (flex)	11.07	400,000	0.35	0
3	Subgrade	0.00	5,250	0.35	0

Total thickness to the top of the subgrade = 16.07 in

Airplane Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth
1	Dual Whl-50	50,000	2,903	2.50
2	BeechJet-400	15,500	1,450	2.50
3	Gulfstream-G-V	90,900	450	2.50
4	A319-100 std	141,978	450	2.50
5	Sngl Whl-3	3,000	10,613	2.50
6	Dual Whl-10	12,500	1,728	2.50
7	Sngl Whl-15	15,000	24,299	2.50
8	Sngl Whl-5	5,000	2,680	2.50

Additional Airplane Information

Subgrade CDF

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	Dual Whl-50	0.00	0.00	1.79
2	BeechJet-400	0.00	0.00	3.24
3	Gulfstream-G-V	0.01	0.08	1.90
4	A319-100 std	0.99	0.99	1.64
5	Sngl Whl-3	0.00	0.00	3.89
6	Dual Whl-10	0.00	0.00	2.54
7	Sngl Whl-15	0.00	0.00	3.17
8	Sngl Whl-5	0.00	0.00	3.69

San Angelo Regional Airport
San Angelo, Texas

Rigid Pavement Section
Option 2

FAARFIELD - Airport Pavement Design (V 1.305, 9/28/10 64-bit)

Section PCC in Job SanAngelAp_2-16.
Working directory is C:\Program Files (x86)\FAA\FAARFIELD\

The structure is New Rigid.
Design Life = 20 years.
A design for this section was completed on 02/24/16 at 14:02:27.

Pavement Structure Information by Layer, Top First

No.	Type	Thickness in	Modulus psi	Poisson's Ratio	Strength R,psi
1	PCC Surface	14.82	4,000,000	0.15	650
2	P-304 CTB	6.00	500,000	0.20	0
3	Subgrade	0.00	5,205	0.40	0

Total thickness to the top of the subgrade = 20.82 in

Airplane Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth
1	Dual Whl-50	50,000	1,903	2.50
2	BeechJet-400	15,500	1,450	2.50
3	Gulfstream-G-V	90,900	450	2.50
4	A319-100 std	141,978	450	2.50
5	Sngl Whl-3	3,000	10,613	2.50
6	Dual Whl-10	12,500	1,728	2.50
7	Sngl Whl-15	15,000	24,299	2.50
8	Sngl Whl-5	5,000	2,680	2.50

Additional Airplane Information

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	Dual Whl-50	0.00	0.00	3.73
2	BeechJet-400	0.00	0.00	4.74
3	Gulfstream-G-V	0.00	0.02	4.23
4	A319-100 std	1.00	1.00	3.68
5	Sngl Whl-3	0.00	0.00	9.82
6	Dual Whl-10	0.00	0.00	10.73
7	Sngl Whl-15	0.00	0.00	4.40
8	Sngl Whl-5	0.00	0.00	7.61

San Angelo Regional Airport
San Angelo, Texas

Rigid Pavement Section
Option 2A

FAARFIELD - Airport Pavement Design (V 1.305, 9/28/10 64-bit)

Section PCC-HMAC in Job SanAngelAp_2-16.
Working directory is C:\Program Files (x86)\FAA\FAARFIELD\

The structure is New Rigid.
Design Life = 20 years.
A design for this section was completed on 02/24/16 at 14:17:19.

Pavement Structure Information by Layer, Top First

No.	Type	Thickness in	Modulus psi	Poisson's Ratio	Strength R,psi
1	PCC Surface	14.89	4,000,000	0.15	650
2	P-401/ P-403 St (flex)	6.00	400,000	0.35	0
3	Subgrade	0.00	5,205	0.40	0

Total thickness to the top of the subgrade = 20.89 in

Airplane Information

No.	Name	Gross Wt. lbs	Annual Departures	% Annual Growth
1	Dual Whl-50	50,000	1,903	2.50
2	BeechJet-400	15,500	1,450	2.50
3	Gulfstream-G-V	90,900	450	2.50
4	A319-100 std	141,978	450	2.50
5	Sngl Whl-3	3,000	10,613	2.50
6	Dual Whl-10	12,500	1,728	2.50
7	Sngl Whl-15	15,000	24,299	2.50
8	Sngl Whl-5	5,000	2,680	2.50

Additional Airplane Information

No.	Name	CDF Contribution	CDF Max for Airplane	P/C Ratio
1	Dual Whl-50	0.00	0.00	3.73
2	BeechJet-400	0.00	0.00	4.74
3	Gulfstream-G-V	0.00	0.02	4.23
4	A319-100 std	1.00	1.00	3.68
5	Sngl Whl-3	0.00	0.00	9.82
6	Dual Whl-10	0.00	0.00	10.73
7	Sngl Whl-15	0.00	0.00	4.40
8	Sngl Whl-5	0.00	0.00	7.61

Appendix E:

Lime Stabilization Results

Determining Stabilization Ability of Lime by the Soil pH Method

San Angelo Regional Airport
San Angelo, Texas

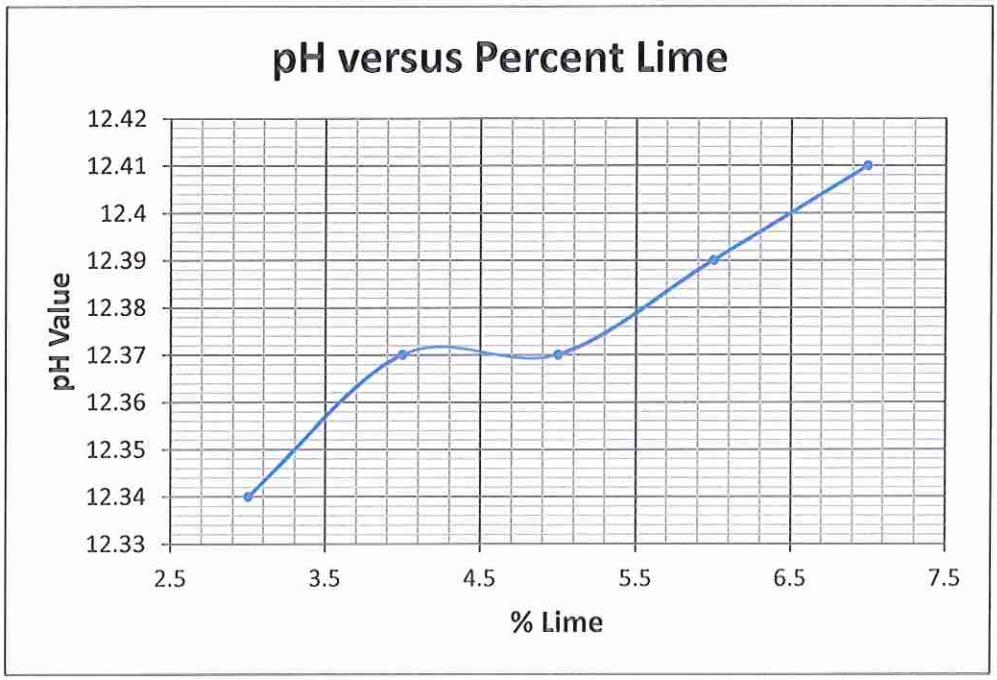
Sample 1-1 from Boring #1

Water Content of Air-Dried Sample

Mass of Wet Sample + Tare (g):	0.0
Mass of Dry Sample + Tare (g):	0.0
Tare Mass (g):	0.0
Hygroscopic Moisture Content (%):	0.0

pH Value of Soil-Lime-Water Mixtures

Lime (%)	3	4	5	6	7
Soil (g)	30.0	30.0	30.0	30.0	30.0
Lime (g)	0.9	1.2	1.5	1.8	2.1
Water (ml)	150	150	150	150	150
pH Value	12.34	12.37	12.37	12.39	12.41



ATTACHMENT B

AC 150/5370-2F
OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION

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U.S. Department of Transportation

Federal Aviation Administration

Advisory Circular

Subject: Operational Safety on Airports During Construction	**Date:** 9/29/11 **Initiated by:** AAS-100	**AC No:** 150/5370-2F

1. Purpose. This AC sets forth guidelines for operational safety on airports during construction.

2. What this AC Cancels. This AC cancels AC 150/5370-2E, Operational Safety on Airports During Construction, dated January 17, 2003.

3. Whom This AC Affects. This AC assists airport operators in complying with Title 14 Code of Federal Regulations (CFR) Part 139, Certification of Airports (Part 139). For those certificated airports, this AC provides one way, but not the only way, of meeting those requirements. The use of this AC is mandatory for those airport construction projects receiving funds under the Airport Improvement Program (AIP) or the Passenger Facility Charge (PFC) Program. See Grant Assurance No. 34, "Policies, Standards, and Specifications," and PFC Assurance No. 9, "Standard and Specifications." While we do not require non-certificated airports without grant agreements to adhere to these guidelines, we recommend that they do so to help these airports maintain operational safety during construction.

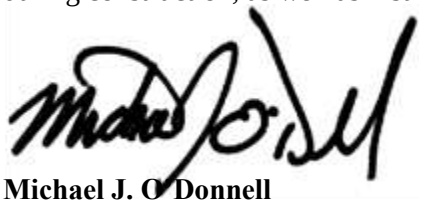
4. Principal Changes.

a. Construction activities are prohibited in safety areas while the associated runway or taxiway is open to aircraft.

b. Guidance is provided in incorporating Safety Risk Management.

c. Recommended checklists are provided for writing Construction Safety and Phasing Plans and for daily inspections.

5. Reading Material Related to this AC. Numerous ACs are referenced in the text of this AC. These references do not include a revision letter, as they are to be read as referring to the latest version. Appendix 1 contains a list of reading material on airport construction, design, and potential safety hazards during construction, as well as instructions for obtaining these documents.



Michael J. O'Donnell
Director of Airport Safety and Standards

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Chapter 1. Planning an Airfield Construction Project

101. Overview. Airports are complex environments, and procedures and conditions associated with construction activities often affect aircraft operations and can jeopardize operational safety. Safety considerations are paramount and may make operational impacts unavoidable. However, careful planning, scheduling, and coordination of construction activities can minimize disruption of normal aircraft operations and avoid situations that compromise the airport's operational safety. The airport operator must understand how construction activities and aircraft operations affect one another to be able to develop an effective plan to complete the project. While the guidance in this AC is primarily used for construction operations, some of the concepts, methods and procedures described may also enhance the day-to-day airport maintenance operations, such as lighting maintenance and snow removal operations.

102. Plan for Safety. Safety, maintaining aircraft operations, and construction costs are all interrelated. Since safety must not be compromised, the airport operator must strike a balance between maintaining aircraft operations and construction costs. This balance will vary widely depending on the operational needs and resources of the airport and will require early coordination with airport users and the FAA. As the project design progresses, the necessary construction locations, activities, and associated costs will be identified. As they are identified, their impact to airport operations must be assessed. Adjustments are made to the proposed construction activities, often by phasing the project, and/or to airport operations in order to maintain operational safety. This planning effort will ultimately result in a project Construction Safety and Phasing Plan (CSPP). The development of the CSPP takes place through the following five steps:

a. Identify Affected Areas. The airport operator must determine the geographic areas on the airport affected by the construction project. Some, such as a runway extension, will be defined by the project. Others may be variable, such as the location of haul routes and material stockpiles.

b. Describe Current Operations. Identify the normal airport operations in each affected area for each phase of the project. This becomes the baseline from which the impact on operations by construction activities can be measured. This should include a narrative of the typical users and aircraft operating within the affected areas. It should also include information related to airport operations: the Aircraft Reference Code (ACRC) for each runway; Airplane Design Group (ADG) and Taxiway Design Group (TDG)[1] for each affected taxiway; designated approach visibility minimums; available approach and departure procedures; most demanding aircraft; declared distances; available air traffic control services; airport Surface Movement Guidance and Control System plan; and others. The applicable seasons, days and times for certain operations should also be identified as applicable.

c. Allow for Temporary Changes to Operations. To the extent practical, current airport operations should be maintained during the construction. In consultation with airport users, Aircraft Rescue and Fire Fighting (ARFF) personnel, and FAA Air Traffic Organization (ATO) personnel, the airport operator should identify and prioritize the airport's most important operations. The construction activities should be planned, through project phasing if necessary, to safely accommodate these operations. When the construction activities cannot be adjusted to safely maintain current operations, regardless of their importance, then the operations must be revised accordingly. Allowable changes include temporary revisions to approach procedures, restricting certain aircraft to specific runways and taxiways, suspension of certain operations, decreased weights for some aircraft due to shortened runways,

[1] Taxiway Design Group will be introduced in AC 150/5300-13A.

and other changes. An example of a table showing temporary operations versus current operations is shown in Table 3-1 Sample Operations Effects.

d. Take Required Measures to Revised Operations. Once the level and type of aircraft operations to be maintained are identified, the airport operator must determine the measures required to safely conduct the planned operations during the construction. These measures will result in associated costs, which can be broadly interpreted to include not only direct construction costs, but also loss of revenue from impacted operations. Analysis of costs may indicate a need to reevaluate allowable changes to operations. As aircraft operations and allowable changes will vary so widely among airports, this AC presents general guidance on those subjects.

e. Manage Safety Risk. Certain airport projects may require the airport operator to provide a Project Proposal Summary to help the FAA to determine the appropriate level of Safety Risk Management (SRM) documentation. The airport operator must coordinate with the appropriate FAA Airports Regional or District Office early in the development of the CSPP to determine the need for SRM documentation. See FAA Order 5200.11, FAA Airports (ARP) Safety Management System (SMS), for more information. If the FAA requires SRM documentation, the airport operator must at a minimum:

(1) Notify the appropriate FAA Airports Regional or District Office during the project "scope development" phase of any project requiring a CSPP.

(2) Provide documents identified by the FAA as necessary to conduct SRM.

(3) Participate in the SRM process for airport projects.

(4) Provide a representative to participate on the SRM panel.

(5) Ensure that all applicable SRM identified risks elements are recorded and mitigated within the CSPP.

103. Develop a Construction Safety and Phasing Plan (CSPP). Development of an effective CSPP will require familiarity with many other documents referenced throughout this AC. See Appendix 1, Related Reading Material for a list of related reading material.

a. List Requirements. A CSPP must be developed for each on-airfield construction project funded by the Airport Improvement Program (AIP) or the Passenger Facility Charge (PFC) program or located on an airport certificated under Part 139. As per Order 5200.11, such projects do not include construction, rehabilitation, or change of any facility that is entirely outside the air operations area, does not involve any expansion of the facility envelope and does not involve construction equipment, haul routes or placement of material in locations that require access to the air operations area, increase the facility envelope, or impact line-of-sight. Such facilities may include passenger terminals and parking or other structures. However, extraordinary circumstances may trigger the need for a Safety Assessment and a CSPP. The CSPP is subject to subsequent review and approval under the FAA's Safety Risk Management procedures (see paragraph 102.e above). Additional information may be found in Order 5200.11.

b. Prepare a Safety Plan Compliance Document. The Safety Plan Compliance Document (SPCD) details how the contractor will comply with the CSPP. Also, it will not be possible to determine all safety plan details (for example specific hazard equipment and lighting, contractor's points of contact, construction equipment heights) during the development of the CSPP. The successful contractor must define such details by preparing an SPCD that the airport operator reviews for approval prior to issuance of a notice-to-proceed. The SPCD is a subset of the CSPP, similar to how a shop drawing review is a subset to the technical specifications.

c. Assume Responsibility for the CSPP. The airport operator is responsible for establishing and enforcing the CSPP. The airport operator may use the services of an engineering consultant to help develop the CSPP. However, writing the CSPP cannot be delegated to the construction contractor. Only those details the airport operator determines cannot be addressed before contract award are developed by the contractor and submitted for approval as the SPCD. The SPCD does not restate nor propose differences to provisions already addressed in the CSPP.

104. Who Is Responsible for Safety During Construction?

a. Establish a Safety Culture. Everyone has a role in operational safety on airports during construction: the airport operator, the airport's consultants, the construction contractor and subcontractors, airport users, airport tenants, ARFF personnel, Air Traffic personnel, including Technical Operations personnel, FAA Airports Division personnel, and others. Close communication and coordination between all affected parties is the key to maintaining safe operations. Such communication and coordination should start at the project scoping meeting and continue through the completion of the project. The airport operator and contractor should conduct onsite safety inspections throughout the project and immediately remedy any deficiencies, whether caused by negligence, oversight, or project scope change.

b. Assess Airport Operator's Responsibilities. An airport operator has overall responsibility for all activities on an airport, including construction. This includes the predesign, design, preconstruction, construction, and inspection phases. Additional information on the responsibilities listed below can be found throughout this AC. The airport operator must:

(1) Develop a CSPP that complies with the safety guidelines of Chapter 2, Construction Safety and Phasing Plans, and Chapter 3, Guidelines for Writing a CSPP. The airport operator may develop the CSPP internally or have a consultant develop the CSPP for approval by the airport operator. For tenant sponsored projects, approve a CSPP developed by the tenant or its consultant.

(2) Require, review and approve the SPCD by the contractor that indicates how it will comply with the CSPP and provides details that cannot be determined before contract award.

(3) Convene a preconstruction meeting with the construction contractor, consultant, airport employees and, if appropriate, tenant sponsor and other tenants to review and discuss project safety before beginning construction activity. The appropriate FAA representatives should be invited to attend the meeting. See AC 150/5300-9, *Predesign, Prebid, and Preconstruction Conferences for Airport Grant Projects.* (Note "FAA" refers to the Airports Regional or District Office, the Air Traffic Organization, Flight Standards Service, and other offices that support airport operations, flight regulations, and construction/environmental policies.)

(4) Ensure contact information is accurate for each representative/point of contact identified in the CSPP and SPCD.

(5) Hold weekly or, if necessary, daily safety meetings with all affected parties to coordinate activities.

(6) Notify users, ARFF personnel, and FAA ATO personnel of construction and conditions that may adversely affect the operational safety of the airport via Notices to Airmen (NOTAM) and other methods, as appropriate. Convene a meeting for review and discussion if necessary.

(7) Ensure construction personnel know of any applicable airport procedures and of changes to those procedures that may affect their work.

(8) Ensure construction contractors and subcontractors undergo training required by the CSPP and SPCD.

(9) Ensure vehicle and pedestrian operations addressed in the CSPP and SPCD are coordinated with airport tenants, the airport traffic control tower (ATCT), and construction contractors.

(10) At certificated airports, ensure each CSPP and SPCD is consistent with Part 139.

(11) Conduct inspections sufficiently frequently to ensure construction contractors and tenants comply with the CSPP and SPCD and that there are no altered construction activities that could create potential safety hazards.

(12) Resolve safety deficiencies immediately. At airports subject to 49 CFR Part 1542, Airport Security, ensure construction access complies with the security requirements of that regulation.

(13) Notify appropriate parties when conditions exist that invoke provisions of the CSPP and SPCD (for example, implementation of low-visibility operations).

(14) Ensure prompt submittal of a Notice of Proposed Construction or Alteration (Form 7460-1) for conducting an aeronautical study of potential obstructions such as tall equipment (cranes, concrete pumps, other.), stock piles, and haul routes. A separate form may be filed for each potential obstruction, or one form may be filed describing the entire construction area and maximum equipment height. In the latter case, a separate form must be filed for any object beyond or higher than the originally evaluated area/height. The FAA encourages online submittal of forms for expediency. The appropriate FAA Airports Regional or District Office can provide assistance in determining which objects require an aeronautical study.

(15) Promptly notify the FAA Airports Regional or District Office of any proposed changes to the CSPP prior to implementation of the change. Changes to the CSPP require review and approval by the airport operator and the FAA. Coordinate with appropriate local and other federal government agencies, such as EPA, OSHA, TSA, and the state environmental agency.

c. Define Construction Contractor's Responsibilities. The contractor is responsible for complying with the CSPP and SPCD. The contractor must:

(1) Submit a Safety Plan Compliance Document (SPCD) to the airport operator describing how it will comply with the requirements of the CSPP and supplying any details that could not be determined before contract award. The SPCD must include a certification statement by the contractor that indicates it understands the operational safety requirements of the CSPP and it asserts it will not deviate from the approved CSPP and SPCD unless written approval is granted by the airport operator. Any construction practice proposed by the contractor that does not conform to the CSPP and SPCD may impact the airport's operational safety and will require a revision to the CSPP and SPCD and re-coordination with the airport operator and the FAA in advance.

(2) Have available at all times copies of the CSPP and SPCD for reference by the airport operator and its representatives, and by subcontractors and contractor employees.

(3) Ensure that construction personnel are familiar with safety procedures and regulations on the airport. Provide a point of contact who will coordinate an immediate response to correct any construction-related activity that may adversely affect the operational safety of the airport. Many projects will require 24-hour coverage.

(4) Identify in the SPCD the contractor's on-site employees responsible for monitoring compliance with the CSPP and SPCD during construction. At least one of these employees must be on-site whenever active construction is taking place.

(5) Conduct inspections sufficiently frequently to ensure construction personnel comply with the CSPP and SPCD and that there are no altered construction activities that could create potential safety hazards.

(6) Restrict movement of construction vehicles and personnel to permitted construction areas by flagging, barricading, erecting temporary fencing, or providing escorts, as appropriate and as specified in the CSPP and SPCD.

(7) Ensure that no contractor employees, employees of subcontractors or suppliers, or other persons enter any part of the air operations area (AOA) from the construction site unless authorized.

(8) Ensure prompt submittal through the airport operator of Form 7460-1 for the purpose of conducting an aeronautical study of contractor equipment such as tall equipment (cranes, concrete pumps, other equipment), stock piles, and haul routes when different from cases previously filed by the airport operator. The FAA encourages online submittal of forms for expediency.

d. Define Tenant's Responsibilities if planning construction activities on leased property. Airport tenants, such as airline operators, fixed base operators, and FAA ATO/Technical Operations sponsoring construction must:

(1) Develop, or have a consultant develop, a project specific CSPP and submit it to the airport operator for certification and subsequent approval by the FAA. The approved CSPP must be made part of any contract awarded by the tenant for construction work.

(2) In coordination with its contractor, develop an SPCD and submit it to the airport operator for approval to be issued prior to issuance of a Notice to Proceed.

(3) Ensure that construction personnel are familiar with safety procedures and regulations on the airport.

(4) Provide a point of contact of who will coordinate an immediate response to correct any construction-related activity that may adversely affect the operational safety of the airport.

(5) Identify in the SPCD the contractor's on-site employees responsible for monitoring compliance with the CSPP and SPCD during construction. At least one of these employees must be on-site whenever active construction is taking place.

(6) Ensure that no tenant or contractor employees, employees of subcontractors or suppliers, or any other persons enter any part of the AOA from the construction site unless authorized.

(7) Restrict movement of construction vehicles to construction areas by flagging and barricading, erecting temporary fencing, or providing escorts, as appropriate, and as specified in the CSPP and SPCD.

(8) Ensure prompt submittal through the airport operator of Form 7460-1 for the purpose of conducting an aeronautical study of contractor equipment such as tall equipment (cranes, concrete pumps, other.), stock piles, and haul routes. The FAA encourages online submittal of forms for expediency.

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Chapter 2. Construction Safety and Phasing Plans

Section 1. Basic Considerations

201. Overview. Aviation safety is the primary consideration at airports, especially during construction. The airport operator's Construction Safety and Phasing Plan (CSPP) and the contractor's Safety Plan Compliance Document (SPCD) are the primary tools to ensure safety compliance when coordinating construction activities with airport operations. These documents identify all aspects of the construction project that pose a potential safety hazard to airport operations and outline respective mitigation procedures for each hazard. They must provide all information necessary for the Airport Operations department to conduct airfield inspections and expeditiously identify and correct unsafe conditions during construction. All aviation safety provisions included within the project drawings, contract specifications, and other related documents must also be reflected in the CSPP and SPCD.

202. Assume Responsibility. Operational safety on the airport remains the airport operator's responsibility at all times. The airport operator must develop, certify, and submit for FAA approval each CSPP. It is the airport operator's responsibility to apply the requirements of the FAA approved CSPP. The airport operator must revise the CSPP when conditions warrant changes and must submit the revised CSPP to the FAA for approval. The airport operator must also require and approve a SPCD from the project contractor.

203. Submit the CSPP. Construction Safety and Phasing Plans should be developed concurrently with the project design. Milestone versions of the CSPP should be submitted for review and approval as follows. While these milestones are not mandatory, early submission will help to avoid delays. Submittals are preferred in 8.5 x 11 in or 11 x 17 in format for compatibility with the FAA's Obstruction Evaluation / Airport Airspace Analysis (OE / AAA) process.

a. Submit an Outline/Draft. By the time approximately 25% to 30% of the project design is completed, the principal elements of the CSPP should be established. Airport operators are encouraged to submit an outline or draft, detailing all CSPP provisions developed to date, to the FAA for review at this stage of the project design.

b. Submit a Construction Safety and Phasing Plan (CSPP). The CSPP should be formally submitted for FAA approval when the project design is 80% to 90% complete. Since provisions in the CSPP will influence contract costs, it is important to obtain FAA approval in time to include all such provisions in the procurement contract.

c. Submit a Safety Plan Compliance Document (SPCD). The contractor should submit the SPCD to the airport operator for approval to be issued prior to the Notice to Proceed.

d. Submit CSPP Revisions. All revisions to the CSPP or SPCD should be submitted to the FAA for approval as soon as required changes are identified.

204. Meet CSPP Requirements.

a. To the extent possible, the CSPP should address the following as outlined in Section 2, Plan Requirements and Chapter 3, Guidelines for Writing a CSPP, as appropriate. Details that cannot be determined at this stage are to be included in the SPCD.

(1) Coordination.

(a) Contractor progress meetings.

(b) Scope or schedule changes.

(c) FAA ATO coordination.

(2) Phasing.

(a) Phase elements.

(b) Construction safety drawings

(3) Areas and operations affected by the construction activity.

(a) Identification of affected areas.

(b) Mitigation of effects.

(4) Protection of navigation aids (NAVAIDs).

(5) Contractor access.

(a) Location of stockpiled construction materials.

(b) Vehicle and pedestrian operations.

(6) Wildlife management.

(a) Trash.

(b) Standing water.

(c) Tall grass and seeds.

(d) Poorly maintained fencing and gates.

(e) Disruption of existing wildlife habitat.

(7) Foreign Object Debris (FOD) management.

(8) Hazardous materials (HAZMAT) management

(9) Notification of construction activities.

(a) Maintenance of a list of responsible representatives/ points of contact.

(b) Notices to Airmen (NOTAM).

(c) Emergency notification procedures.

(d) Coordination with ARFF Personnel.

(e) Notification to the FAA.

(10) Inspection requirements.

(a) Daily (or more frequent) inspections.

(b) Final inspections.

(11) Underground utilities.

(12) Penalties.

(13) Special conditions.

(14) Runway and taxiway visual aids. Marking, lighting, signs, and visual NAVAIDs.

(a) General.

(b) Markings.

(c) Lighting and visual NAVAIDs.

(d) Signs.

(15) Marking and signs for access routes.

(16) Hazard marking and lighting.

(a) Purpose.

(b) Equipment.

(17) Protection. Of runway and taxiway safety areas, object free areas, obstacle free zones, and approach/departure surfaces

(a) Runway Safety Area (RSA).

(b) Runway Object Free Area (ROFA).

(c) Taxiway Safety Area (TSA).

(d) Taxiway Object Free Area (TOFA).

(e) Obstacle Free Zone (OFZ).

(f) Runway approach/departure surfaces.

(18) Other limitations on construction.

(a) Prohibitions.

(b) Restrictions.

b. The Safety Plan Compliance Document (SPCD) should include a general statement by the construction contractor that he/she has read and will abide by the CSPP. In addition, the SPCD must include all supplemental information that could not be included in the CSPP prior to the contract award. The contractor statement should include the name of the contractor, the title of the project CSPP, the approval date of the CSPP, and a reference to any supplemental information (that is, "I , Name of Contractor , have read the Title of Project CSPP, approved on Date , and will abide by it as written and with the following additions as noted:"). The supplemental information in the SPCD should be written to match the format of the CSPP indicating each subject by corresponding CSPP subject number and title. If no supplemental information is necessary for any specific subject, the statement, "No supplemental information," should be written after the corresponding subject title. The SPCD should not duplicate information in the CSPP:

(1) Coordination. Discuss details of proposed safety meetings with the airport operator and with contractor employees and subcontractors.

(2) Phasing. Discuss proposed construction schedule elements, including:

(a) Duration of each phase.

(b) Daily start and finish of construction, including "night only" construction.

(c) Duration of construction activities during:

(i) Normal runway operations.

(ii) Closed runway operations.

(iii) Modified runway "Aircraft Reference Code" usage.

(3) Areas and operations affected by the construction activity. These areas and operations should be identified in the CSPP and should not require an entry in the SPCD.

(4) Protection of NAVAIDs. Discuss specific methods proposed to protect operating NAVAIDs.

(5) Contractor access. Provide the following:

(a) Details on how the contractor will maintain the integrity of the airport security fence (gate guards, daily log of construction personnel, and other).

(b) Listing of individuals requiring driver training (for certificated airports and as requested).

(c) Radio communications.

(i) Types of radios and backup capabilities.

(ii) Who will be monitoring radios.

(iii) Whom to contact if the ATCT cannot reach the contractor's designated person by radio.

(d) Details on how the contractor will escort material delivery vehicles.

(6) Wildlife management. Discuss the following:

(a) Methods and procedures to prevent wildlife attraction.

(b) Wildlife reporting procedures.

(7) Foreign Object Debris (FOD) management. Discuss equipment and methods for control of FOD, including construction debris and dust.

(8) Hazardous material (HAZMAT) management. Discuss equipment and methods for responding to hazardous spills.

(9) Notification of construction activities. Provide the following:

(a) Contractor points of contact.

(b) Contractor emergency contact.

(c) Listing of tall or other requested equipment proposed for use on the airport and the timeframe for submitting 7460-1 forms not previously submitted by the airport operator.

(d) Batch plant details, including 7460-1 submittal.

(10) Inspection requirements. Discuss daily (or more frequent) inspections and special inspection procedures.

(11) Underground utilities. Discuss proposed methods of identifying and protecting underground utilities.

(12) Penalties. Penalties should be identified in the CSPP and should not require an entry in the SPCD.

(13) Special conditions. Discuss proposed actions for each special condition identified in the CSPP.

(14) Runway and taxiway visual aids. Including marking, lighting, signs, and visual NAVAIDs. Discuss proposed visual aids including the following:

(a) Equipment and methods for covering signage and airfield lights.

(b) Equipment and methods for temporary closure markings (paint, fabric, other).

(c) Types of temporary Visual Guidance Slope Indicators (VGSI).

(15) Marking and signs for access routes. Discuss proposed methods of demarcating access routes for vehicle drivers.

(16) Hazard marking and lighting. Discuss proposed equipment and methods for identifying excavation areas.

(17) Protection of runway and taxiway safety areas. including object free areas, obstacle free zones, and approach/departure surfaces. Discuss proposed methods of identifying, demarcating, and protecting airport surfaces including:

(a) Equipment and methods for maintaining Taxiway Safety Area standards.

(b) Equipment and methods for separation of construction operations from aircraft operations, including details of barricades.

(18) Other limitations on construction should be identified in the CSPP and should not require an entry in the SPCD.

Section 2. Plan Requirements

205. Coordination. Airport operators, or tenants conducting construction on their leased properties, should use predesign, prebid, and preconstruction conferences to introduce the subject of airport operational safety during construction (see AC 150/5300-9). In addition, the following should be coordinated as required:

a. Contractor Progress Meetings. Operational safety should be a standing agenda item for discussion during progress meetings throughout the project.

b. Scope or Schedule Changes. Changes in the scope or duration of the project may necessitate revisions to the CSPP and review and approval by the airport operator and the FAA.

c. FAA ATO Coordination. Early coordination with FAA ATO is required to schedule airway facility shutdowns and restarts. Relocation or adjustments to NAVAIDs, or changes to final grades in critical areas, may require an FAA flight inspection prior to restarting the facility. Flight inspections must be coordinated and scheduled well in advance of the intended facility restart. Flight inspections may require a reimbursable agreement between the airport operator and FAA ATO. Reimbursable agreements should be coordinated a minimum of 12 months prior to the start of construction. (See 213.e(3)(b) for required FAA notification regarding FAA owned NAVAIDs.)

206. Phasing. Once it has been determined what types and levels of airport operations will be maintained, the most efficient sequence of construction may not be feasible. In such a case, the sequence of construction may be phased to gain maximum efficiency while allowing for the required operations. The development of the resulting construction phases should be coordinated with local Air Traffic personnel and airport users. The sequenced construction phases established in the CSPP must be incorporated into the project design and must be reflected in the contract drawings and specifications.

a. Phase Elements. For each phase the CSPP should detail:

- Areas closed to aircraft operations

- Duration of closures
- Taxi routes
- ARFF access routes
- Construction staging areas
- Construction access and haul routes
- Impacts to NAVAIDs
- Lighting and marking changes
- Available runway length
- Declared distances (if applicable)
- Required hazard marking and lighting
- Lead times for required notifications

b. Construction Safety Drawings. Drawings specifically indicating operational safety procedures and methods in affected areas (that is, construction safety drawings) should be developed for each construction phase. Such drawings should be included in the CSPP as referenced attachments and should likewise be included in the contract drawing package.

207. Areas and Operations Affected by Construction Activity. Runways and taxiways should remain in use by aircraft to the maximum extent possible without compromising safety. Pre-meetings with the FAA Air Traffic Organization (ATO) will support operational simulations. See Chapter 3 for an example of a table showing temporary operations versus current operations.

a. Identification of Affected Areas. Identifying areas and operations affected by the construction will help to determine possible safety problems. The affected areas should be indentified in the construction safety drawings for each construction phase. (See 206.b above.) Of particular concern are:

(1) Closing, or partial closing, of runways, taxiways and aprons. When a runway is partially closed, a portion of the pavement is unavailable for any aircraft operation, meaning taxiing, landing, or taking off in either direction on that pavement is prohibited. A displaced threshold, by contrast, is established to ensure obstacle clearance and adequate safety area for landing aircraft. The pavement prior to the displaced threshold is available for take-off in the direction of the displacement and for landing and taking off in the opposite direction. Misunderstanding this difference, and issuance of a subsequently inaccurate NOTAM, can lead to a hazardous condition.

(2) Closing of Aircraft Rescue and Fire Fighting access routes.

(3) Closing of access routes used by airport and airline support vehicles.

(4) Interruption of utilities, including water supplies for fire fighting.

(5) Approach/departure surfaces affected by heights of objects.

(6) Construction areas, storage areas, and access routes near runways, taxiways, aprons, or helipads.

b. Mitigation of Effects. Establishment of specific procedures is necessary to maintain the safety and efficiency of airport operations. The CSPP must address:

(1) Temporary changes to runway and/or taxi operations.

(2) Detours for ARFF and other airport vehicles.

(3) Maintenance of essential utilities.

(4) Temporary changes to air traffic control procedures. Such changes must be coordinated with the ATO.

208. Navigation Aid (NAVAID) Protection. Before commencing construction activity, parking vehicles, or storing construction equipment and materials near a NAVAID, coordinate with the appropriate FAA ATO/Technical Operations office to evaluate the effect of construction activity and the required distance and direction from the NAVAID. (See paragraph 213.e(3) below.) Construction activities, materials/equipment storage, and vehicle parking near electronic NAVAIDs require special consideration since they may interfere with signals essential to air navigation. If any NAVAID may be affected, the CSPP and SPCD must show an understanding of the "critical area" associated with each NAVAID and describe how it will be protected. Where applicable, the operational critical areas of NAVAIDs should be graphically delineated on the project drawings. Pay particular attention to stockpiling material, as well as to movement and parking of equipment that may interfere with line of sight from the ATCT or with electronic emissions. Interference from construction equipment and activities may require NAVAID shutdown or adjustment of instrument approach minimums for low visibility operations. This condition requires that a NOTAM be filed (see paragraph 213.b below). Construction activities and materials/equipment storage near a NAVAID must not obstruct access to the equipment and instruments for maintenance. Submittal of a 7460-1 form is required for construction vehicles operating near FAA NAVAIDs. (See paragraph 213.e(1) below.)

209. Contractor Access. The CSPP must detail the areas to which the contractor must have access, and explain how contractor personnel will access those areas. Specifically address:

a. Location of Stockpiled Construction Materials. Stockpiled materials and equipment storage are not permitted within the RSA and OFZ, and if possible should not be permitted within the Object Free Area (OFA) of an operational runway. Stockpiling material in the OFA requires submittal of a 7460-1 form and justification provided to the appropriate FAA Airports Regional or District Office for approval. The airport operator must ensure that stockpiled materials and equipment adjacent to these areas are prominently marked and lighted during hours of restricted visibility or darkness. (See paragraph 218.b below.) This includes determining and verifying that materials are stabilized and stored at an approved location so as not to be a hazard to aircraft operations and to prevent attraction of wildlife and foreign object damage. See paragraphs 210 and 211 below.

b. Vehicle and Pedestrian Operations. The CSPP should include specific vehicle and pedestrian requirements. Vehicle and pedestrian access routes for airport construction projects must be controlled to prevent inadvertent or unauthorized entry of persons, vehicles, or animals onto the AOA. The airport operator should coordinate requirements for vehicle operations with airport tenants, contractors, and the FAA air traffic manager. In regard to vehicle and pedestrian operations, the CSPP should include the following, and detail associated training requirements:

(1) Construction site parking. Designate in advance vehicle parking areas for contractor employees to prevent any unauthorized entry of persons or vehicles onto the AOA. These areas should provide reasonable contractor employee access to the job site.

(2) Construction equipment parking. Contractor employees must park and service all construction vehicles in an area designated by the airport operator outside the OFZ and never in the safety area of an active runway or taxiway. Unless a complex setup procedure makes movement of specialized equipment infeasible, inactive equipment must not be parked on a closed taxiway or runway. If it is necessary to leave specialized equipment on a closed taxiway or runway at night, the equipment must be well lighted. Employees should also park construction vehicles outside the OFA when not in use by

construction personnel (for example, overnight, on weekends, or during other periods when construction is not active). Parking areas must not obstruct the clear line of sight by the ATCT to any taxiways or runways under air traffic control nor obstruct any runway visual aids, signs, or navigation aids. The FAA must also study those areas to determine effects on airport design criteria, surfaces established by 14 CFR Part 77, Safe, Efficient Use, and Preservation of the Navigable Airspace (Part 77), and on NAVAIDs and Instrument Approach Procedures (IAP). See paragraph 213.e(1) below for further information.

(3) Access and haul roads. Determine the construction contractor's access to the construction sites and haul roads. Do not permit the construction contractor to use any access or haul roads other than those approved. Access routes used by contractor vehicles must be clearly marked to prevent inadvertent entry to areas open to airport operations. Pay special attention to ensure that if construction traffic is to share or cross any ARFF routes that ARFF right of way is not impeded at any time, and that construction traffic on haul roads does not interfere with NAVAIDs or approach surfaces of operational runways.

(4) Marking and lighting of vehicles in accordance with AC 150/5210-5, Painting, Marking, and Lighting of Vehicles Used on an Airport.

(5) Description of proper vehicle operations on various areas under normal, lost communications, and emergency conditions.

(6) Required escorts.

(7) Training requirements for vehicle drivers to ensure compliance with the airport operator's vehicle rules and regulations. Specific training should be provided to those vehicle operators providing escorts. See AC 150/5210-20, Ground Vehicle Operations on Airports, for information on training and records maintenance requirements.

(8) Situational awareness. Vehicle drivers must confirm by personal observation that no aircraft is approaching their position (either in the air or on the ground) when given clearance to cross a runway, taxiway, or any other area open to airport operations. In addition, it is the responsibility of the escort vehicle driver to verify the movement/position of all escorted vehicles at any given time.

(9) Two-way radio communication procedures.

(a) General. The airport operator must ensure that tenant and construction contractor personnel engaged in activities involving unescorted operation on aircraft movement areas observe the proper procedures for communications, including using appropriate radio frequencies at airports with and without ATCT. When operating vehicles on or near open runways or taxiways, construction personnel must understand the critical importance of maintaining radio contact, as directed by the airport operator, with:

(i) Airport operations

(ii) ATCT

(iii) Common Traffic Advisory Frequency (CTAF), which may include UNICOM, MULTICOM.

(iv) Automatic Terminal Information Service (ATIS). This frequency is useful for monitoring conditions on the airport. Local air traffic will broadcast information regarding construction related runway closures and "shortened" runways on the ATIS frequency.

(b) Areas requiring two-way radio communication with the ATCT. Vehicular traffic crossing active movement areas must be controlled either by two-way radio with the ATCT, escort, flagman, signal light, or other means appropriate for the particular airport.

(c) Frequencies to be used. The airport operator will specify the frequencies to be used by the contractor, which may include the CTAF for monitoring of aircraft operations. Frequencies may also be assigned by the airport operator for other communications, including any radio frequency in compliance with Federal Communications Commission requirements. At airports with an ATCT, the airport operator will specify the frequency assigned by the ATCT to be used between contractor vehicles and the ATCT.

(d) Proper radio usage, including read back requirements.

(e) Proper phraseology, including the International Phonetic Alphabet.

(f) Light gun signals. Even though radio communication is maintained, escort vehicle drivers must also familiarize themselves with ATCT light gun signals in the event of radio failure. See the FAA safety placard "Ground Vehicle Guide to Airport Signs and Markings." This safety placard may be downloaded through the Runway Safety Program Web site at http://www.faa.gov/airports/runway_safety/publications/ (See "Signs & Markings Vehicle Dashboard Sticker".) or obtained from the FAA Airports Regional Office.

(10) Maintenance of the secured area of the airport, including:

(a) Fencing and gates. Airport operators and contractors must take care to maintain security during construction when access points are created in the security fencing to permit the passage of construction vehicles or personnel. Temporary gates should be equipped so they can be securely closed and locked to prevent access by animals and unauthorized people. Procedures should be in place to ensure that only authorized persons and vehicles have access to the AOA and to prohibit "piggybacking" behind another person or vehicle. The Department of Transportation (DOT) document DOT/FAA/AR-00/52, Recommended Security Guidelines for Airport Planning and Construction, provides more specific information on fencing. A copy of this document can be obtained from the Airport Consultants Council, Airports Council International, or American Association of Airport Executives.

(b) Badging requirements.

(c) Airports subject to 49 CFR Part 1542, Airport Security, must meet standards for access control, movement of ground vehicles, and identification of construction contractor and tenant personnel.

210. Wildlife Management. The CSPP and SPCD must be in accordance with the airport operator's wildlife hazard management plan, if applicable. See also AC 150/5200-33, Hazardous Wildlife Attractants On or Near Airports, and Certalert 98-05, Grasses Attractive to Hazardous Wildlife. Construction contractors must carefully control and continuously remove waste or loose materials that might attract wildlife. Contractor personnel must be aware of and avoid construction activities that can create wildlife hazards on airports, such as:

a. Trash. Food scraps must be collected from construction personnel activity.

b. Standing Water.

c. Tall Grass and Seeds. Requirements for turf establishment can be at odds with requirements for wildlife control. Grass seed is attractive to birds. Lower quality seed mixtures can contain seeds of plants (such as clover) that attract larger wildlife. Seeding should comply with the guidance in AC 150/5370-10, Standards for Specifying Construction of Airports, Item T-901, Seeding. Contact the local office of the United Sates Department of Agriculture Soil Conservation Service or the State University Agricultural Extension Service (County Agent or equivalent) for assistance and recommendations. These agencies can also provide liming and fertilizer recommendations.

d. Poorly Maintained Fencing and Gates. See 209.b(10)(a) above.

e. Disruption of Existing Wildlife Habitat. While this will frequently be unavoidable due to the nature of the project, the CSPP should specify under what circumstances (location, wildlife type) contractor personnel should immediately notify the airport operator of wildlife sightings.

211. Foreign Object Debris (FOD) Management. Waste and loose materials, commonly referred to as FOD, are capable of causing damage to aircraft landing gears, propellers, and jet engines. Construction contractors must not leave or place FOD on or near active aircraft movement areas. Materials capable of creating FOD must be continuously removed during the construction project. Fencing (other than security fencing) may be necessary to contain material that can be carried by wind into areas where aircraft operate. See AC 150/5210-24, Foreign Object Debris (FOD) Management.

212. Hazardous Materials (HAZMAT) Management. Contractors operating construction vehicles and equipment on the airport must be prepared to expeditiously contain and clean-up spills resulting from fuel or hydraulic fluid leaks. Transport and handling of other hazardous materials on an airport also requires special procedures. See AC 150/5320-15, Management of Airport Industrial Waste.

213. Notification of Construction Activities. The CSPP and SPCD must detail procedures for the immediate notification of airport users and the FAA of any conditions adversely affecting the operational safety of the airport. It must address the notification actions described below, as applicable.

a. List of Responsible Representatives/ points of contact for all involved parties, and procedures for contacting each of them, including after hours.

b. NOTAMs. Only the airport operator may initiate or cancel NOTAMs on airport conditions, and is the only entity that can close or open a runway. The airport operator must coordinate the issuance, maintenance, and cancellation of NOTAMs about airport conditions resulting from construction activities with tenants and the local air traffic facility (control tower, approach control, or air traffic control center), and must provide information on closed or hazardous conditions on airport movement areas to the FAA Flight Service Station (FSS) so it can issue a NOTAM. The airport operator must file and maintain a list of authorized representatives with the FSS. Refer to AC 150/5200-28, Notices to Airmen (NOTAMs) for Airport Operators, for a sample NOTAM form. Only the FAA may issue or cancel NOTAMs on shutdown or irregular operation of FAA owned facilities. Any person having reason to believe that a NOTAM is missing, incomplete, or inaccurate must notify the airport operator. See paragraph 207.a(1) above regarding issuing NOTAMs for partially closed runways versus runways with displaced thresholds.

c. Emergency notification procedures for medical, fire fighting, and police response.

d. Coordination with ARFF. The CSPP must detail procedures for coordinating through the airport sponsor with ARFF personnel, mutual aid providers, and other emergency services if construction requires:

- The deactivation and subsequent reactivation of water lines or fire hydrants, or
- The rerouting, blocking and restoration of emergency access routes, or
- The use of hazardous materials on the airfield.

e. Notification to the FAA.

(1) Part 77. Any person proposing construction or alteration of objects that affect navigable airspace, as defined in Part 77, must notify the FAA. This includes construction equipment and proposed

parking areas for this equipment (i.e. cranes, graders, other equipment) on airports. FAA Form 7460-1, Notice of Proposed Construction or Alteration, can be used for this purpose and submitted to the appropriate FAA Airports Regional or District Office. See Appendix 1, Related Reading Material, to download the form. Further guidance is available on the FAA web site at oeaaa.faa.gov.

(2) Part 157. With some exceptions, Title 14 CFR Part 157, Notice of Construction, Alteration, Activation, and Deactivation of Airports, requires that the airport operator notify the FAA in writing whenever a non-Federally funded project involves the construction of a new airport; the construction, realigning, altering, activating, or abandoning of a runway, landing strip, or associated taxiway; or the deactivation or abandoning of an entire airport. Notification involves submitting FAA Form 7480-1, Notice of Landing Area Proposal, to the nearest FAA Airports Regional or District Office. See Appendix 1, Related Reading Material to download the form.

(3) NAVAIDS. For emergency (short-notice) notification about impacts to both airport owned and FAA owned NAVAIDs, contact: 866-432-2622.

(a) Airport owned/FAA maintained. If construction operations require a shutdown of more than 24 hours, or more than 4 hours daily on consecutive days, of a NAVAID owned by the airport but maintained by the FAA, provide a 45-day minimum notice to FAA ATO/Technical Operations prior to facility shutdown.

(b) FAA owned.

(i) General. The airport operator must notify the appropriate FAA ATO Service Area Planning and Requirements (P&R) Group a minimum of 45 days prior to implementing an event that causes impacts to NAVAIDs. (Impacts to FAA equipment covered by a Reimbursable Agreement (RA) do not have to be reported by the airport operator.)

(ii) Coordinate work for an FAA owned NAVAID shutdown with the local FAA ATO/Technical Operations office, including any necessary reimbursable agreements and flight checks. Detail procedures that address unanticipated utility outages and cable cuts that could impact FAA NAVAIDs. In addition, provide seven days notice to schedule the actual shutdown.

214. Inspection Requirements.

a. Daily Inspections. Inspections should be conducted at least daily, but more frequently if necessary to ensure conformance with the CSPP. A sample checklist is provided in Appendix 3, Safety and Phasing Plan Checklist. See also AC 150/5200-18, Airport Safety Self-Inspection.

b. Final Inspections. New runways and extended runway closures may require safety inspections at certificated airports prior to allowing air carrier service. Coordinate with the FAA Airport Certification Safety Inspector (ACSI) to determine if a final inspection will be necessary.

215. Underground Utilities. The CSPP and/or SPCD must include procedures for locating and protecting existing underground utilities, cables, wires, pipelines, and other underground facilities in excavation areas. This may involve coordinating with public utilities and FAA ATO/Technical Operations. Note that “One Call” or “Miss Utility” services do not include FAA ATO/Technical Operations

216. Penalties. The CSPP should detail penalty provisions for noncompliance with airport rules and regulations and the safety plans (for example, if a vehicle is involved in a runway incursion). Such penalties typically include rescission of driving privileges or access to the AOA.

217. Special Conditions. The CSPP must detail any special conditions that affect the operation of the

airport and will require the activation of any special procedures (for example, low-visibility operations, snow removal, aircraft in distress, aircraft accident, security breach, Vehicle / Pedestrian Deviation (VPD) and other activities requiring construction suspension/resumption).

218. Runway and Taxiway Visual Aids. Includes marking, lighting, signs, and visual NAVAIDS. The CSPP must ensure that areas where aircraft will be operating are clearly and visibly separated from construction areas, including closed runways. Throughout the duration of the construction project, verify that these areas remain clearly marked and visible at all times and that marking, lighting, signs, and visual NAVAIDs remain in place and operational. The CSPP must address the following, as appropriate:

a. General. Airport markings, lighting, signs, and visual NAVAIDs must be clearly visible to pilots, not misleading, confusing, or deceptive. All must be secured in place to prevent movement by prop wash, jet blast, wing vortices, or other wind currents and constructed of materials that would minimize damage to an aircraft in the event of inadvertent contact.

b. Markings. Markings must be in compliance with the standards of AC 150/5340-1, Standards for Airport Markings. Runways and runway exit taxiways closed to aircraft operations are marked with a yellow X. The preferred visual aid to depict temporary runway closure is the lighted X signal placed on or near the runway designation numbers. (See paragraph 218.b(1)(b) below.)

(1) Closed Runways and Taxiways.

(a) Permanently Closed Runways. For runways, obliterate the threshold marking, runway designation marking, and touchdown zone markings, and place Xs at each end and at 1,000-foot (300 m) intervals.

(b) Temporarily Closed Runways. For runways that have been temporarily closed, place an X at the each end of the runway directly on or as near as practicable to the runway designation numbers. Figure 2-1 illustrates.

Figure 2-1 Markings for a Temporarily Closed Runway

(c) Partially Closed Runways and Displaced Thresholds. When threshold markings are needed to identify the temporary beginning of the runway that is available for landing, the markings must comply with AC 150/5340-1. An X is not used on a partially closed runway or a runway with a displaced threshold. See paragraph 207.a(1) above for the difference between partially closed runways and runways with displaced thresholds.

(i) Partially Closed Runways. Pavement markings for temporary closed portions of the runway consist of a runway threshold bar and yellow chevrons to identify pavement areas that are unsuitable for takeoff or landing (see AC 150/5340-1).

(ii) Displaced Thresholds. Pavement markings for a displaced threshold consist of a runway threshold bar and white arrowheads with and without arrow shafts. These markings are required to identify the portion of the runway before the displaced threshold to provide centerline guidance for pilots during approaches, takeoffs, and landing rollouts from the opposite direction. See AC 150/5340-1.

(d) Taxiways.

(i) Permanently Closed Taxiways. AC 150/5300-13 notes that it is preferable to remove the pavement, but for pavement that is to remain, place an X at the entrance to both ends of the closed section. Obliterate taxiway centerline markings, including runway leadoff lines, leading to the closed taxiway. Figure 2-2 illustrates.

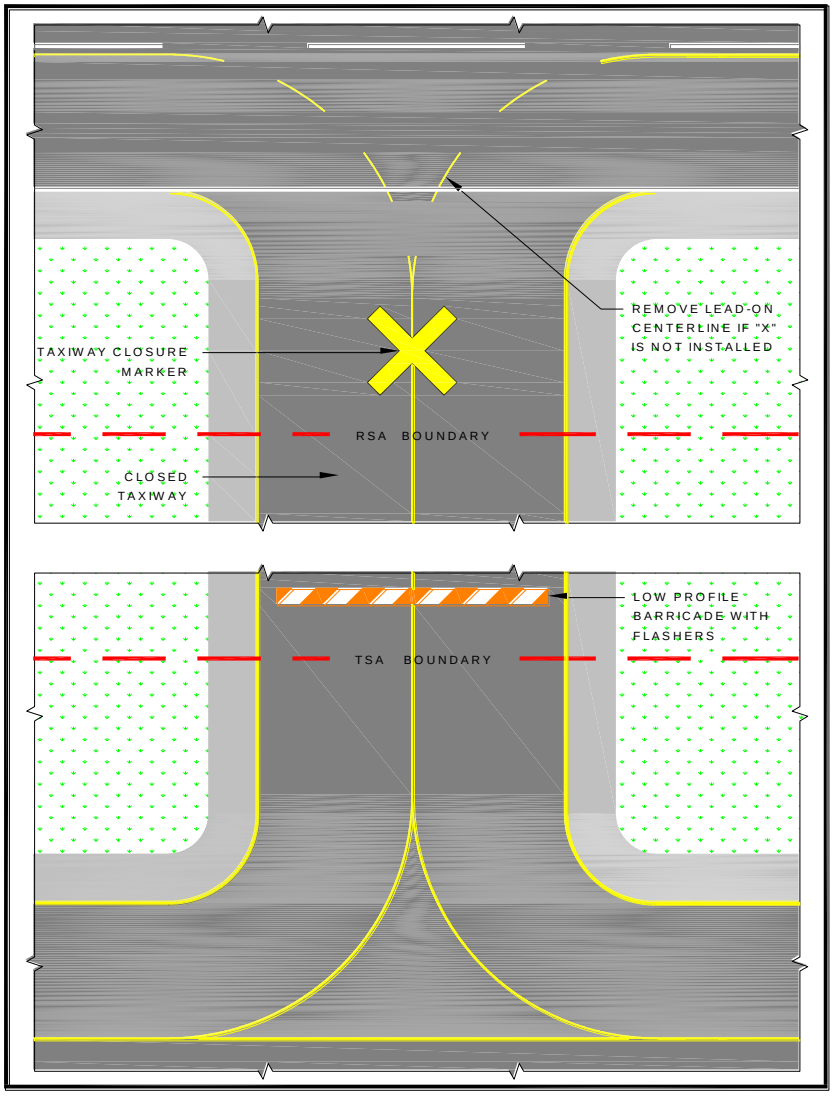

Figure 2-2 Taxiway Closure

(ii) Temporarily Closed Taxiways. Place barricades outside the safety area of intersecting taxiways. For runway/taxiway intersections, place an X at the entrance to the closed taxiway from the runway. If the taxiway will be closed for an extended period, obliterate taxiway centerline markings, including runway leadoff lines, leading to the closed section. If the centerline markings will be reused upon reopening the taxiway, it is preferable to paint over the marking. This will result in less damage to the pavement when the upper layer of paint is ultimately removed.

(e) Temporarily Closed Airport. When the airport is closed temporarily, mark all the runways as closed.

(2) If unable to paint temporary markings on the pavement, construct them from any of the following materials: fabric, colored plastic, painted sheets of plywood, or similar materials. They must be properly configured and appropriately secured to prevent movement by prop wash, jet blast, or other wind currents.

(3) It may be necessary to remove or cover runway markings, including but not limited to, runway designation markings, threshold markings, centerline markings, edge stripes, touchdown zone markings and aiming point markings, depending on the length of construction and type of activity at the airport. When removing runway markings, apply the same treatment to areas between stripes or numbers, as the cleaned area will appear to pilots as a marking in the shape of the treated area.

(4) If it is not possible to install threshold bars, chevrons, and arrows on the pavement, temporary outboard markings may be used. Locate them outside of the runway pavement surface on both sides of the runway. The dimension along the runway direction must be the same as if installed on the pavement. The lateral dimension must be at least one-half that of on-pavement markings. If the markings are not discernible on grass or snow, apply a black background with appropriate material over the ground to ensure they are clearly visible.

(5) The application rate of paint to mark a short-term temporary runway and taxiway markings may deviate from the standard (see Item P-620, "Runway and Taxiway Painting," in AC 150/5370-10), but the dimensions must meet the existing standards.

c. Lighting and Visual NAVAIDs. This paragraph refers to standard runway and taxiway lighting systems. See below for hazard lighting. Lighting must be in conformance with AC 150/5340-30, Design and Installation Details for Airport Visual Aids, and AC 150/5345-50, Specification for Portable Runway and Taxiway Lights. When disconnecting runway and taxiway lighting fixtures, disconnect the associated isolation transformers. Alternately, cover the light fixture in such a way as to prevent light leakage. Avoid removing the lamp from energized fixtures because an excessive number of isolation transformers with open secondaries may damage the regulators and/or increase the current above its normal value. Secure, identify, and place any above ground temporary wiring in conduit to prevent electrocution and fire ignition sources.

(1) Permanently Closed Runways and Taxiways. For runways and taxiways that have been permanently closed, disconnect the lighting circuits.

(2) Temporarily Closed Runways. If available, use a lighted X, both at night and during the day, placed at each end of the runway facing the approach. The use of a lighted X is required if night work requires runway lighting to be on. See AC 150/5345-55, Specification for L-893, Lighted Visual Aid to Indicate Temporary Runway Closure. For runways that have been temporarily closed, but for an extended period, and for those with pilot controlled lighting, disconnect the lighting circuits or secure switches to prevent inadvertent activation. For runways that will be opened periodically, coordinate procedures with the FAA air traffic manager or, at airports without an ATCT, the airport operator. Activate stop bars if available. Figure 2-3 shows a lighted X by day. Figure 2-4 shows a lighted X at night.

Figure 2-3 Lighted X in Daytime

Figure 2-4 Lighted X at Night

(3) Partially Closed Runways and Displaced Thresholds. When a runway is partially closed, a portion of the pavement is unavailable for any aircraft operation, meaning taxiing and landing or

taking off in either direction. A displaced threshold, by contrast, is put in place to ensure obstacle clearance by landing aircraft. The pavement prior to the displaced threshold is available for takeoff in the direction of the displacement, and for landing and takeoff in the opposite direction. Misunderstanding this difference and issuance of a subsequently inaccurate NOTAM can result in a hazardous situation. For both partially closed runways and displaced thresholds, approach lighting systems at the affected end must be placed out of service

(a) Partially Closed Runways. Disconnect edge and threshold lights on that part of the runway at and behind the threshold (that is, the portion of the runway that is closed). Alternately, cover the light fixture in such a way as to prevent light leakage.

(b) Displaced Thresholds. Edge lighting in the area of the displacement emits red light in the direction of approach and yellow light in the opposite direction. Centerline lights are blanked out in the direction of approach if the displacement is 700 ft or less. If the displacement is over 700 ft, place the centerline lights out of service. See AC 150/5340-30 for details on lighting displaced thresholds.

(c) Temporary runway thresholds and runway ends must be lighted if the runway is lighted and it is the intended threshold for night landings or instrument meteorological conditions.

(d) A temporary threshold on an unlighted runway may be marked by retroreflective, elevated markers in addition to markings noted in paragraph 218.b(1)(c) above. Markers seen by aircraft on approach are green. Markers at the rollout end of the runway are red. At certificated airports, temporary elevated threshold markers must be mounted with a frangible fitting (see 14 CFR Part 139.309). At non-certificated airports, the temporary elevated threshold markings may either be mounted with a frangible fitting or be flexible. See AC 150/5345-39, Specification for L-853, Runway and Taxiway Retroreflective Markers.

(e) Temporary threshold lights and end lights and related visual NAVAIDs are installed outboard of the edges of the full-strength pavement only when they cannot be installed on the pavement. They are installed with bases at grade level or as low as possible, but not more than 3 in (7.6 cm) above ground. When any portion of a base is above grade, place properly compacted fill around the base to minimize the rate of gradient change so aircraft can, in an emergency, cross at normal landing or takeoff speeds without incurring significant damage. See AC 150/5370-10.

(f) Maintain threshold and edge lighting color and spacing standards as described in AC 150/5340-30. Battery powered, solar, or portable lights that meet the criteria in AC 150/5345-50 may be used. These systems are intended primarily for visual flight rules (VFR) aircraft operations but may be used for instrument flight rules (IFR) aircraft operations, upon individual approval from the Flight Standards Division of the applicable FAA Regional Office.

(g) Reconfigure yellow lenses (caution zone), as necessary. If the runway has centerline lights, reconfigure the red lenses, as necessary, or place the centerline lights out of service.

(h) Relocate the visual glide slope indicator (VGSI), such as VASI and PAPI; other airport lights, such as Runway End Identifier Lights (REIL); and approach lights to identify the temporary threshold. Another option is to disable the VGSI or any equipment that would give misleading indications to pilots as to the new threshold location. Installation of temporary visual aids may be necessary to provide adequate guidance to pilots on approach to the affected runway. If the FAA owns and operates the VGSI, coordinate its installation or disabling with the local ATO/Technical Operations Office. Relocation of such visual aids will depend on the duration of the project and the benefits gained from the relocation, as this can result in great expense.

(i) Issue a NOTAM to inform pilots of temporary lighting conditions.

(4) Temporarily Closed Taxiways. If possible, deactivate the taxiway lighting circuits. When deactivation is not possible (for example other taxiways on the same circuit are to remain open),

cover the light fixture in such a way as to prevent light leakage.

d. Signs. To the extent possible, signs must be in conformance with AC 150/5345-44, Specification for Runway and Taxiway Signs and AC 150/5340-18, Standard for Airport Sign Systems. Any time a sign does not serve its normal function; it must be covered or removed to prevent misdirecting pilots. Note that information signs identifying a crossing taxiway continue to perform their normal function even if the crossing taxiway is closed. For long term construction projects, consider relocating signs, especially runway distance remaining signs.

219. Marking and Signs for Access Routes. The CSPP should indicate that pavement markings and signs for construction personnel will conform to AC 150/5340-18 and, to the extent practicable, with the Federal Highway Administration Manual on Uniform Traffic Control Devices (MUTCD) and/or State highway specifications. Signs adjacent to areas used by aircraft must comply with the frangibility requirements of AC 150/5220-23, Frangible Connections, which may require modification to size and height guidance in the MUTCD.

220. Hazard Marking, Lighting and Signing.

a. Hazard Marking and Lighting Prevents Pilots from entering areas closed to aircraft, and prevents construction personnel from entering areas open to aircraft. The CSPP must specify prominent, comprehensible warning indicators for any area affected by construction that is normally accessible to aircraft, personnel, or vehicles. Hazard marking and lighting must also be specified to identify open manholes, small areas under repair, stockpiled material, waste areas, and areas subject to jet blast. Also consider less obvious construction-related hazards and include markings to identify FAA, airport, and National Weather Service facilities cables and power lines; instrument landing system (ILS) critical areas; airport surfaces, such as RSA, OFA, and OFZ; and other sensitive areas to make it easier for contractor personnel to avoid these areas.

b. Equipment.

(1) Barricades, including traffic cones, (weighted or sturdily attached to the surface) are acceptable methods used to identify and define the limits of construction and hazardous areas on airports. Careful consideration must be given to selecting equipment that poses the least danger to aircraft but is sturdy enough to remain in place when subjected to typical winds, prop wash and jet blast. The spacing of barricades must be such that a breach is physically prevented barring a deliberate act. For example, if barricades are intended to exclude vehicles, gaps between barricades must be smaller than the width of the excluded vehicles, generally 4 ft. Provision must be made for ARFF access if necessary. If barricades are intended to exclude pedestrians, they must be continuously linked. Continuous linking may be accomplished through the use of ropes, securely attached to prevent FOD.

(2) Lights must be red, either steady burning or flashing, and must meet the luminance requirements of the State Highway Department. Batteries powering lights will last longer if lights flash. Lights must be mounted on barricades and spaced at no more than 10 ft. Lights must be operated between sunset and sunrise and during periods of low visibility whenever the airport is open for operations. They may be operated by photocell, but this may require that the contractor turn them on manually during periods of low visibility during daytime hours.

(3) Supplement barricades with signs (for example “No Entry,” “No Vehicles”) as necessary.

(4) Air Operations Area – General. Barricades are not permitted in any active safety area. Within a runway or taxiway object free area, and on aprons, use orange traffic cones, flashing or steady burning red lights as noted above, collapsible barricades marked with diagonal, alternating orange and

white stripes; and/or signs to separate all construction/maintenance areas from the movement area. Barricades may be supplemented with alternating orange and white flags at least 20 by 20 in (50 by 50 cm) square and securely fastened to eliminate FOD. All barricades adjacent to any open runway or taxiway / taxilane safety area, or apron must be as low as possible to the ground, and no more than 18 in high, exclusive of supplementary lights and flags. Barricades must be of low mass; easily collapsible upon contact with an aircraft or any of its components; and weighted or sturdily attached to the surface to prevent displacement from prop wash, jet blast, wing vortex, or other surface wind currents. If affixed to the surface, they must be frangible at grade level or as low as possible, but not to exceed 3 in (7.6 cm) above the ground. Figure 2-5 and Figure 2-6 show sample barricades with proper coloring and flags.

Figure 2-5 Interlocking Barricades

Figure 2-6 Low Profile Barricades

(5) Air Operations Area – Runway/Taxiway Intersections. Use highly reflective barricades with lights to close taxiways leading to closed runways. Evaluate all operating factors when determining how to mark temporary closures that can last from 10 to 15 minutes to a much longer period of time. However, even for closures of relatively short duration, close all taxiway/runway intersections with barricades. The use of traffic cones is appropriate for short duration closures.

(6) Air Operations Area – Other. Beyond runway and taxiway object free areas and

aprons, barricades intended for construction vehicles and personnel may be many different shapes and made from various materials, including railroad ties, sawhorses, jersey barriers, or barrels.

(7) Maintenance. The construction specifications must include a provision requiring the contractor to have a person on call 24 hours a day for emergency maintenance of airport hazard lighting and barricades. The contractor must file the contact person's information with the airport operator. Lighting should be checked for proper operation at least once per day, preferably at dusk.

221. Protection of Runway and Taxiway Safety Areas. Runway and taxiway safety areas, Obstacle Free zones (OFZ), object free areas (OFA), and approach surfaces are described in AC 150/5300-13. Protection of these areas includes limitations on the location and height of equipment and stockpiled material. An FAA airspace study may be required. Coordinate with the appropriate FAA Airports Regional or District Office if there is any doubt as to requirements or dimensions (See paragraph 213.e above.) as soon as the location and height of materials or equipment are known. The CSPP should include drawings showing all safety areas, object free areas, obstacle free zones and approach departure surfaces affected by construction.

a. Runway Safety Area (RSA). A runway safety area is the defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway (see AC 150/5300-13). Construction activities within the existing RSA are subject to the following conditions:

(1) No construction may occur within the existing RSA while the runway is open for aircraft operations. The RSA dimensions may be temporarily adjusted if the runway is restricted to aircraft operations requiring an RSA that is equal to the RSA width and length beyond the runway ends available during construction. (see AC 150/5300-13). The temporary use of declared distances and/or partial runway closures may provide the necessary RSA under certain circumstances. Coordinate with the appropriate FAA Airports Regional or District Office to have declared distances information published. See AC 150/5300-13 for guidance on the use of declared distances.

(2) The airport operator must coordinate the adjustment of RSA dimensions as permitted above with the appropriate FAA Airports Regional or District Office and the local FAA air traffic manager and issue a NOTAM.

(3) The CSPP and SPCD must provide procedures for ensuring adequate distance for protection from blasting operations, if required by operational considerations.

(4) Excavations.

(a) Open trenches or excavations are not permitted within the RSA while the runway is open. If possible, backfill trenches before the runway is opened. If the runway must be opened before excavations are backfilled, cover the excavations appropriately. Covering for open trenches must be designed to allow the safe operation of the heaviest aircraft operating on the runway across the trench without damage to the aircraft.

(b) Construction contractors must prominently mark open trenches and excavations at the construction site with red or orange flags, as approved by the airport operator, and light them with red lights during hours of restricted visibility or darkness.

(5) Erosion Control. Soil erosion must be controlled to maintain RSA standards, that is, the RSA must be cleared and graded and have no potentially hazardous ruts, humps, depressions, or other surface variations, and capable, under dry conditions, of supporting snow removal equipment, aircraft rescue and fire fighting equipment, and the occasional passage of aircraft without causing structural damage to the aircraft.

b. Runway Object Free Area (ROFA). Construction, including excavations, may be permitted in the ROFA. However, equipment must be removed from the ROFA when not in use, and material should not be stockpiled in the ROFA if not necessary. Stockpiling material in the OFA requires submittal of a 7460-1 form and justification provided to the appropriate FAA Airports Regional or District Office for approval.

c. Taxiway Safety Area (TSA). A taxiway safety area is a defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an airplane unintentionally departing the taxiway. (See AC 150/5300-13.) Construction activities within the TSA are subject to the following conditions:

(1) No construction may occur within the TSA while the taxiway is open for aircraft operations. The TSA dimensions may be temporarily adjusted if the taxiway is restricted to aircraft operations requiring a TSA that is equal to the TSA width available during construction (see AC 150/5300-13, Table 4-1).

(2) The airport operator must coordinate the adjustment of the TSA width as permitted above with the appropriate FAA Airports Regional or District Office and the FAA air traffic manager and issue a NOTAM.

(3) The CSPP and SPCD must provide procedures for ensuring adequate distance for protection from blasting operations.

(4) Excavations.

(a) Open trenches or excavations are not permitted within the TSA while the taxiway is open. If possible, backfill trenches before the taxiway is opened. If the taxiway must be opened before excavations are backfilled, cover the excavations appropriately. Covering for open trenches must be designed to allow the safe operation of the heaviest aircraft operating on the taxiway across the trench without damage to the aircraft.

(b) Construction contractors must prominently mark open trenches and excavations at the construction site with red or orange flags, as approved by the airport operator, and light them with red lights during hours of restricted visibility or darkness.

(5) Erosion Control. Soil erosion must be controlled to maintain TSA standards, that is, the TSA must be cleared and graded and have no potentially hazardous ruts, humps, depressions, or other surface variations, and capable, under dry conditions, of supporting snow removal equipment, aircraft rescue and fire fighting equipment, and the occasional passage of aircraft without causing structural damage to the aircraft.

d. Taxiway Object Free Area (TOFA). Unlike the Runway Object Free Area, aircraft wings regularly penetrate the taxiway object free area during normal operations. Thus the restrictions are more stringent. Except as provided below, no construction may occur within the taxiway object free area while the taxiway is open for aircraft operations.

(1) The taxiway object free area dimensions may be temporarily adjusted if the taxiway is restricted to aircraft operations requiring a taxiway object free area that is equal to the taxiway object free area width available.

(2) Offset taxiway pavement markings may be used as a temporary measure to provide the required taxiway object free area. Where offset taxiway pavement markings are provided, centerline lighting or reflectors are required.

(3) Construction activity may be accomplished without adjusting the width of the taxiway object free area, subject to the following restrictions:

(a) Appropriate NOTAMs are issued.

(b) Marking and lighting meeting the provisions of paragraphs 218 and 220 above are implemented.

(c) Five-foot clearance is maintained between equipment and materials and any part of an aircraft (includes wingtip overhang). In these situations, flaggers must be used to direct construction equipment, and wing walkers will be necessary to guide aircraft. Wing walkers should be airline/aviation personnel rather than construction workers. If such clearance can only be maintained if an aircraft does not have full use of the entire taxiway width (with its main landing gear at the edge of the pavement), then it will be necessary to move personnel and equipment for the passage of that aircraft.

e. Obstacle Free Zone (OFZ). In general, personnel, material, and/or equipment may not penetrate the OFZ while the runway is open for aircraft operations. If a penetration to the OFZ is necessary, it may be possible to continue aircraft operations through operational restrictions. Coordinate with the FAA through the appropriate FAA Airports Regional or District Office.

f. Runway Approach/Departure Areas and Clearways. All personnel, materials, and/or equipment must remain clear of the applicable threshold siting surfaces, as defined in Appendix 2, "Threshold Siting Requirements," of AC 150/5300-13. Objects that do not penetrate these surfaces may still be obstructions to air navigation and may affect standard instrument approach procedures. Coordinate with the FAA through the appropriate FAA Airports Regional or District Office.

(1) Construction activity in a runway approach/departure area may result in the need to partially close a runway or displace the existing runway threshold. Partial runway closure, displacement of the runway threshold, as well as closure of the complete runway and other portions of the movement area also require coordination through the airport operator with the appropriate FAA air traffic manager (FSS if non-towered) and ATO/Technical Operations (for affected NAVAIDS) and airport users.

(2) Caution regarding partial runway closures. When filing a NOTAM for a partial runway closure, clearly state to OCC personnel that the portion of pavement located prior to the threshold is not available for landing and departing traffic. In this case, the threshold has been moved for both landing and takeoff purposes (this is different than a displaced threshold). There may be situations where the portion of closed runway is available for taxiing only. If so, the NOTAM must reflect this condition).

(3) Caution regarding displaced thresholds. : Implementation of a displaced threshold affects runway length available for aircraft landing over the displacement. Depending on the reason for the displacement (to provide obstruction clearance or RSA), such a displacement may also require an adjustment in the landing distance available and accelerate-stop distance available in the opposite direction. If project scope includes personnel, equipment, excavation, other work. within the existing RSA of any usable runway end, do not implement a displaced threshold unless arrivals and departures toward the construction activity are prohibited. Instead, implement a partial closure.

222. Other Limitations on Construction. The CSPP must specify any other limitations on construction, including but not limited to:

a. Prohibitions.

(1) No use of tall equipment (cranes, concrete pumps, and so on) unless a 7460-1 determination letter is issued for such equipment.

(2) No use of open flame welding or torches unless fire safety precautions are provided and the airport operator has approved their use.

(3) No use of electrical blasting caps on or within 1,000 ft (300 m) of the airport property.

See AC 150/5370-10.

(4) No use of flare pots within the AOA.

b. Restrictions.

(1) Construction suspension required during specific airport operations.

(2) Areas that cannot be worked on simultaneously.

(3) Day or night construction restrictions.

(4) Seasonal construction restrictions.

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Chapter 3. Guidelines for Writing a CSPP

301. General Requirements. The CSPP is a standalone document written to correspond with the subjects outlined in Chapter 2, Section 1, paragraph 204. The CSPP is organized by numbered sections corresponding to each subject listed in Chapter 2, Section 1, paragraph 204, and described in detail in Chapter 2, Section 2. Each section number and title in the CSPP matches the corresponding subject outlined in Chapter 2, paragraph 204 (for example, 1. Coordination, 2. Phasing, 3. Areas and Operations Affected by the Construction Activity, and so on.). With the exception of the project scope of work outlined in Section 2. Phasing, only subjects specific to operational safety during construction should be addressed.

302. Applicability of Subjects. Each section should, to the extent practical, focus on the specific subject. Where an overlapping requirement spans several sections, the requirement should be explained in detail in the most applicable section. A reference to that section should be included in all other sections where the requirement may apply. For example, the requirement to protect existing underground FAA Instrument Landing System (ILS) cables during trenching operations could be considered FAA ATO coordination (Section 1. Coordination, paragraph 205.c), an area and operation affected by the construction activity (Section 3. Areas and Operations Affected by the Construction Activity, paragraph 207.a(4)), a protection of a NAVAID (Section 4. Protection of Navigational Aids (NAVAIDs),paragraph 208), or a notification to the FAA of construction activities (Section 9. Notification of Construction Activities, paragraph 210.e(3)(b)). However, it is more specifically an underground utility requirement (Section 11. Underground Utilities, paragraph 215). The procedure for protecting underground ILS cables during trenching operations should therefore be described in Section 11: "*The contractor must coordinate with the local FAA System Support Center (SSC) to mark existing ILS cable routes along Runway 17-35. The ILS cables will be located by hand digging whenever the trenching operation moves within 10 feet of the cable markings.*" All other applicable sections should include a reference to Section 11: "*ILS cables shall be identified and protected as described in Section 11*" or "*See Section 11 for ILS cable identification and protection requirements.*" Thus, the CSPP should be considered as a whole, with no need to duplicate responses to related issues.

303. Graphical Representations. Construction safety drawings should be included in the CSPP as attachments. When other graphical representations will aid in supporting written statements, the drawings, diagrams, and/or photographs should also be attached to the CSPP. References should be made in the CSPP to each graphical attachment and may be made in multiple sections.

304. Reference Documents. The CSPP must not incorporate a document by reference unless reproduction of the material in that document is prohibited. In that case, either copies of or a source for the referenced document must be provided to the contractor.

305. Restrictions. The CSPP should not be considered as a project design review document. The CSPP should also avoid mention of permanent ("as-built") features such as pavements, markings, signs, and lighting, except when such features are intended to aid in maintaining operational safety during the construction.

306. Coordination. Include in this section a detailed description of conferences and meetings both before and during the project. Include appropriate information from AC 150/5300-9. Discuss coordination procedures and schedules for each required FAA ATO airway facility shutdown and restart and all required flight inspections.

307. Phasing. Include in this section a detailed scope of work description for the project as a whole and each phase of work covered by the CSPP. This includes all locations and durations of the work proposed. Attach drawings to graphically support the written scope of work. Detail in this section the sequenced phases of the proposed construction. Include a reference to paragraph 308 below, as appropriate.

308. Areas and Operations Affected By Construction. Focus in this section on identifying the areas and operations affected by the construction. Describe corresponding mitigation that is not covered in detail elsewhere in the CSPP. Include references to paragraphs below as appropriate. Attach drawings as necessary to graphically describe affected areas and mechanisms proposed. Tables and charts such as the following may be helpful in highlighting issues to be addressed.

Table 3-1 Sample Operations Effects

Project	Runway 15-33 Reconstruction	
Phase	Phase II: Reconstruct Runway 15 End	
Scope of Work	Reconstruct 1,000 ft of north end of Runway 15-33 with Portland Cement Concrete (PCC).	
Operational Requirements	**Normal (Existing)**	**Phase II (Anticipated)**
Runway 15 Average Aircraft Operations	Carrier: 52 /day GA: 26 /day Military: 11 /day	Carrier: 52 / day GA: 20 / day Military: 0 /day
Runway 33 Average Aircraft Operations	Carrier: 40 /day GA: 18 /day Military: 10 /day	Carrier: 20 /day GA: 5 /day Military: 0 /day
Runway 15-33 ARC	C-IV	C-IV
Runway 15 Approach Visibility Minimums	¾ mile	1 mile
Runway 33 Approach Visibility Minimums	¾ mile	1 mile
Runway 15 Declared Distances	TORA: 7,820	TORA: 6,420
	TODA: 7,820	TODA: 6,420
	ASDA: 7,820	ASDA: 6,420
	LDA: 7,820	LDA: 6,420
Runway 33 Declared Distances	TORA: 8,320	TORA: 6,920
	TODA: 8,320	TODA: 6,920
	ASDA: 8,320	ASDA: 6,920
	LDA: 7,820	LDA: 6,420
Runway 15 Approach Procedures	ILS	LOC only
	RNAV	N/A
	VOR	N/A
Runway 33 Approach Procedures	ILS	Visual only
	RNAV	N/A
	VOR	N/A
Runway 15 NAVAIDs	ILS/DME, MALSR, RVR	LOC/DME, PAPI (temp), RVR

Runway 33 NAVAIDs	ILS/DME, MALSF, PAPI, RVR	MALSF, PAPI, RVR
Taxiway G ADG	IV	IV (N/A between T/W H and R/W 15 end)
Taxiway E ADG	IV	IV
ATCT (hours open)	06:00 – 24:00 local	06:00 – 24:00 local
ARFF Index	D	D
Special Conditions	Air National Guard (ANG) military operations	Military operations relocated to alternate ANG Base
	Airline XYZ requires VGSI	Airline XYZ requires VGSI

Complete the following chart for each phase to determine the area that must be protected along the runway edges:

Runway	**Aircraft Approach Category* A, B, C, or D**	**Airplane Design Group* I, II, III, or IV**	**RSA Width in Feet Divided by 2***
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
*See AC 150/5300-13 to complete the chart for a specific runway.			

Complete the following chart for each phase to determine the area that must be protected before the runway threshold:

Runway End Number	**Airplane Design Group* I, II, III, or IV**	**Aircraft Approach Category* A, B, C, or D**	**Minimum Safety Area Prior to the Threshold***	**Minimum Distance to Threshold Based on Required Approach Slope***	
_____	_____	_____	_____ ft	_____ ft	_____: 1
_____	_____	_____	_____ ft	_____ ft	_____: 1
_____	_____	_____	_____ ft	_____ ft	_____: 1
_____	_____	_____	_____ ft	_____ ft	_____: 1
*See AC 150/5300-13 to complete the chart for a specific runway.					

309. Navigation Aid (NAVAID) Protection. List in this section all NAVAID facilities that will be affected by the construction. Identify NAVAID facilities that will be placed out of service at any time prior to or during construction activities. Identify individuals responsible for coordinating each shutdown and when each facility will be out of service. Include a reference to paragraph 306 above for FAA ATO NAVAID shutdown, restart, and flight inspection coordination. Outline in detail procedures to protect each NAVAID facility remaining in service from interference by construction activities. Include a reference to paragraph 314 for the issuance of NOTAMs as required. Include a reference to paragraph 316 for the protection of underground cables and piping serving NAVAIDs. If temporary visual aids are proposed to replace or supplement existing facilities, include a reference to paragraph 319. Attach drawings to graphically indicate the affected NAVAIDS and the corresponding critical areas.

310. Contractor Access. This will necessarily be the most extensive section of the CSPP. Provide

sufficient detail so that a contractor not experienced in working on airports will understand the unique restrictions such work will require. Due to this extent, it should be broken down into subsections as described below:

a. Location of Stockpiled Construction Materials. Describe in this section specific locations for stockpiling material. Note any height restrictions on stockpiles. Include a reference to paragraph 321 for hazard marking and lighting devices used to identify stockpiles. Include a reference to paragraph 311 for provisions to prevent stockpile material from becoming wildlife attractants. Include a reference to paragraph 312 for provisions to prevent stockpile material from becoming FOD. Attach drawings to graphically indicate the stockpile locations.

b. Vehicle and Pedestrian Operations. While there are many items to be addressed in this major subsection of the CSPP, all are concerned with one main issue: keeping people and vehicles from areas of the airport where they don't belong. This includes preventing unauthorized entry to the AOA and preventing the improper movement of pedestrians or vehicles on the airport. In this section, focus on mechanisms to prevent construction vehicles and workers traveling to and from the worksite from unauthorized entry into movement areas. Specify locations of parking for both employee vehicles and construction equipment, and routes for access and haul roads. In most cases, this will best be accomplished by attaching a drawing. Quote from AC 150/5210-5 specific requirements for contractor vehicles rather than referring to the AC as a whole, and include special requirements for identifying Hazardous Material (HAZMAT) vehicles. Quote from, rather than incorporate by reference, AC 150/5210-20 as appropriate to address the airport's rules for ground vehicle operations, including its training program. Discuss the airport's recordkeeping system listing authorized vehicle operators.

c. Two-Way Radio Communications. Include a special section to identify all individuals who are required to maintain communications with Air Traffic (AT) at airports with active towers, or monitor Common Traffic Advisory Frequencies (CTAF) at airports without or with closed ATCT. Include training requirements for all individuals required to communicate with AT. Individuals required to monitor AT frequencies should also be identified. If construction employees are also required to communicate by radio with Airport Operations, this procedure should be described in detail. Usage of vehicle mounted radios and/or portable radios should be addressed. Communication procedures for the event of disabled radio communication (that is, light signals, telephone numbers, others) must be included. All radio frequencies should by identified (Tower, Ground Control, CTAF, UNICOM, ATIS, and so on).

d. Airport Security. Address security as it applies to vehicle and pedestrian operations. Discuss TSA requirements, security badging requirements, perimeter fence integrity, gate security, and other needs. Attach drawings to graphically indicate secured and/or Security Identification Display Areas (SIDA), perimeter fencing, and available access points.

311. Wildlife Management. Discuss in this section wildlife management procedures. Describe the maintenance of existing wildlife mitigation devices, such as perimeter fences, and procedures to limit wildlife attractants. Include procedures to notify Airport Operations of wildlife encounters. Include a reference to paragraph 310 for security (wildlife) fence integrity maintenance as required.

312. Foreign Object Debris (FOD) Management. In this section, discuss methods to control and monitor FOD: worksite housekeeping, ground vehicle tire inspections, runway sweeps, and so on. Include a reference to paragraph 315 for inspection requirements as required.

313. Hazardous Materials (HAZMAT) Management. Describe in this section HAZMAT management procedures: fuel deliveries, spill recovery procedures, Material Safety Data Sheet (MSDS) availability, and other considerations. Any specific airport HAZMAT restrictions should also be

identified. Include a reference to paragraph 310 for HAZMAT vehicle identification requirements. Quote from, rather than incorporate by reference, AC 150/5320-15.

314. Notification of Construction Activities. List in this section the names and telephone numbers of points of contact for all parties affected by the construction project. We recommend a single list that includes all telephone numbers required under this section. Include emergency notification procedures for all representatives of all parties potentially impacted by the construction. Identify individual representatives – and at least one alternate – for each party. List both on-duty and off-duty contact information for each individual, including individuals responsible for emergency maintenance of airport construction hazard lighting and barricades. Describe procedures to coordinate immediate response to events that might adversely affect the operational safety of the airport (such as interrupted NAVAID service). Explain requirements for and the procedures for the issuance of Notices to Airmen (NOTAMs), notification to FAA required by 14 CFR Part 77 and Part 157 and in the event of affected NAVAIDs. For NOTAMs, identify an individual, and at least one alternate, responsible for issuing and cancelling each specific type of Notice to Airmen (NOTAM) required. Detail notification methods for police, fire fighting, and medical emergencies. This may include 911, but should also include direct phone numbers of local police departments and nearby hospitals. The local Poison Control number should be listed. Procedures regarding notification of Airport Operations and/or the ARFF Department of such emergencies should be identified, as applicable. If airport radio communications are identified as a means of emergency notification, include a reference to paragraph 310. Differentiate between emergency and nonemergency notification of ARFF personnel, the latter including activities that affect ARFF water supplies and access roads. Identify the primary ARFF contact person and at least one alternate. If notification is to be made through Airport Operations, then detail this procedure. Include a method of confirmation from the ARFF department.

315. Inspection Requirements. Describe in this section inspection requirements to ensure airfield safety compliance. Include a requirement for routine inspections by the resident engineer (RE) and the construction contractors. If the engineering consultants and/or contractors have a Safety Officer who will conduct such inspections, identify this individual. Describe procedures for special inspections, such as those required to reopen areas for aircraft operations. Part 139 requires daily airfield inspections at certificated airports, but these may need to be more frequent when construction is in progress. Discuss the role of such inspections on areas under construction. Include a requirement to immediately remedy any deficiencies, whether caused by negligence, oversight, or project scope change.

316. Underground Utilities. Explain how existing underground utilities will be located and protected. Identify each utility owner and include contact information for each company/agency in the master list. Address emergency response procedures for damaged or disrupted utilities. Include a reference to paragraph 314 above for notification of utility owners of accidental utility disruption as required.

317. Penalties. Describe in this section specific penalties imposed for noncompliance with airport rules and regulations, including the CSPP: SIDA violations, Vehicle/Pedestrian Deviations (VPD), and others.

318. Special Conditions. Identify any special conditions that may trigger specific safety mitigation actions outlined in this CSPP: low visibility operations, snow removal, aircraft in distress, aircraft accident, security breach, VPD, and other activities requiring construction suspension/resumption. Include a reference to paragraph 310 above for compliance with airport safety and security measures and for radio communications as required. Include a reference to paragraph 319 below for emergency notification of all involved parties, including police/security, ARFF, and medical services.

319. Runway and Taxiway Visual Aids. Include marking, lighting, signs, and visual NAVAIDS.

Detail temporary runway and taxiway marking, lighting, signs, and visual NAVAIDs required for the construction. Discuss existing marking, lighting, signs, and visual NAVAIDs that are temporarily, altered, obliterated, or shut down. Consider non-federal facilities and address requirements for reimbursable agreements necessary for alteration of FAA facilities and for necessary flight checks. Identify temporary TORA signs or runway distance remaining signs if appropriate. Identify required temporary visual NAVAIDs such as REIL or PAPI. Quote from, rather than incorporate by reference, AC 150/5340-1, Standards for Airport Markings, AC 150/5340-18, Standards for Airport Sign Systems, and AC 150/5340-30, as required. Attach drawings to graphically indicate proposed marking, lighting, signs, and visual NAVAIDs.

320. Marking and Signs for Access Routes. Detail plans for marking and signs for vehicle access routes. To the extent possible, signs should be in conformance with the Federal Highway Administration Manual on Uniform Traffic Control Devices (MUTCD) and/or State highway specifications, not hand lettered. Detail any modifications to the guidance in the MUTCD necessary to meet frangibility/height requirements.

321. Hazard Marking and Lighting. Specify all marking and lighting equipment, including when and where each type of device is to be used. Specify maximum gaps between barricades and the maximum spacing of hazard lighting. Identify one individual and at least one alternate responsible for maintenance of hazard marking and lighting equipment in the master telephone list. Include a reference to paragraph 314 above. Attach drawings to graphically indicate the placement of hazard marking and lighting equipment.

322. Protection of Runway and Taxiway Safety Areas. This section should focus exclusively on procedures for protecting all safety areas, including those altered by the construction: methods of demarcation, limit of access, movement within safety areas, stockpiling and trenching restrictions, and so on. Reference AC 150/5300-13: Airport Design as required. Include a reference to paragraph 310 above for procedures regarding vehicle and personnel movement within safety areas. Include a reference to paragraph 310 above for material stockpile restrictions as required. Detail requirements for trenching, excavations, and backfill. Include a reference to paragraph 321 for hazard marking and lighting devices used to identify open excavations as required. If runway and taxiway closures are proposed to protect safety areas, or if temporary displaced thresholds and/or revised declared distances are used to provide adequate Runway Safety Area, include a reference to paragraphs 314 and 319 above. Detail procedures for protecting the runway OFZ, runway OFA, taxiway OFA and runway approach surfaces including those altered by the construction: methods of demarcation, limit of cranes, storage of equipment, and so on. Quote from, rather than incorporate by reference, AC 150/5300-13: Airport Design as required. Include a reference to paragraph 323 for height (i.e. crane) restrictions as required. One way to address the height of equipment that will move during the project is to establish a three-dimensional “box” within which equipment will be confined that can be studied as a single object. Attach drawings to graphically indicate the safety area, OFZ, and OFA boundaries.

323. Other Limitations on Construction. This section should describe what limitations must be applied to each area of work and when each limitation will be applied: limitations due to airport operations, height (i.e. crane) restrictions, areas which cannot be worked at simultaneously, day/night work restrictions, winter construction, and other limitations. Include a reference to paragraph 307 above for project phasing requirements based on construction limitations as required.

Appendix 1. Related Reading Material

Obtain the latest version of the following free publications from the FAA on its Web site at http://www.faa.gov/airports/.

AC	Title and Description
AC 150/5200-28	Notices to Airmen (NOTAMs) for Airport Operators
	Guidance for using the NOTAM System in airport reporting.
AC 150/5200-30	Airport Winter Safety and Operations
	Guidance for airport owners/operators on the development of an acceptable airport snow and ice control program and on appropriate field condition reporting procedures.
AC 150/5200-33	Hazardous Wildlife Attractants On or Near Airports
	Guidance on locating certain land uses that might attract hazardous wildlife to public-use airports.
AC 150/5210-5	Painting, Marking, and Lighting of Vehicles Used on an Airport.
	Guidance, specifications, and standards for painting, marking, and lighting vehicles operating in the airport air operations areas.
AC 150/5210-20	Ground Vehicle Operations on Airports
	Guidance to airport operators on developing ground vehicle operation training programs.
AC 150/5300-13	Airport Design
	FAA standards and recommendations for airport design, establishes approach visibility minimums as an airport design parameter, and contains the Object Free area and the obstacle free-zone criteria.
AC 150/5310-24	Airport Foreign Object Debris Management
	Guidance for developing and managing an airport foreign object debris (FOD) program
AC 150/5220-4	Water Supply Systems for Aircraft Fire and Rescue Protection.
	Guidance on selecting a water source and meeting standards for a distribution system to support aircraft rescue and fire fighting service operations on airports.
AC 150/5320-15	Management of Airport Industrial Waste
	Basic information on the characteristics, management, and regulations of industrial wastes generated at airports. Guidance for developing a Storm Water Pollution Prevention Plan (SWPPP) that applies best management practices to eliminate, prevent, or reduce pollutants in storm water runoff with particular airport industrial activities.
AC 150/5340-1	Standards for Airport Markings
	FAA standards for markings used on airport runways, taxiways, and aprons.
AC 150/5340-18	Standards for Airport Sign Systems
	FAA standards for the siting and installation of signs on airport runways and taxiways.
AC 150/5345-28	Precision Approach Path Indicator (PAPI) Systems
	FAA standards for PAPI systems, which provide pilots with visual glide slope guidance during approach for landing.

AC	Title and Description
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
	Guidance and recommendations on the installation of airport visual aids.
AC 150/5345-39	Specification for L-853, Runway and Taxiway Retroreflective Markers
AC 150/5345-44	Specification for Runway and Taxiway Signs
	FAA specifications for unlighted and lighted signs for taxiways and runways.
AC 150/5345-53	Airport Lighting Certification Program
	Details on the Airport Lighting Equipment Certification Program (ALECP).
AC 150/5345-50	Specification for Portable Runway and Taxiway Lights
	FAA standards for portable runway and taxiway lights and runway end identifier lights for temporary use to permit continued aircraft operations while all or part of a runway lighting system is inoperative.
AC 150/5345-55	Specification for L-893, Lighted Visual Aid to Indicate Temporary Runway Closure
AC 150/5370-10	Standards for Specifying Construction of Airports
	Standards for construction of airports, including earthwork, drainage, paving, turfing, lighting, and incidental construction.
FAA Order 5200.11	FAA Airports (ARP) Safety Management System (SMS)
	Basics for implementing SMS within ARP. Includes roles and responsibilities of ARP management and staff as well as other FAA lines of business that contribute to the ARP SMS.
FAA Certalert 98-05	Grasses Attractive to Hazardous Wildlife
	Guidance on grass management and seed selection.
FAA Form 7460-1	Notice of Proposed Construction or Alteration
FAA Form 7480-1	Notice of Landing Area Proposal

Obtain the latest version of the following free publications from the Electronic Code of Federal Regulations at http://ecfr.gpoaccess.gov/.

Title 14 CFR Part 139	Certification of Airports
Title 49 CFR Part 1542	Airport Security

Obtain the latest version of the Manual on Uniform Traffic Control Devices from the Federal Highway Administration at http://mutcd.fhwa.dot.gov/.

Appendix 2. Definition of Terms

Term	Definition
7460-1	Notice Of Proposed Construction Or Alteration. For on-airport projects, the form submitted to the FAA regional or airports division office as formal written notification of any kind of construction or alteration of objects that affect navigable airspace, as defined in 14 CFR Part 77, safe, efficient use, and preservation of the navigable airspace. (See guidance available on the FAA web site at oeaaa.faa.gov.) The form may be downloaded at http://www.faa.gov/airports/resources/forms/, or filed electronically at: https://oeaaa.faa.gov.
7480-1	Notice Of Landing Area Proposal. Form submitted to the FAA Airports Regional Division Office or Airports District Office as formal written notification whenever a project without an airport layout plan on file with the FAA involves the construction of a new airport; the construction, realigning, altering, activating, or abandoning of a runway, landing strip, or associated taxiway; or the deactivation or abandoning of an entire airport The form may be downloaded at http://www.faa.gov/airports/resources/forms/.
AC	Advisory Circular
ACRC	Aircraft Reference Code
ACSI	Airport Certification Safety Inspector
ADG	Airplane Design Group
AIP	Airport Improvement Program
ALECP	Airport Lighting Equipment Certification Program
ANG	Air National Guard
AOA	Air Operations Area. Any area of the airport used or intended to be used for the landing, takeoff, or surface maneuvering of aircraft. An air operations area includes such paved or unpaved areas that are used or intended to be used for the unobstructed movement of aircraft in addition to its associated runways, taxiways, or aprons.
ARFF	Aircraft Rescue and Fire Fighting
ARP	FAA Office of Airports
ASDA	Accelerate-Stop Distance Available
ATCT	Airport Traffic Control Tower
ATIS	Automatic Terminal Information Service
ATO	Air Traffic Organization
Certificated Airport	An airport that has been issued an Airport Operating Certificate by the FAA under the authority of 14 CFR Part 139, Certification of Airports.
CFR	Code of Federal Regulations
Construction	The presence and movement of construction-related personnel, equipment, and materials in any location that could infringe upon the movement of aircraft.
CSPP	Construction Safety And Phasing Plan. The overall plan for safety and phasing of a construction project developed by the airport operator, or developed by the airport operator's consultant and approved by the airport operator. It is included in the invitation for bids and becomes part of the project specifications.

Term	Definition
CTAF	Common Traffic Advisory Frequency
Displaced Threshold	A threshold that is located at a point on the runway other than the designated beginning of the runway. The portion of pavement behind a displaced threshold is available for takeoffs in either direction or landing from the opposite direction.
DOT	Department of Transportation
EPA	Environmental Protection Agency
FOD	Foreign Object Debris
HAZMAT	Hazardous Materials
IFR	Instrument Flight Rules
ILS	Instrument Landing System
LDA	Landing Distance Available
LOC	Localizer antenna array
Movement Area	The runways, taxiways, and other areas of an airport that are used for taxiing or hover taxiing, air taxiing, takeoff, and landing of aircraft, exclusive of loading aprons and aircraft parking areas (reference 14 CFR Part 139).
MSDS	Material Safety Data Sheet
MUTCD	Manual on Uniform Traffic Control Devices
NAVAID	Navigation Aid
NAVAID Critical Area	An area of defined shape and size associated with a NAVAID that must remain clear and graded to avoid interference with the electronic signal.
Non-Movement Area	The area inside the airport security fence exclusive of the Movement Area. It is important to note that the non-movement area includes pavement traversed by aircraft.
NOTAM	Notices to Airmen
Obstruction	Any object/obstacle exceeding the obstruction standards specified by 14 CFR Part 77, subpart C.
OE / AAA	Obstruction Evaluation / Airport Airspace Analysis
OFA	Object Free Area. An area on the ground centered on the runway, taxiway, or taxi lane centerline provided to enhance safety of aircraft operations by having the area free of objects except for those objects that need to be located in the OFA for air navigation or aircraft ground maneuvering purposes. (See AC 150/5300-13, for additional guidance on OFA standards and wingtip clearance criteria.)
OFZ	Obstacle Free Zone. The airspace below 150 ft (45 m) above the established airport elevation and along the runway and extended runway centerline that is required to be clear of all objects, except for frangible visual NAVAIDs that need to be located in the OFZ because of their function, in order to provide clearance protection for aircraft landing or taking off from the runway and for missed approaches. The OFZ is subdivided as follows: Runway OFZ, Inner Approach OFZ, Inner Transitional OFZ, and Precision OFZ. Refer to AC 150/5300-13 for guidance on OFZ.
OSHA	Occupational Safety and Health Administration
P&R	Planning and Requirements Group

Term	Definition
PAPI	Precision Approach Path Indicators
PFC	Passenger Facility Charge
PLASI	Pulse Light Approach Slope Indicators
Project Proposal Summary	A clear and concise description of the proposed project or change that is the object of Safety Risk Management.
RE	Resident Engineer
REIL	Runway End Identifier Lights
RNAV	Area Navigation
ROFA	Runway Object Free Area
RSA	Runway Safety Area. A defined surface surrounding the runway prepared or suitable for reducing the risk of damage to airplanes in the event of an undershoot, overshoot, or excursion from the runway, in accordance with AC 150/5300-13.
SIDA	Security Identification Display Area
SMS	Safety Management System
SPCD	Safety Plan Compliance Document. Details developed and submitted by a contractor to the airport operator for approval providing details on how the performance of a construction project will comply with the CSPP.
SRM	Safety Risk Management
Taxiway Safety Area	A defined surface alongside the taxiway prepared or suitable for reducing the risk of damage to an airplane unintentionally departing the taxiway, in accordance with AC 150/5300-13.
TDG	Taxiway Design Group
Temporary	Any condition that is not intended to be permanent.
Temporary Runway End	The beginning of that portion of the runway available for landing and taking off in one direction, and for landing in the other direction. Note the difference from a displaced threshold.
Threshold	The beginning of that portion of the runway available for landing. In some instances, the landing threshold may be displaced.
TODA	Takeoff Distance Available
TOFA	Taxiway Object Free Area
TORA	Takeoff Run Available. The length of the runway less any length of runway unavailable and/or unsuitable for takeoff run computations. See AC 150/5300-13 for guidance on declared distances.
TSA	Taxiway Safety Area Transportation Security Administration
UNICOM	A radio communications system of a type used at small airports.
VASI	Visual Approach Slope Indicators

Term	Definition
VGSI	Visual Glide Slope Indicator. A device that provides a visual glide slope indicator to landing pilots. These systems include precision approach path indicators (PAPI), visual approach slope indicators (VASI), and pulse light approach slope indicators (PLASI).
VFR	Visual Flight Rules
VOR	VHF Omnidirectional Radio Range
VPD	Vehicle / Pedestrian Deviation

Appendix 3. Safety and Phasing Plan Checklist

This appendix is keyed to Section 2. Plan Requirements. In the electronic version of this AC, clicking on the paragraph designation in the Reference column will access the applicable paragraph. There may be instances where the CSPP requires provisions that are not covered by the list in this appendix.

This checklist is intended as an aid, not as a required submittal.

Coordination	Reference	Addressed			Remarks
General Considerations					
Requirements for predesign, prebid, and preconstruction conferences to introduce the subject of airport operational safety during construction are specified.	205	☐ Yes	☐ No	☐ NA	
Operational safety is a standing agenda item for construction progress meetings.	205	☐ Yes	☐ No	☐ NA	
Scheduling of the construction phases is properly addressed.	206	☐ Yes	☐ No	☐ NA	
Areas and Operations Affected by Construction Activity					
Drawings showing affected areas are included.	207.a	☐ Yes	☐ No	☐ NA	
Closed or partially closed runways, taxiways, and aprons are depicted on drawings.	207.a(1)	☐ Yes	☐ No	☐ NA	
Access routes used by ARFF vehicles affected by the project are addressed.	207.a(2)	☐ Yes	☐ No	☐ NA	
Access routes used by airport and airline support vehicles affected by the project are addressed.	207.a(3)	☐ Yes	☐ No	☐ NA	
Underground utilities, including water supplies for fire fighting and drainage.	207.a(4)	☐ Yes	☐ No	☐ NA	
Approach/departure surfaces affected by heights of temporary objects are addressed.	207.a(5)	☐ Yes	☐ No	☐ NA	
Construction areas, storage areas, and access routes near runways, taxiways, aprons, or helipads are properly depicted on drawings.	207.a	☐ Yes	☐ No	☐ NA	
Temporary changes to taxi operations are addressed.	207.b(1)	☐ Yes	☐ No	☐ NA	

Coordination	Reference	Addressed			Remarks
Detours for ARFF and other airport vehicles are identified.	207.b(2)	☐ Yes	☐ No	☐ NA	
Maintenance of essential utilities and underground infrastructure is addressed.	207.b(3)	☐ Yes	☐ No	☐ NA	
Temporary changes to air traffic control procedures are addressed.	207.b(4)	☐ Yes	☐ No	☐ NA	
NAVAIDS					
Critical areas for NAVAIDs are depicted on drawings.	208	☐ Yes	☐ No	☐ NA	
Effects of construction activity on the performance of NAVAIDS, including unanticipated power outages, are addressed.	208	☐ Yes	☐ No	☐ NA	
Protection of NAVAID facilities is addressed.	208	☐ Yes	☐ No	☐ NA	
The required distance and direction from each NAVAID to any construction activity is depicted on drawings.	208	☐ Yes	☐ No	☐ NA	
Procedures for coordination with FAA ATO/Technical Operations, including identification of points of contact, are included.	208, 213.a, 213.e(3)(a), 218.a	☐ Yes	☐ No	☐ NA	
Contractor Access					
The CSPP addresses areas to which contractor will have access and how the areas will be accessed.	209	☐ Yes	☐ No	☐ NA	
The application of 49 CFR Part 1542 Airport Security, where appropriate, is addressed.	209	☐ Yes	☐ No	☐ NA	
The location of stockpiled construction materials is depicted on drawings.	209.a	☐ Yes	☐ No	☐ NA	
The requirement for stockpiles in the ROFA to be approved by FAA is included.	209.a	☐ Yes	☐ No	☐ NA	
Requirements for proper stockpiling of materials are included.	209.a	☐ Yes	☐ No	☐ NA	

Coordination	Reference	Addressed			Remarks
Construction site parking is addressed.	209.b(1)	☐ Yes	☐ No	☐ NA	
Construction equipment parking is addressed.	209.b(2)	☐ Yes	☐ No	☐ NA	
Access and haul roads are addressed.	209.b(3)	☐ Yes	☐ No	☐ NA	
A requirement for marking and lighting of vehicles to comply with AC 150/5210-5, Painting, Marking and Lighting of Vehicles Used on an Airport, is included.	209.b(4)	☐ Yes	☐ No	☐ NA	
Proper vehicle operations, including requirements for escorts, are described.	209.b(5), 209.b(6)	☐ Yes	☐ No	☐ NA	
Training requirements for vehicle drivers are addressed.	209.b(7)	☐ Yes	☐ No	☐ NA	
Two-way radio communications procedures are described.	209.b(9)	☐ Yes	☐ No	☐ NA	
Maintenance of the secured area of the airport is addressed.	209.b(10)	☐ Yes	☐ No	☐ NA	
Wildlife Management					
The airport operator's wildlife management procedures are addressed.	210	☐ Yes	☐ No	☐ NA	
Foreign Object Debris Management					
The airport operator's FOD management procedures are addressed.	211	☐ Yes	☐ No	☐ NA	
Hazardous Materials Management					
The airport operator's hazardous materials management procedures are addressed.	212	☐ Yes	☐ No	☐ NA	
Notification of Construction Activities					
Procedures for the immediate notification of airport user and local FAA of any conditions adversely affecting the operational safety of the airport are detailed.	213	☐ Yes	☐ No	☐ NA	

Coordination	Reference	Addressed			Remarks
Maintenance of a list by the airport operator of the responsible representatives/points of contact for all involved parties and procedures for contacting them 24 hours a day, seven days a week is specified.	213.a	☐ Yes	☐ No	☐ NA	
A list of local ATO/Technical Operations personnel is included.	213.a	☐ Yes	☐ No	☐ NA	
A list of ATCT managers on duty is included.	213.a	☐ Yes	☐ No	☐ NA	
A list of authorized representatives to the OCC is included.	213.b	☐ Yes	☐ No	☐ NA	
Procedures for coordinating, issuing, maintaining and cancelling by the airport operator of NOTAMS about airport conditions resulting from construction are included.	208, 213.b, 218.b(4)(i)	☐ Yes	☐ No	☐ NA	
Provision of information on closed or hazardous conditions on airport movement areas by the airport operator to the OCC is specified.	213.b	☐ Yes	☐ No	☐ NA	
Emergency notification procedures for medical, fire fighting, and police response are addressed.	213.c	☐ Yes	☐ No	☐ NA	
Coordination with ARFF personnel for non-emergency issues is addressed.	213.d	☐ Yes	☐ No	☐ NA	
Notification to the FAA under 14 CFR parts 77 and 157 is addressed.	213.e	☐ Yes	☐ No	☐ NA	
Reimbursable agreements for flight checks and/or design and construction for FAA owned NAVAIDs are addressed.	213.e(3)(b)	☐ Yes	☐ No	☐ NA	
Inspection Requirements					
Daily inspections by both the airport operator and contractor are specified.	214.a	☐ Yes	☐ No	☐ NA	
Final inspections at certificated airports are specified when required.	214.b	☐ Yes	☐ No	☐ NA	
Underground Utilities					
Procedures for protecting existing underground facilities in excavation areas are described.	215	☐ Yes	☐ No	☐ NA	

Coordination	Reference	Addressed			Remarks
Penalties					
Penalty provisions for noncompliance with airport rules and regulations and the safety plans are detailed.	216	☐ Yes	☐ No	☐ NA	
Special Conditions					
Any special conditions that affect the operation of the airport or require the activation of any special procedures are addressed.	217	☐ Yes	☐ No	☐ NA	
Runway and Taxiway Visual Aids - Marking, Lighting, Signs, and Visual NAVAIDs					
The proper securing of temporary airport markings, lighting, signs, and visual NAVAIDs is addressed.	218.a	☐ Yes	☐ No	☐ NA	
Frangibility of airport markings, lighting, signs, and visual NAVAIDs is specified.	218.a, 218.c, 219, 220.b(4)	☐ Yes	☐ No	☐ NA	
The requirement for markings to be in compliance with AC 150/5340-1, Standards for Airport Markings is specified.	218.b	☐ Yes	☐ No	☐ NA	
The requirement for lighting to conform to AC 150/5340-30, Design and Installation Details for Airport Visual Aids, AC 150/5345-50, Specification for Portable Runway and Taxiway Lights , and AC 150/5345-53 Airport Lighting Certification Program, is specified.	218.b(1)(f)	☐ Yes	☐ No	☐ NA	
The use of a lighted X is specified where appropriate.	218.b(1)(b), 218.b(3)	☐ Yes	☐ No	☐ NA	
The requirement for signs to conform to AC 150/5345-44, Specification for Runway and Taxiway Signs, AC 50/5340-18, Standards for Airport Sign Systems, and AC 150/5345-53, Airport Lighting Certification Program, is specified.	218.c	☐ Yes	☐ No	☐ NA	
Marking and Signs For Access Routes					
The CSPP specifies that pavement markings and signs intended for construction personnel should conform to AC 150/5340-18 and, to the extent practicable, with the MUTCD and/or State highway specifications.	219	☐ Yes	☐ No	☐ NA	
Hazard Marking and Lighting					
Prominent, comprehensible warning indicators for any area affected by construction that is normally accessible to aircraft, personnel, or vehicles are specified.	220.a	☐ Yes	☐ No	☐ NA	

Coordination	Reference	Addressed			Remarks
Hazard marking and lighting are specified to identify open manholes, small areas under repair, stockpiled material, and waste areas.	220.a	☐ Yes	☐ No	☐ NA	
The CSPP considers less obvious construction-related hazards.	220.a	☐ Yes	☐ No	☐ NA	
Equipment that poses the least danger to aircraft but is sturdy enough to remain in place when subjected to typical winds, prop wash and jet blast is specified.	220.b(1)	☐ Yes	☐ No	☐ NA	
The spacing of barricades is specified such that a breach is physically prevented barring a deliberate act.	220.b(1)	☐ Yes	☐ No	☐ NA	
Red lights meeting the luminance requirements of the State Highway Department are specified.	220.b(2)	☐ Yes	☐ No	☐ NA	
Barricades, temporary markers, and other objects placed and left in areas adjacent to any open runway, taxiway, taxi lane, or apron are specified to be as low as possible to the ground, and no more than 18 in high.	220.b(4)	☐ Yes	☐ No	☐ NA	
Barricades marked with diagonal, alternating orange and white stripes are specified to indicate construction locations in which no part of an aircraft may enter.	220.b(4)	☐ Yes	☐ No	☐ NA	
Highly reflective barriers with lights are specified to barricade taxiways leading to closed runways.	220.b(5)	☐ Yes	☐ No	☐ NA	
Markings for temporary closures are specified.	220.b(5)	☐ Yes	☐ No	☐ NA	
The provision of a contractor's representative on call 24 hours a day for emergency maintenance of airport hazard lighting and barricades is specified.	220.b(7)	☐ Yes	☐ No	☐ NA	
Protection of Runway and Taxiway Safety Areas					
The CSPP clearly states that no construction may occur within a safety area while the associated runway or taxiway is open for aircraft operations.	221.a(1), 221.c(1)	☐ Yes	☐ No	☐ NA	
The CSPP specifies that the airport operator coordinates the adjustment of RSA or TSA dimensions with the ATCT and the appropriate FAA Airports Regional or District Office and issues a local NOTAM.	221.a(2), 221.c(2)	☐ Yes	☐ No	☐ NA	

Coordination	Reference	Addressed			Remarks
Procedures for ensuring adequate distance for protection from blasting operations, if required by operational considerations, are detailed.	221.c(3)	☐ Yes	☐ No	☐ NA	
The CSPP specifies that open trenches or excavations are not permitted within a safety area while the associated runway or taxiway is open.	221.a(4)	☐ Yes	☐ No	☐ NA	
Appropriate covering of excavations in the RSA or TSA that cannot be backfilled before the associated runway or taxiway is open is detailed.	221.a(4)	☐ Yes	☐ No	☐ NA	
The CSPP includes provisions for prominent marking of open trenches and excavations at the construction site.	221.a(4)	☐ Yes	☐ No	☐ NA	
Grading and soil erosion control to maintain RSA/TSA standards are addressed.	221.c(5)	☐ Yes	☐ No	☐ NA	
The CSPP specifies that equipment is to be removed from the ROFA when not in use.	221.b	☐ Yes	☐ No	☐ NA	
The CSPP clearly states that no construction may occur within a taxiway safety area while the taxiway is open for aircraft operations.	221.c	☐ Yes	☐ No	☐ NA	
Appropriate details are specified for any construction work to be accomplished in a taxiway object free area.	221.d	☐ Yes	☐ No	☐ NA	
Measures to ensure that personnel, material, and/or equipment do not penetrate the OFZ or threshold siting surfaces while the runway is open for aircraft operations are included.	221.e	☐ Yes	☐ No	☐ NA	
Provisions for protection of runway approach/departure areas and clearways are included.	221.f	☐ Yes	☐ No	☐ NA	
Other Limitations on Construction					
The CSPP prohibits the use of open flame welding or torches unless adequate fire safety precautions are provided and the airport operator has approved their use.	222.a(2)	☐ Yes	☐ No	☐ NA	
The CSPP prohibits the use of flare pots within the AOA at any time.	222.a(4)	☐ Yes	☐ No	☐ NA	
The CSPP prohibits the use of electrical blasting caps on or within 1,000 ft (300 m) of the airport property.	222.a(3)	☐ Yes	☐ No	☐ NA	

Appendix 4. Construction Project Daily Safety Inspection Checklist

The situations identified below are potentially hazardous conditions that may occur during airport construction projects. Safety area encroachments, unauthorized and improper ground vehicle operations, and unmarked or uncovered holes and trenches near aircraft operating surfaces pose the most prevalent threats to airport operational safety during airport construction projects. The list below is one tool that the airport operator or contractor may use to aid in identifying and correcting potentially hazardous conditions. It should be customized as appropriate for each project.

Potentially Hazardous Conditions

Item	Action Required	or	None
Excavation adjacent to runways, taxiways, and aprons improperly backfilled.			☐
Mounds of earth, construction materials, temporary structures, and other obstacles near any open runway, taxiway, or taxi lane; in the related Object Free area and aircraft approach or departure areas/zones; or obstructing any sign or marking.			☐
Runway resurfacing projects resulting in lips exceeding 3 in (7.6 cm) from pavement edges and ends.			☐
Heavy equipment (stationary or mobile) operating or idle near AOA, in runway approaches and departures areas, or in OFZ.			☐
Equipment or material near NAVAIDs that may degrade or impair radiated signals and/or the monitoring of navigation and visual aids. Unauthorized or improper vehicle operations in localizer or glide slope critical areas, resulting in electronic interference and/or facility shutdown.			☐
Tall and especially relatively low visibility units (that is, equipment with slim profiles) — cranes, drills, and similar objects — located in critical areas, such as OFZ and approach zones.			☐
Improperly positioned or malfunctioning lights or unlighted airport hazards, such as holes or excavations, on any apron, open taxiway, or open taxi lane or in a related safety, approach, or departure area.			☐
Obstacles, loose pavement, trash, and other debris on or near AOA. Construction debris (gravel, sand, mud, paving materials) on airport pavements may result in aircraft propeller, turbine engine, or tire damage. Also, loose materials may blow about, potentially causing personal injury or equipment damage.			☐

Item	Action Required	or	None
Inappropriate or poorly maintained fencing during construction intended to deter human and animal intrusions into the AOA. Fencing and other markings that are inadequate to separate construction areas from open AOA create aviation hazards.			☐
Improper or inadequate marking or lighting of runways (especially thresholds that have been displaced or runways that have been closed) and taxiways that could cause pilot confusion and provide a potential for a runway incursion. Inadequate or improper methods of marking, barricading, and lighting of temporarily closed portions of AOA create aviation hazards.			☐
Wildlife attractants — such as trash (food scraps not collected from construction personnel activity), grass seeds, tall grass, or standing water — on or near airports.			☐
Obliterated or faded temporary markings on active operational areas.			☐
Misleading or malfunctioning obstruction lights. Unlighted or unmarked obstructions in the approach to any open runway pose aviation hazards.			☐
Failure to issue, update, or cancel NOTAMs about airport or runway closures or other construction related airport conditions.			☐
Failure to mark and identify utilities or power cables. Damage to utilities and power cables during construction activity can result in the loss of runway / taxiway lighting; loss of navigation, visual, or approach aids; disruption of weather reporting services; and/or loss of communications.			☐
Restrictions on ARFF access from fire stations to the runway / taxiway system or airport buildings.			☐
Lack of radio communications with construction vehicles in airport movement areas.			☐
Objects, regardless of whether they are marked or flagged, or activities anywhere on or near an airport that could be distracting, confusing, or alarming to pilots during aircraft operations.			☐
Water, snow, dirt, debris, or other contaminants that temporarily obscure or derogate the visibility of runway/taxiway marking, lighting, and pavement edges. Any condition or factor that obscures or diminishes the visibility of areas under construction.			☐
Spillage from vehicles (gasoline, diesel fuel, oil) on active pavement areas, such as runways, taxiways, aprons, and airport roadways.			☐

Item	Action Required	or	None
Failure to maintain drainage system integrity during construction (for example, no temporary drainage provided when working on a drainage system).			☐
Failure to provide for proper electrical lockout and tagging procedures. At larger airports with multiple maintenance shifts/workers, construction contractors should make provisions for coordinating work on circuits.			☐
Failure to control dust. Consider limiting the amount of area from which the contractor is allowed to strip turf.			☐
Exposed wiring that creates an electrocution or fire ignition hazard. Identify and secure wiring, and place it in conduit or bury it.			☐
Site burning, which can cause possible obscuration.			☐
Construction work taking place outside of designated work areas and out of phase.			☐

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ATTACHMENT C

AC 150/5345-53D
AIRPORT LIGHTING EQUIPMENT CERTIFICATION, APPENDIX 1 ADDENDUM

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APPENDIX 1. THIRD PARTY CERTIFICATION BODIES.

The following Third Party Certification Bodies (Third Party Certifiers) have met the requirements contained in ADVISORY CIRCULAR 150/5345-53D, AIRPORT LIGHTING EQUIPMENT CERTIFICATIO PROGRAM, dated 9/26/12 and have been accepted as Third Party Certifiers under the Airport Lighting Equipment Certification Program.

Intertek Testing Services
(Formerly ETL Testing Laboratories, Inc.)
3933 U.S. Route 11
Cortland, New York 13045
(607) 753-6711 or (800) 345-3851

THIS LISTING CONTAINS A COMPLETE UPDATE OF THE CERTIFIED EQUIPMENT AND MANUFACTURERS LISTS, ADDENDUM TO APPENDIX 3 AND APPENDIX 4, OF ADVISORY CIRCULAR 150/5345-53D, AIRPORTING LIGHTING EQUIPMENT CERTIFICATION PROGRAM, DATED 09/26/12. EQUIPMENT NOT LISTED HERE, BUT LISTED IN PRIOR ADDENDUMS TO THE ADVISORY CIRCULAR HAVE BEEN DELETED.

Users should consult equipment manufacturers' catalogs or literature for complete ordering. For each lighting fixture listed in the addendum, the number in parentheses () after the manufacturer's catalog number indicates the specific lamp used in certification of the equipment. The (L), in parentheses (), the last letter after the L-number designation indicated a LED lamp required for the listed manufacturer part numbers.

MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
L-801 / L-802 Medium and High Intensity Beacons (FAA AC 150/5345-12E)							
HALI-BRITE INC.	L-801A	1					L801A1116 (410)
HALI-BRITE INC.	L-801A	2					L801A1216 (410)
HALI-BRITE INC.	L-801H	1					L801H7116 (410)
HALI-BRITE INC.	L-801H	2					L801H7216 (410)
L-801 / L-802 Medium and High Intensity Beacons (FAA AC 150/5345-12F)							
MANAIRCO, INC.	L-801A	1					AB-1000D(88); AB-1000F (88)
MANAIRCO, INC.	L-801A	2					AB-1000DA(88); AB-1000FA (88)
HALI-BRITE INC.	L-802H	1					L801H7116 (410)
HALI-BRITE INC.	L-802H	2					L801H7216 (410)
HALI-BRITE INC.	L-802M	1					L802M6116 (629)
HALI-BRITE INC.	L-802M	2					L802M6216 (629)
HALI-BRITE INC.	L-802A	1					L802A6116 (208); L802A6125 (208)
HALI-BRITE INC.	L-802A	2					L802A6216 (208); L802A6225 (208)
L-804 Runway Guard Lights (FAA AC 150/5345-46D)							
AIRPORT LIGHTING COMPANY	L-804 (L)			1			RGL-X-M-S (518)
AIRPORT LIGHTING COMPANY	L-804 (L)			2			RGL-X-M-S (518)
ASTRONICS DME CORPORATION	L-804 (L)			1			L804-L-1-1-1-0 (669)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-804 (L)			1			804E4-066-X (639)
L-804 Runway Guard Lights (FAA AC 150/5345-46E)							
ADB SAFEGATE AMERICAS, LLC	L-804 (L)			1			ERGL-1111X; ERGL-3111X (599)
ADB SAFEGATE AMERICAS, LLC	L-804 (L)			2			ERGL-5112X; ERGL-6112X (599)
ADB SAFEGATE AMERICAS, LLC	L-804			1			44A4744-1X11 (667)
ADB SAFEGATE AMERICAS, LLC	L-804			2			44A4744-2X12 (667); 44A4744-3X12 (667)
L-806/L-807 Wind Cones (FAA AC 150/5345-27E)							
HALI-BRITE INC.	L-806		IA		1		L806-S1-EX-120-ON-N (226)
HALI-BRITE INC.	L-806		IB		1		L806-S1-IN-120-ON-5 (601)
HALI-BRITE INC.	L-806		II		1		L806-S1-UN-NON-ON-N
HALI-BRITE INC.	L-806(L)		IA		1		L806-S1-EX-120-ON-5 (427); L806-S1-EX-66A-ON-5 (429); L806-S1-EX-12-ON-5 (428)

Any runway fixture listed above that uses a LED lighting source may not be compatible with Enhanced Flight Vision Systems that use IR energy emissions for imaging.
(L) Indicates LED fixture. IR element present is not tested nor certified under this program as to compatible with any night vision equipment.

MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
HALI-BRITE INC.	L-806(L)		IB		1		L806-S1-IN-66A-ON-5 (602)
POINT LIGHTING CORPORATION	L-806(L)		IA		1		PWC-8061L-1-ON-LF (632)
POINT LIGHTING CORPORATION	L-806		II		1		PWC-8061U-0-ON
HALI-BRITE INC.	L-807		IA		1		L-807-S1-EX-120-ON-N(226)
HALI-BRITE INC.	L-807		II		1		L-807-S1-UN-NON-ON-N
HALI-BRITE INC.	L-807(L)		IA		1		L-807-S1-EX-120-ON-5(427); L-807-S1-EX-12-ON-5(428); L-807-S1-EX-66A-ON-5(429)
HALI-BRITE INC.	L-807(L)		IB		1		L-807-S1-IN-120-ON-5(601); L-807-S1-IN-66A-ON-5(602)
HALI-BRITE INC.	L-807		IA		2		L-807-S2-EX-120-ON-N(226)
HALI-BRITE INC.	L-807		IB		2		L-807-S2-IN-120-ON-N(434)
HALI-BRITE INC.	L-807		II		2		L-807-S2-UN-NON-ON-N
HALI-BRITE INC.	L-807(L)		IA		2		L-807-S2-EX-120-ON-5(430); L-807-S2-EX-12-ON-5(431); L-807-S2-EX-66A-ON-5(432)
HALI-BRITE INC.	L-807(L)		IB		2		L-807-S2-IN-66A-ON-3(423); L-807-S2-IN-120-ON-5(443); L-807-S2-IN-120-ON-N(650)
POINT LIGHTING CORPORATION	L-807		II		1		PWC-8071U-0-ON
POINT LIGHTING CORPORATION	L-807		II		2		PWC-8072U-0-ON
POINT LIGHTING CORPORATION	L-807(L)		IA		1		PWC-8071L-1-ON-LF (632)
POINT LIGHTING CORPORATION	L-807(L)		IA		2		PWC-8072L-1-ON-LF (632)
L-810 Red Obstruction Lights (FAA AC 150/5345-43G)							
AUSTIN INSULATORS INC.	L-810(L)		Single Unit				A-L810 (411)
AVLITE SYSTEMS	L-810(L)		Single Unit				AV-OL-FL810-12-R (565); AV-OL-FL810-12-RIR (566); AV-OL-FL810-UM-R (567); AV-OL-FL810-UM-RIR (568)
AVLITE SYSTEMS	L-810(L)		Double Unit				AV-OL-FL810-12-R-D (565); AV-OL-FL810-12-RIR-D (566); AV-OL-FL810-UM-R-D (567); AV-OL-FL810-UM-RIR-D (568)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-810		Single Unit				40940-R-116 (506); 50033-R-116 (506); 50021-R-116 (506)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-810		Double Unit				50021-R-116 (389)(506)
DIALIGHT CORPORATION	L-810(L)		Single Unit				860-1R01-001 (174); 860-1R02-001 (300); 860-1R03-001 (232); 860-1R04-001 (234); 860-1R05-001 (233); 860-2R01-001 (174); 860-2R02-001 (300)
DIALIGHT CORPORATION	L-810(L)		Double Unit				860-1R01-002 (174); 860-1R02-002 (300) 860-1R03-002 (232); 860-1R04-002 (234) 860-1R05-002 (233); 860-2R01-002 (174); 860-2R02-002 (300)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
DIALIGHT CORPORATION	L-810(L)		Single Unit				RTO-1R08-001 (379); RTO-1R08-004 (379) RTO-1R07-001 (378); RTO-1R07-004 (378) RTO-1R06-001 (377); RTO-1R06-004 (377) RTO-CR07-001 (438); RTO-CR08-001 (439) RTO-1R18-001 (456); RTO-1R18-004 (456)
DIALIGHT CORPORATION	L-810(L)		Double Unit				RTO-1R08-002 (379); RTO-1R07-002 (378); RTO-1R06-002 (377); RTO-CR07-002 (438); RTO-CR08-002 (439); RTO-1R18-002 (456)
FARLIGHT LLC	L-810(L)		Single Unit				L810LED-XXXX-XXX(515); NV-L810LED1-XXXX-XXX (515)
FARLIGHT LLC	L-810(L)		Double Unit				L810LED-XXXX-XXX(515); NV-L810LED1-XXXX-XXX(515)
FLIGHT LIGHT INC.	L-810		Single Unit				FL-810-R-AC1-S-10B (32B)
FLIGHT LIGHT INC.	L-810		Double Unit				FL-810-R-AC1-D-10B (32B)
INTERNATIONAL TOWER LIGHTING, LLC	L-810		Single Unit				MKR-S-750-0DH (507)
INTERNATIONAL TOWER LIGHTING, LLC	L-810		Double Unit				MKR-D-750-000 (507)
INTERNATIONAL TOWER LIGHTING, LLC	L-810(L)		Single Unit				MKR-LTE1-000 (592); MKR-LTE1-0IR (622)
INTERNATIONAL TOWER LIGHTING, LLC	L-810(L)		Double Unit				MKR-LTE2-000 (592); MKR-LTE2-0IR (622)
TWR LIGHTING, INC.	L-810		Single Unit				OL-1 (32B)
TWR LIGHTING, INC.	L-810		Double Unit				OL-2 (32B)
TWR LIGHTING, INC.	L-810(L)		Single Unit				OL1VLED2 (297); OL1VLED3 (297); OL1VLED4 (297)
L-810 Red Obstruction Lights (FAA AC 150/5345-43H)							
ADB SAFEGATE AMERICAS, LLC	L-810(L)		Single Unit				SBOL-112X (561); SBOL-122X (561)
ADB SAFEGATE AMERICAS, LLC	L-810(L)		Double Unit				SBOL-132X (561); SBOL-152X (561)
ADB SAFEGATE AMERICAS, LLC	L-810		Single Unit				44C1005-1 (267)
ADB SAFEGATE AMERICAS, LLC	L-810		Double Unit				44C1007-1 (267)
FLASH TECHNOLOGY LLC	L-810(L)						FTS 371 AC (751); FTS 371 SMART AC (751); FTS 371 AC (752); FTS 371 SMART AC (752);

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
FLASH TECHNOLOGY LLC	L-810(L)(F)						FTS 371 AC (751); FTS 371 SMART AC (751); FTS 371 AC (752); FTS 371 SMART AC (752);
FLASH TECHNOLOGY LLC	L-810(L)		Single Unit				MKR 370 DC (551); MKR 370 DC IR (583); MKR 370 AC (563); MKR 370 AC IR (582)
HUGHEY & PHILLIPS, LLC	L-810		Single Unit				OB20A31 (399); OB20A41 (399); OB21A31 (399); OB21A41 (399)
HUGHEY & PHILLIPS, LLC	L-810		Double Unit				OB22A31 (399); OB22A41 (399); OB24A31 (399); OB24A41 (399); OB22A31TM1 (399); OB22A41TM1 (399); OB24A31TM1 (399); OB24A41TM1 (399)
HUGHEY & PHILLIPS, LLC	L-810(L)		Single Unit				45-1000-001 (477); 45-1001-001 (477); 45-1002-001 (477) ;45-1003-001 (477); 45-1008-001 (478); 45-1009-001 (478); 45-1010-001 (478); 45-1011-001 (478)
HUGHEY & PHILLIPS, LLC	L-810(L)		Double Unit				45-1004-001 (477); 45-1005-001 (477); 45-1006-001 (477); 45-1007-001 (477); 45-1012-001 (478); 45-1013-001 (478); 45-1014-001 (478); 45-1015-001 (478)
POINT LIGHTING CORPORATION	L-810		Single Unit				POL-20000(32C)
POINT LIGHTING CORPORATION	L-810		Double Unit				POL-20000-DJ (32C)
POINT LIGHTING CORPORATION	L-810(L)		Single Unit				POL-21005-XF-R-34B-S (631); POL-21005-XF-R-10B-S (631); POL-22001-XF-R-34B-S (630); POL-22001-XF-R-10B-S (630)
POINT LIGHTING CORPORATION	L-810(L)		Double Unit				POL-21005-xF-R-34B-D (631); POL-21005-xF-R-10B-D (631); POL-22001-xF-R-34B-D (630); POL-22001-xF-R-10B-D (630)
L-821 Airport Lighting Control Panel (FAA AC 150/5345-3G)							
ADB SAFEGATE AMERICAS, LLC	I	F, S, W	1	1			L-821
ADB SAFEGATE AMERICAS, LLC	III	W	3	1			44A7675/XXXXX2-XX0
CONTROLLED POWER INC.	I	F, S, W	1	1			RLP-10; RLP-20: RLP-30; RLP-40; RLP-50; RLP-60; RLP-70; RLP-80
RURAL ELECTRIC INC.	I	F, S, W	1	1			L-821
RURAL ELECTRIC INC.	III	F, S, W	3	1			L-821-III
L-823 Cable Connectors (FAA AC 150/5345-26D)							
ADB SAFEGATE AMERICAS, LLC	I	A	2				73A0151
ADB SAFEGATE AMERICAS, LLC	I	A	9				73A0152
ADB SAFEGATE AMERICAS, LLC	III	A	8				73A0153-12; 73A0153-14

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	II	B	5				SCK1PXX
ADB SAFEGATE AMERICAS, LLC	II	B	4				SCK2PXX
ADB SAFEGATE AMERICAS, LLC	II	B	12				SCK1RXX
ADB SAFEGATE AMERICAS, LLC	II	B	11				SCK2RXX
ADB SAFEGATE AMERICAS, LLC	II	A	6				1MC6PAXXXX01
ADB SAFEGATE AMERICAS, LLC	I	A	2				73A0169
ADB SAFEGATE AMERICAS, LLC	I	A	9				73A0170
ADB SAFEGATE AMERICAS, LLC	II	A	8				73A0190
ADB SAFEGATE BVBA	II	A	1				1458.03.530
ADB SAFEGATE BVBA	I	A	2				1458.03.502
ADB SAFEGATE BVBA	II	A	8				1458.03.522
ADB SAFEGATE BVBA	I	A	9				1458.03.512
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	II	A	6				X8405-40919-X
EFLA OY	I	B	3, 10				KD500; KD500.1; KD500.2; KD500.3; KD500.4; KD500.5; KD500.6
EFLA OY	I	A	2				KDCR510.XX
EFLA OY	I	A	9				KDCP510.XX
EFLA OY	I	B	3, 10				KD510; KD510.1; KD510.2; KD510.3; KD510.4; KD510.5; KD510.6
EFLA OY	II	A	1				KDC501.X.XX; KDC503.X.XX
EFLA OY	II	A	7				KDC502.X.XX; KDC503R.X.XX
EFLA OY	II	A	6				KDCT506.X.XX; KDC506.X.XX; KDCZ506.X.XX;
EFLA OY	II	A	8				KDC508.X.X
INTEGRO, LLC.	II	B	4				11254-11; 11254-12; 11254-21; 11254-22
INTEGRO, LLC.	II	B	5				11432-31; 11432-32; 11432-41; 11432-42
INTEGRO, LLC.	II	B	11				11255-11; 11255-12; 11255-21; 11255-22
INTEGRO, LLC.	II	B	12				11433-31; 11433-32; 11433-41; 11433-42
INTEGRO, LLC.	I	B	3,10				11174-01; 11174-02; 11174-04; 11174-05
INTEGRO, LLC.	I	B	3,10				11805-01; 11805-02; 11805-04; 11805-05
INTEGRO, LLC.	II	A	1				10518-01-XXX; 10518-14-XXX; 10518-15-XXX; 10518-16-XXX; 10518-17-XXX; 10518-18-XXX; 10518-19-XXX
INTEGRO, LLC.	II	A	7				10519-07-YYY; 10519-08-YYY
INTEGRO, LLC.	I	A	2				10949-02-YYY
INTEGRO, LLC.	II	A	8				10875-05-YYY
INTEGRO, LLC.	I	A	9				10950-02-YYY
INTEGRO, LLC.	II	A					11155-01-XXX; 11155-03-XXX
INTEGRO, LLC.	II	A					10875-106-YYY
THOMAS AND BETTS CORPORATION	I	B	3, 10				54 XX-XX
THOMAS AND BETTS CORPORATION	II	B	4, 11				90PX-X; 90RX-X
THOMAS AND BETTS CORPORATION	I	A	2				54MPN-X; 54MPPN-X

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
THOMAS AND BETTS CORPORATION	I	A	9				54MRN-X; 54MRRN-X
THOMAS AND BETTS CORPORATION	I	A	2, 9				54MPRN-X
THOMAS AND BETTS CORPORATION	II	A	1				95MPX-X
THOMAS AND BETTS CORPORATION	II	A	1, 7				96MPR7R7X-X; 96MPPR7X-X
THOMAS AND BETTS CORPORATION	II	A	1, 8				96MPPR8X-X
THOMAS AND BETTS CORPORATION	II	A	6				95MP6X-X
THOMAS AND BETTS CORPORATION	II	A	7				95MR7X-X
THOMAS AND BETTS CORPORATION	II	A	8				95MR8X-X
THOMAS AND BETTS CORPORATION	II	B	5, 12				91PX-X; 91RX-X
THOMAS AND BETTS CORPORATION	I	B	3, 10				54 XXXX
THOMAS AND BETTS CORPORATION	I	B	3, 10				54Super XX-XX
THOMAS AND BETTS CORPORATION	I	B	3, 10				52SUPER-I-XXX-XXX
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	I	A	2				FMC-1-P(N)T-XX-XX
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	I	A	9				FMC-1-R(N)T-XX-XX
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	II	A	1				FMC-2-P(N)T-XX-XX
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	II	A	8				FMC-2-R(N)T-XX-XX
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	II	A	6				FMC-2-P(N)F-02-06
L-824 Underground Electrical Cable for Airport Lighting Circuits (FAA AC 150/5345-7F)							
CONDUCTORES MONTERREY, S.A. de C.V./ViAKON	L-824C					5000V	AIR5KV8; AIR5KV6; AIR5KV4

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
DRAKA CABLETEQ USA	L-824C					5000V	CLR-XLPE 393000; CLR-XLPE 393001; CLR-XLPE 393002; CLR-XLPE 393003; CLR-XLPE 393004; CLR-XLPE 393005; CLR-XLPE 393006; CLR-XLPE 393007; CLR-XLPE 393008; CLR-XLPE 393009; CLR-XLPE 393010; CLR-XLPE 393011; CLR-XLPE 393012; CLR-XLPE 393013; CLR-XLPE 393014; CLR-XLPE 393015; CLR-XLPE 393016; CLR-XLPE 393017; CLR-XLPE 393018; CLR-XLPE 393019; CLR-XLPE 393020; CLR-XLPE 393021; CLR-XLPE 393022; CLR-XLPE 393023; CLR-XLPE 393024; CLR-XLPE 393025; CLR-XLPE 393026; CLR-XLPE 393027; CLR-XLPE 393028; CLR-XLPE 393029; CLR-XLPE 393030; CLR-XLPE 393031; CLR-XLPE 393032; CLR-XLPE 393033; CLR-XLPE 393034; CLR-XLPE 393035; CLR-XLPE 393036; CLR-XLPE 393037; CLR-XLPE 393038; CLR-XLPE 393039; CLR-XLPE 393040; CLR-XLPE 393041; CLR-XLPE 393042; CLR-XLPE 393043; CLR-XLPE 393044; CLR-XLPE 393045; CLR-XLPE 393046; CLR-XLPE 393047; CLR-XLPE 393048; CLR-XLPE 393049; CLR-XLPE 393050; CLR-XLPE 393051; CLR-XLPE 393052; CLR-XLPE 393053; CLR-XLPE 393054; CLR-XLPE 393055; CLR-XLPE 393056; CLR-XLPE 393057; CLR-XLPE 393058; CLR-XLPE 393059
DRAKA CABLETEQ USA	L-824B					5000V	388270; 388270-XX; 388271; 388271-XX; 388150; 388150-XX; 388278; 388278-XX; 388785; 388785-XX; 389152; 389152-XX
DRAKA CABLETEQ USA	L-824C					5000V	389171; 389171-XX; 389172; 389172-XX; 389181; 389181-XX; 389201; 389201-XX; 389202; 389202-XX; 389203; 389203-XX; 389221; 389221-XX; 389222; 389222-XX; 389223; 389223-XX
DRAKA CABLETEQ USA	L-824C					5000V	032632; 032632XX; 032633; 032633XX; 032634; 032634XX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
DRAKA CABLETEQ USA	L-824C					5000V	EXT SEMI-CON/XLPE 389431; EXT SEMI-CON/XLPE 389432, EXT SEMI-CON/XLPE 389433; EXT SEMI-CON/XLPE 389434; EXT SEMI-CON/XLPE 389435; EXT SEMI-CON/XLPE 389436; EXT SEMI-CON/XLPE 389437; EXT SEMI-CON/XLPE 389438; EXT SEMI-CON/XLPE 389439; EXT SEMI-CON/XLPE 389440; EXT SEMI-CON/XLPE 389441; EXT SEMI-CON/XLPE 389442; EXT SEMI-CON/XLPE 389443; EXT SEMI-CON/XLPE 389444; EXT SEMI-CON/XLPE 389445; EXT SEMI-CON/XLPE 389446; EXT SEMI-CON/XLPE 389447; EXT SEMI-CON/XLPE 389448; EXT SEMI-CON/XLPE 389449; EXT SEMI-CON/XLPE 389450; EXT SEMI-CON/XLPE 389451; EXT SEMI-CON/XLPE 389452; EXT SEMI-CON/XLPE 389453; EXT SEMI-CON/XLPE 389454; EXT SEMI-CON/XLPE 389455; EXT SEMI-CON/XLPE 389456; EXT SEMI-CON/XLPE 389457; EXT SEMI-CON/XLPE 389458; EXT SEMI-CON/XLPE 389459, EXT SEMI-CON/XLPE 389460

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
DRAKA CABLETEQ USA	L-824C					5000V	EXT SEMI-CON/XLPE 389461; EXT SEMI-CON/XLPE 389462, EXT SEMI-CON/XLPE 389463; EXT SEMI-CON/XLPE 389464; EXT SEMI-CON/XLPE 389465; EXT SEMI-CON/XLPE 389466; EXT SEMI-CON/XLPE 389467; EXT SEMI-CON/XLPE 389468; EXT SEMI-CON/XLPE 389469; EXT SEMI-CON/XLPE 389470; EXT SEMI-CON/XLPE 389471; EXT SEMI-CON/XLPE 389472; EXT SEMI-CON/XLPE 389473; EXT SEMI-CON/XLPE 389474; EXT SEMI-CON/XLPE 389475; EXT SEMI-CON/XLPE 389476; EXT SEMI-CON/XLPE 389477; EXT SEMI-CON/XLPE 389478; EXT SEMI-CON/XLPE 389479; EXT SEMI-CON/XLPE 389480
NEHRING ELECTRICAL WORKS COMPANY	L-824C					600V	8-7/W SD AIR 600V; 6-7/W SD AIR 600V; 4-7/W SD AIR 600V
NEHRING ELECTRICAL WORKS COMPANY	L-824C					5000V	8-7/W SD AIR 5000V; 6-7/W SD AIR 5000V; 4-7/W SD AIR 5000V
NEHRING ELECTRICAL WORKS COMPANY	L-824C					5000V	8-19/W SD AIR 5000V; 6-19/W SD AIR 5000V; 4-19/W SD AIR 5000V
NEXANS ENERGY USA INC.	L-824C					5000V	611491; 611533; 635290; 660615; 660616
PRYSMIAN POWER CABLES AND SYSTEMS USA, LLC.	L-824B					5000V	#4-303362; #6-303361; #8-303334
SOUTHWIRE CO.	L-824C					600V	14727-xxxxx; 24111-xxxxx; 14728-xxxxx; 14729xxxxx; 14730-xxxxx; 19707-xxxxx; 19708-xxxxx; 24051xxxxx; 19709-xxxxx; 34629-xxxxx; 19710-xxxxx; 23840-xxxxx; 19712-xxxxx; 19715-xxxxx; 26900-xxxxx; 30801-xxxxx; 30802 xxxxx; 34630-xxxxx; 39261-xxxxx; 20030-xxxxx; 20031-xxxxx; 30321-xxxxx
SOUTHWIRE CO.	L-824C					5000V	14723; 14724; 14726
SOUTHWIRE CO.	L-824C					5000V	19758-XXXXX; 25702-XXXXX;19760-XXXXX; 19761-XXXXX; 19762-XXXXX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
SYNERGY CABLE LTD	L-824C					5000V	1LC290811; 1LC290812; 1LC290611; LC290612; 1LC290411; 1LC290412; 1LC290821; 1LC290822; 1LC290621; 1LC290622; 1LC290421; LC290422; 1LC290831; 1LC290832; 1LC290631; LC290632; 1LC290431; 1LC290432; 1LC290841; LC290842; 1LC290641; 1LC290642; 1LC290441; 1LC290442; 1LC290851; 1LC290852; 1LC290651; 1LC290652; 1LC290451; 1LC290452; 1LC290861; 1LC290862; 1LC290661; 1LC290662; 1LC290461; 1LC290462
SYNERGY CABLE LTD	L-824C					5000V	1LC01108; 1LC01106; 1LC01104; 1LC11108; 1LC11106; 1LC11104; 1LC21108; 1LC21106; 1LC21104; 1LC09081; 1LC09082; 1LC09061; 1LC09062; 1LC09041; 1LC09042; 1LC19081; 1LC19082; 1LC19061; 1LC19062; 1LC19041; 1LC19042; 1LC29081; 1LC29082; 1LC29061; 1LC29062; 1LC29041; 1LC29042
THE OKONITE COMPANY	L-824B					5000V	114-24-2213; 114-24-2214; 114-24-2215; 114-24-2216; 114-24-2217; 114-24-2219; 114-24-2319; 114-24-2320; 114 24-2321; 114-24-2413; 114-24-2414; 114-24-2415; 114-24-2416; 114-24-2417; 114-24-2419; 114-24-2420; 114 24-2421
THE OKONITE COMPANY	L-824B					5000V	114-24-2425; 114-24-2426; 114-24-2427; 114-24-2412; 114-24-2430; 114-24-2431; 114-24-2432; 114-24-2418; 114-24-2525; 114-24-2526; 114-24-2527; 114-24-2512; 114-24-2530; 114-24-2531; 114-24-2532; 114-24-2518
UNIKA UNIVERSAL KABLO SANAYI VE TIC A.S.	L-824C					5000V	TExYBAP 8AWG; KExYBAP 8AWG; TExYPAP 8AWG; KExYPAP 8AWG; TExYBAY 8AWG; KExYBAY 8AWG; TExYPAY 8AWG; KExYPAY 8AWG x = XLPE insulation
UNIKA UNIVERSAL KABLO SANAYI VE TIC A.S.	L-824B					600V	T5ARAE; T5ARAR
UNTEL KABLOLARI SAN VE TIC A.S.	L-824C					5000V	UNT-AGL UNSCREENED POWER C PRIMARY CABLE; UNT-AGL COPPER POWER PRIMARY CABLE; UNT-AGL BRASS POWER PRIMARY CABLE
L-827 Constant Current Regulator Monitors (FAA AC 150/5345-10G)							
ADB SAFEGATE AMERICAS, LLC	L-827						Air Cooled CCR - ACE2™ 44A6602-XXXXX0; ACE2™ 44A6505-X0; ACE2™ 44A507-XXX0
MANAIRCO, INC.	L-827						MRML827XB-01
MANAIRCO, INC.	L-827						MRML827XB-01
MANAIRCO, INC.	L-827						MRML827XB-02
MANAIRCO, INC.	L-827						MRML827XB-03
MANAIRCO, INC.	L-827						MRML827XB-04

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MANAIRCO, INC.	L-827						MRML827XB-05
MANAIRCO, INC.	L-827						MRML827XB-06
MANAIRCO, INC.	L-827						MRML8275B-07
MANAIRCO, INC.	L-827						MRML8275B-08
L-828 Constant Current Regulators (FAA AC 150/5345-10G)							
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			4	PHF6604-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			7.5	PHF6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			10	PHF6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			15	PHFXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			20	PHFXX20-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			30	PHFXX30-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	2	2			50	PHF2050-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	2	2			70	PHF2070-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			4	PHSF6604-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			7.5	PHSF6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			10	PHSF6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			15	PHSFXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			20	PHSFXX20-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			30	PHSFXX30-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	2	2			50	PHSF2050-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	2	2			70	PHSF2070-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			2.5	PSF6602-X1XX; PSF6602-X2XX; PSF6602-X3XX; PSF6602-X4XX; PSF6602-X5XX; PSF6602-XBXX; PSF6602-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			4	PSF6604-X1XX; PSF6604-X2XX; PSF6604-X3XX; PSF6604-X4XX; PSF6604-X5XX; PSF6604-XBXX; PSF6604-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			5	PSF6605-X1XX; PSF6605-X2XX; PSF6605-X3XX; PSF6605-X4XX; PSF6605-X5XX; PSF6605-XBXX; PSF6605-XDXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			7.5	PSF6607-X1XX; PSF6607-X2XX; PSF6607-X3XX; PSF6607-X4XX; PSF6607-X5XX; PSF6607-XBXX; PSF6607-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			10	PSF6610-X1XX; PSF6610-X2XX; PSF6610-X3XX; PSF6610-X4XX; PSF6610-X5XX; PSF6610-XBXX; PSF6610-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			15	PSFXX15-X1XX; PSFXX15-X2XX; PSFXX15-X3XX; PSFXX15-X4XX; PSFXX15-X5XX; PSFXX15-XBXX; PSFXX15-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			20	PSFXX20-X1XX; PSFXX20-X2XX; PSFXX20-X3XX; PSFXX20-X4XX; PSFXX20-X5XX; PSFXX20-XBXX; PSFXX20-XDXX;

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			25	PSFXX25-X1XX; PSFXX25-X2XX; PSFXX25-X3XX; PSFXX25-X4XX; PSFXX25-X5XX; PSFXX25-XBXX; PSFXX25-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			30	PSFXX30-X1XX; PSFXX30-X2XX; PSFXX30-X3XX; PSFXX30-X4XX; PSFXX30-X5XX; PSFXX30-XBXX; PSFXX30-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			2.5	PSSF6602-X1XX; PSSF6602-X2XX; PSSF6602-X3XX; PSSF6602-X4XX; PSSF6602-X5XX; PSSF6602-XBXX; PSSF6602-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			4	PSSF6604-X1XX; PSSF6604-X2XX; PSSF6604-X3XX; PSSF6604-X4XX; PSSF6604-X5XX; PSSF6604-XBXX; PSSF6604-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			5	PSSF6605-X1XX; PSSF6605-X2XX; PSSF6605-X3XX; PSSF6605-X4XX; PSSF6605-X5XX; PSSF6605-XBXX; PSSF6605-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			7.5	PSSF6607-X1XX; PSSF6607-X2XX; PSSF6607-X3XX; PSSF6607-X4XX; PSSF6607-X5XX; PSSF6607-XBXX; PSSF6607-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			10	PSSF6610-X1XX; PSSF6610-X2XX; PSSF6610-X3XX; PSSF6610-X4XX; PSSF6610-X5XX; PSSF6610-XBXX; PSSF6610-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			15	PSSFXX15-X1XX; PSSFXX15-X2XX; PSSFXX15-X3XX; PSSFXX15-X4XX; PSSFXX15-X5XX; PSSFXX15-XBXX; PSSFXX15-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			20	PSSFXX20-X1XX; PSSFXX20-X2XX; PSSFXX20-X3XX; PSSFXX20-X4XX; PSSFXX20-X5XX; PSSFXX20-XBXX; PSSFXX20-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			25	PSSFXX25-X1XX; PSSFXX25-X2XX; PSSFXX25-X3XX; PSSFXX25-X4XX; PSSFXX25-X5XX; PSSFXX25-XBXX; PSSFXX25-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			30	PSSFXX30-X1XX; PSSFXX30-X2XX; PSSFXX30-X3XX; PSSFXX30-X4XX; PSSFXX30-X5XX; PSSFXX30-XBXX; PSSFXX30-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			4	CHF6604-XXXX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			5	CHF6605-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			7.5	CHF6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			10	CHF6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			15	CHFXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			20	CHFXX20-XXXX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			25	CHFXX25-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			30	CHFXX30-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	2	2			50	CHF2050-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	2	2			70	CHF2070-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			4	CCT6604-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			5	CCT6605-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			7.5	CCT6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			10	CCT6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			15	CCTXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			20	CCTXX20-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			25	CCTXX25-XXXX
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			30	CCTXX30-XXXX
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			4kW; 7.5kW; 10kW	82860F-XXX-XX-X; 82862F-XXX-XX-X 82860F-XXX-XX-X-S592; 82862F-XXX-XX-X-S592
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			15kW	82860F1-XXX-15-X; 82860F1-XXX-15-X-S592
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	2	1, 2			15kW	82860F1-XXX-16-X; 82860F1-XXX-16-X-S592
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			20kW	82860F1-XXX-20-X; 82860F1-XXX-20-X-S592

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	2	1, 2			20kW	82860F1-XXX-21-X; 82860F1-XXX-21-X-S592
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			30kW	82860F2-XXX-30-X; 82860F2-XXX-30-X-S592
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	2	1, 2			30kW	82860F2-XXX-31-X; 82860F2-XXX-31-X-S592
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			4kW	828SGS-480-04-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			7.5kW	828SGS-480-07-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			10kW	828SGS-480-10-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			15kW	828SGS-480-15-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			15kW	828SGS-480-16-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			20kW	828SGS-480-20-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			20kW	828SGS-480-21-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			30kW	828SGS-480-30-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			30kW	828SGS-480-31-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			4kW	FSF8X-04XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			7.5kW	FSF8X-07XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			10kW	FSF8X-10XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			15kW	FSF8X-15XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			20kW	FSF8X-20XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			25kW	FSF8X-25XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			30kW	FSF8X-30XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			1kW	SST8-01X1XX-XX; SST8-01X2XX-XX; SST8-01X3XX-XX; SST8-01X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			2kW	SST8-02X1XX-XX; SST8-02X2XX-XX; SST8-02X3XX-XX; SST8-02X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			4kW	SST8-04X1XX-XX; SST8-04X2XX-XX; SST8-04X3XX-XX; SST8-04X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			7.5kW	SST8-07X1XX-XX; SST8-07X2XX-XX; SST8-07X3XX-XX; SST8-07X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			10kW	SST8-10X1XX-XX; SST8-10X2XX-XX; SST8-10X3XX-XX; SST8-10X4XX-XX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			15kW	SST8-15X1XX-XX; SST8-15X2XX-XX; SST8-15X3XX-XX; SST8-15X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			20kW	SST8-20X1XX-XX; SST8-20X2XX-XX; SST8-20X3XX-XX; SST8-20X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			25kW	SST8-25X1XX-XX; SST8-25X2XX-XX; SST8-25X3XX-XX; SST8-25X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			30kW	SST8-30X1XX-XX; SST8-30X2XX-XX; SST8-30X3XX-XX; SST8-30X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			4kW	FSF8X-04X-XX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			7.5kW	FSF8X-07X-XX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			10kW	FSF8X-10X-XX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			15kW	FSF8X-15X-XX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			20kW	FSF8X-20X-XX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			25kW	FSF8X-25X-XX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			30kW	FSF8X-30X-XX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			1kW	SST8-01X1XX-XX; SST8-01X2XX-XX; SST8-01X3XX-XX; SST8-01X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			2kW	SST8-02X1XX-XX; SST8-02X2XX-XX; SST8-02X3XX-XX; SST8-02X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			4kW	SST8-04X1XX-XX; SST8-04X2XX-XX; SST8-04X3XX-XX; SST8-04X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			7.5kW	SST8-07X1XX-XX; SST8-07X2XX-XX; SST8-07X3XX-XX; SST8-07X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			10kW	SST8-10X1XX-XX; SST8-10X2XX-XX; SST8-10X3XX-XX; SST8-10X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			15kW	SST8-15X1XX-XX; SST8-15X2XX-XX; SST8-15X3XX-XX; SST8-15X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			20kW	SST8-20X1XX-XX; SST8-20X2XX-XX; SST8-20X3XX-XX; SST8-20X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			25kW	SST8-25X1XX-XX; SST8-25X2XX-XX; SST8-25X3XX-XX; SST8-25X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-828	1, 2	1, 2			30kW	SST8-30X1XX-XX; SST8-30X2XX-XX; SST8-30X3XX-XX; SST8-30X4XX-XX
MANAIRCO, INC.	L-828	1	1			2kW	MSR02L8283B-XX
MANAIRCO, INC.	L-828	1	2			2kW	MSR02L8285B-XX
MANAIRCO, INC.	L-828	1	1			4kW	MSR04L8283B-XX
MANAIRCO, INC.	L-828	1	2			4kW	MSR04L8285B-XX
MANAIRCO, INC.	L-828	1	1			7.5kW	MSR07L8283B-XX
MANAIRCO, INC.	L-828	1	2			7.5kW	MSR07L8285B-XX
MANAIRCO, INC.	L-828	1	1			10kW	MR10L8283B-XX
MANAIRCO, INC.	L-828	1	2			10kW	MR10L8285B-XX
MANAIRCO, INC.	L-828	1	1			15kW	MR15L8283B-XX
MANAIRCO, INC.	L-828	1	2			15kW	MR15L8285B-XX
MANAIRCO, INC.	L-828	1	1			20kW	MR20L8283B-XX
MANAIRCO, INC.	L-828	1	2			20kW	MR20L8285B-XX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MANAIRCO, INC.	L-828	1	1			30kW	MR30L8283B-XX
MANAIRCO, INC.	L-828	1	2			30kW	MR30L8285B-XX
MANAIRCO, INC.	L-828	2	2			30kW	MR30L82820-XX
MANAIRCO, INC.	L-828	2	2			50kW	MR50L82820-XX
L-828 Constant Current Regulators (FAA AC 150/5345-10H)							
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			2.5	CSF6602-X1X0; CSF6602-X2X0; CSF6602-X3X0; CSF6602-X4X0; CSF6602-X5X0; CSF6602-XBX0; CSF6602-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			4	CSF6604-X1X0; CSF6604-X2X0; CSF6604-X3X0; CSF6604-X4X0; CSF6604-X5X0; CSF6604-XBX0; CSF6604-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			5	CSF6605-X1X0; CSF6605-X2X0; CSF6605-X36X0; CSF6605-X4X0; CSF6605-X5X0; CSF6605-XBX0; CSF6605-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			7.5	CSF6607-X1X0; CSF6607-X2X0; CSF6607-X3X0; CSF6607-X4X0; CSF6607-X5X0; CSF6607-XBX0; CSF6607-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1	1, 2			10	CSF6610-X1X0; CSF6610-X2X0; CSF6610-X3X0; CSF6610-X4X0; CSF6610-X5X0; CSF6610-XBX0; CSF6610-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			15	CSFXX15-X1X0; CSFXX15-X2X0; CSFXX15-X3X0; CSFXX15-X4X0; CSFXX15-X5X0; CSFXX15-XBX0; CSFXX15-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			20	CSFXX20-X1X0; CSFXX20-X2X0; CSFXX20-X3X0; CSFXX20-X4X0; CSFXX20-X5X0; CSFXX20-XBX0; CSFXX20-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			25	CSFXX25-X1X0; CSFXX25-X2X0; CSFXX25-X3X0; CSFXX25-X4X0; CSFXX25-X5X0; CSFXX25-XBX0; CSFXX25-XDX0
ADB SAFEGATE AMERICAS, LLC	L-828	1, 2	1, 2			30	CSFXX30-X1X0; CSFXX30-X2X0; CSFXX30-X3X0; CSFXX30-X4X0; CSFXX30-X5X0; CSFXX30-XBX0; CSFXX30-XDX0
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				82860PES-XXX-04-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				82860PES-XXX-07-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				82860PES-XXX-10-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				82860PEM-XXX-15-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				82860PEM-XXX-20-X

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				82860PEL-XXX-30-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			10kW	82860-W-11-1-66-0X; 82860-W-11-2-66-0X 82860-W-11-4-66-0X; 82860-W-11-8-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			15kW	82860-W-15-1-66-0X; 82860-W-15-2-66-0X 82860-W-15-4-66-0X; 82860-W-15-8-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			20kW	82860-W-20-1-XX-0X; 82860-W-20-2-XX-0X 82860-W-20-4-XX-0X; 82860-W-20-8-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			30kW	82860-W-30-1-XX-0X; 82860-W-30-2-XX-0X 82860-W-30-4-XX-0X; 82860-W-30-8-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	2	1, 2			37.5kW	82860-W-37-4-20-0X; 82860-W-37-8-20-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	2	1, 2			50kW	82860-W-50-8-20-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			10kW	828X0-D-11-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			15kW	828X0-D-15-X-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			20kW	828X0-D-20-X-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			30kW	828X0-D-30-X-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			4kW	828X0-D-04-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			7.5kW	828X0-D-07-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			10kW	828X0-D-10-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2			10kW	828X0-D-11-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			15kW	828X0-D-15-X-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			20kW	828X0-D-20-X-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1, 2	1, 2			30kW	828X0-D-30-X-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				828X0-D-04-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				828X0-D-07-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-828	1	1, 2				828X0-D-10-X-66-0X

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YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			4kW	CCR1-12042
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			5kW	CCR1-12052
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			7kW	CCR1-12072
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			10kW	CCR1-12102
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			15kW	CCR1-12152
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			20kW	CCR1-12202
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			25kW	CCR1-12252
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-828	1	1, 2			30kW	CCR1-12302
L-829 Constant Current Regulators with Monitoring (FAA AC 150/5345-10G)							
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			4kW	PHF6604-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			7.5kW	PHF6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			10kW	PHF6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			15kW	PHFXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			20kW	PHFXX20-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			30kW	PHFXX30-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	2	2			50kW	PHF2050-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	2	2			70kW	PHF2070-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			4kW	PHSF6604-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			7.5kW	PHSF6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			10kW	PHSF6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			15kW	PHSFXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			20kW	PHSFXX20-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			30kW	PHSFXX30-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	2	2			50kW	PHSF2050-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	2	2			70kW	PHSF2070-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			2.5kW	PSF6602-X1XX; PSF6602-X2XX; PSF6602-X3XX; PSF6602-X4XX; PSF6602-X5XX; PSF6602-XBXX; PSF6602-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			4kW	PSF6604-X1XX; PSF6604-X2XX; PSF6604-X3XX; PSF6604-X4XX; PSF6604-X5XX; PSF6604-XBXX; PSF6604-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			5kW	PSF6605-X1XX; PSF6605-X2XX; PSF6605-X3XX; PSF6605-X4XX; PSF6605-X5XX; PSF6605-XBXX; PSF6605-XDXX;

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ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			7.5kW	PSF6607-X1XX; PSF6607-X2XX; PSF6607-X3XX; PSF6607-X4XX; PSF6607-X5XX; PSF6607-XBXX; PSF6607-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			10kW	PSF6610-X1XX; PSF6610-X2XX; PSF6610-X3XX; PSF6610-X4XX; PSF6610-X5XX; PSF6610-XBXX; PSF6610-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			15kW	PSFXX15-X1XX; PSFXX15-X2XX; PSFXX15-X3XX; PSFXX15-X4XX; PSFXX15-X5XX; PSFXX15-XBXX; PSFXX15-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			20kW	PSFXX20-X1XX; PSFXX20-X2XX; PSFXX20-X3XX; PSFXX20-X4XX; PSFXX20-X5XX; PSFXX20-XBXX; PSFXX20-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			25kW	PSFXX25-X1XX; PSFXX25-X2XX; PSFXX25-X3XX; PSFXX25-X4XX; PSFXX25-X5XX; PSFXX25-XBXX; PSFXX25-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			30kW	PSFXX30-X1XX; PSFXX30-X2XX; PSFXX30-X3XX; PSFXX30-X4XX; PSFXX30-X5XX; PSFXX30-XBXX; PSFXX30-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			2.5kW	PSSF6602-X1XX; PSSF6602-X2XX; PSSF6602-X3XX; PSSF6602-X4XX; PSSF6602-X5XX; PSSF6602-XBXX; PSSF6602-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			4kW	PSSF6604-X1XX; PSSF6604-X2XX; PSSF6604-X3XX; PSSF6604-X4XX; PSSF6604-X5XX; PSSF6604-XBXX; PSSF6604-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			5kW	PSSF6605-X1XX; PSSF6605-X2XX; PSSF6605-X3XX; PSSF6605-X4XX; PSSF6605-X5XX; PSSF6605-XBXX; PSSF6605-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			7.5kW	PSSF6607-X1XX; PSSF6607-X2XX; PSSF6607-X3XX; PSSF6607-X4XX; PSSF6607-X5XX; PSSF6607-XBXX; PSSF6607-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			10kW	PSSF6610-X1XX; PSSF6610-X2XX; PSSF6610-X3XX; PSSF6610-X4XX; PSSF6610-X5XX; PSSF6610-XBXX; PSSF6610-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			15kW	PSSF6615-X1XX; PSSF6615-X2XX; PSSF6615-X3XX; PSSF6615-X4XX; PSSF6615-X5XX; PSSF6615-XBXX; PSSF6615-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			20kW	PSSFXX20-X1XX; PSSFXX20-X2XX; PSSFXX20-X3XX; PSSFXX20-X4XX; PSSFXX20-X5XX; PSSFXX20-XBXX; PSSFXX20-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			25kW	PSSFXX25-X1XX; PSSFXX25-X2XX; PSSFXX25-X3XX; PSSFXX25-X4XX; PSSFXX25-X5XX; PSSFXX25-XBXX; PSSFXX25-XDXX;

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			30kW	PSSFXX30-X1XX; PSSFXX30-X2XX; PSSFXX30-X3XX; PSSFXX30-X4XX; PSSFXX30-X5XX; PSSFXX30-XBXX; PSSFXX30-XDXX;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			4kW	CHF6604-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			5kW	CHF6605-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			7.5kW	CHF6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			10kW	CHF6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			15kW	CHFXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			20kW	CHFXX20-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			25kW	CHFXX25-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			30kW	CHFXX30-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	2	2			50kW	CHF2050-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	2	2			70kW	CHF2070-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			4kW	CCT6604-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			5kW	CCT6605-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			7.5kW	CCT6607-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			10kW	CCT6610-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			15kW	CCTXX15-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			20kW	CCTXX20-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			25kW	CCTXX25-XXXX
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			30kW	CCTXX30-XXXX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			4kW	FSF9X-04XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			7.5kW	FSF9X-07XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			10kW	FSF9X-10XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			15kW	FSF9X-15XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			20kW	FSF9X-20XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			25kW	FSF9X-25XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			30kW	FSF9X-30XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			1kW	SST9-01X1XX-XX; SST9-01X2XX-XX; SST9-01X3XX-XX; SST9-01X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			2kW	SST9-02X1XX-XX; SST9-02X2XX-XX; SST9-02X3XX-XX; SST9-02X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			4kW	SST9-04X1XX-XX; SST9-04X2XX-XX; SST9-04X3XX-XX; SST9-04X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			7.5kW	SST9-07X1XX-XX; SST9-07X2XX-XX; SST9-07X3XX-XX; SST9-07X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			10kW	SST9-10X1XX-XX; SST9-10X2XX-XX; SST9-10X3XX-XX; SST9-10X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			15kW	SST9-15X1XX-XX; SST9-15X2XX-XX; SST9-15X3XX-XX; SST9-15X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			20kW	SST9-20X1XX-XX; SST9-20X2XX-XX; SST9-20X3XX-XX; SST9-20X4XX-XX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			25kW	SST9-25X1XX-XX; SST9-25X2XX-XX; SST9-25X3XX-XX; SST9-25X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			30kW	SST9-30X1XX-XX; SST9-30X2XX-XX; SST9-30X3XX-XX; SST9-30X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			4kW	FSF9X-04XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			7.5kW	FSF9X-07XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			10kW	FSF9X-10XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			15kW	FSF9X-15XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			20kW	FSF9X-20XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			25kW	FSF9X-25XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			30kW	FSF9X-30XXX-X
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			1kW	SST9-01X1XX-XX; SST9-01X2XX-XX; SST9-01X3XX-XX; SST9-01X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			2kW	SST9-02X1XX-XX; SST9-02X2XX-XX; SST9-02X3XX-XX; SST9-02X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			4kW	SST9-04X1XX-XX; SST9-04X2XX-XX; SST9-04X3XX-XX; SST9-04X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			7.5kW	SST9-07X1XX-XX; SST9-07X2XX-XX; SST9-07X3XX-XX; SST9-07X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			10kW	SST9-10X1XX-XX; SST9-10X2XX-XX; SST9-10X3XX-XX; SST9-10X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			15kW	SST9-15X1XX-XX; SST9-15X2XX-XX; SST9-15X3XX-XX; SST9-15X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			20kW	SST9-20X1XX-XX; SST9-20X2XX-XX; SST9-20X3XX-XX; SST9-20X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			25kW	SST9-25X1XX-XX; SST9-25X2XX-XX; SST9-25X3XX-XX; SST9-25X4XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-829	1, 2	1, 2			30kW	SST9-30X1XX-XX; SST9-30X2XX-XX; SST9-30X3XX-XX; SST9-30X4XX-XX
MANAIRCO, INC.	L-829	1	1			15kW	MR15L8293B-XX
MANAIRCO, INC.	L-829	1	2			15kW	MR15L8295B-XX
MANAIRCO, INC.	L-829	1	1			20kW	MR20L8293B-XX
MANAIRCO, INC.	L-829	1	2			20kW	MR20L8295B-XX
MANAIRCO, INC.	L-829	1	1			30kW	MR30L8293B-XX
MANAIRCO, INC.	L-829	1	2			30kW	MR30L8295B-XX
MANAIRCO, INC.	L-829	2	2			30kW	MR30L82920-XX
MANAIRCO, INC.	L-829	2	2			50kW	MR50L82920-XX
MANAIRCO, INC.	L-829	1	1			2kW	MSR02L8293B-XX
MANAIRCO, INC.	L-829	1	2			2kW	MSR02L8295B-XX
MANAIRCO, INC.	L-829	1	1			4kW	MSR02L8293B-XX
MANAIRCO, INC.	L-829	1	2			4kW	MSR02L8295B-XX
MANAIRCO, INC.	L-829	1	1			7.5kW	MSR04L8293B-XX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MANAIRCO, INC.	L-829	1	2			7.5kW	MSR04L8295B-XX
MANAIRCO, INC.	L-829	1	1			10kW	MSR07L8293B-XX
MANAIRCO, INC.	L-829	1	2			10kW	MSR07L8295B-XX
L-829 Constant Current Regulators with Monitoring (FAA AC 150/5345-10H)							
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			2.5kW	CSF6602-X1X0; CSF6602-X2X0; CSF6602-X3X0; CSF6602-X4X0; CSF6602-X5X0; CSF6602-XBX0; CSF6602-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			4kW	CSF6604-X1X0; CSF6604-X2X0; CSF6604-X3X0; CSF6604-X4X0; CSF6604-X5X0; CSF6604-XBX0; CSF6604-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			5kW	CSF6605-X1X0; CSF6605-X2X0; CSF6605-X36X0; CSF6605-X4X0; CSF6605-X5X0; CSF6605-XBX0; CSF6605-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			7.5kW	CSF6607-X1X0; CSF6607-X2X0; CSF6607-X3X0; CSF6607-X4X0; CSF6607-X5X0; CSF6607-XBX0; CSF6607-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1	1, 2			10kW	CSF6610-X1X0; CSF6610-X2X0; CSF6610-X3X0; CSF6610-X4X0; CSF6610-X5X0; CSF6610-XBX0; CSF6610-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			15kW	CSFXX15-X1X0; CSFXX15-X2X0; CSFXX15-X3X0; CSFXX15-X4X0; CSFXX15-X5X0; CSFXX15-XBX0; CSFXX15-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			20kW	CSFXX20-X1X0; CSFXX20-X2X0; CSFXX20-X3X0; CSFXX20-X4X0; CSFXX20-X5X0; CSFXX20-XBX0; CSFXX20-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			25kW	CSFXX25-X1X0; CSFXX25-X2X0; CSFXX25-X3X0; CSFXX25-X4X0; CSFXX25-X5X0; CSFXX25-XBX0; CSFXX25-XDX0;
ADB SAFEGATE AMERICAS, LLC	L-829	1, 2	1, 2			30kW	CSFXX30-X1X0; CSFXX30-X2X0; CSFXX30-X3X0; CSFXX30-X4X0; CSFXX30-X5X0; CSFXX30-XBX0; CSFXX30-XDX0;
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			4kW	82960PES-XXX-04-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			7.5kW	82960PES-XXX-07-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			10kW	82960PES-XXX-10-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			15kW	82960PEM-XXX-15-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			20kW	82960PEM-XXX-20-X

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CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			30kW	82960PEL-XXX-30-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			10kW	82960-W-11-1-66-0X; 82960-W-11-2-66-0X 82960-W-11-4-66-0X; 82960-W-11-8-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1, 2	1, 2			15kW	82960-W-15-1-66-0X; 82960-W-15-2-66-0X 82960-W-15-4-66-0X; 82960-W-15-8-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1, 2	1, 2			20kW	82960-W-20-1-XX-0X; 82960-W-20-2-XX-0X 82960-W-20-4-XX-0X; 82960-W-20-8-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1, 2	1, 2			30kW	82960-W-30-1-XX-0X; 82960-W-30-2-XX-0X 82960-W-30-4-XX-0X; 82960-W-30-8-XX-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	2	1, 2			37.5kW	82960-W-37-4-20-0X; 82960-W-37-8-20-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	2	1, 2			50kW	82960-W-50-8-20-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			4kW	829X0-D-04-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			7.5kW	829X0-D-07-X-66-0X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-829	1	1, 2			10kW	829X0-D-10-X-66-0X
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			4kW	CCR2-12042
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			5kW	CCR2-12052
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			7kW	CCR2-12072
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			10kW	CCR2-12102
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			15kW	CCR2-12152
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			20kW	CCR2-12202
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			25kW	CCR2-12252
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-829	1	1, 2			30kW	CCR2-12302
L-830 Isolation Transformers 60Hz (FAA AC 150/5345-47C)							
ADB SAFEGATE AMERICAS, LLC	L-830-16					10/15W	1ST010666010
ADB SAFEGATE AMERICAS, LLC	L-830-17					20/25W	1ST020666010
ADB SAFEGATE AMERICAS, LLC	L-830-1					30/45W	1ST045666010
ADB SAFEGATE AMERICAS, LLC	L-830-3					65W	1ST065666010
ADB SAFEGATE AMERICAS, LLC	L-830-4					100W	1ST100666010

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ADB SAFEGATE AMERICAS, LLC	L-830-18					150W	1ST150666010
ADB SAFEGATE AMERICAS, LLC	L-830-6					200W	1ST200666010
ADB SAFEGATE AMERICAS, LLC	L-830-10					300W	1ST300666010
ADB SAFEGATE BVBA	L-830-1					30/45W	1ST045666OS
ADB SAFEGATE BVBA	L-830-3					65W	1ST065666OS
ADB SAFEGATE BVBA	L-830-4					100W	1ST100666OS
ADB SAFEGATE BVBA	L-830-18					150W	1ST150666OS
ADB SAFEGATE BVBA	L-830-6					200W	1ST200666OS
ADB SAFEGATE BVBA	L-830-10					300W	1ST300666OS
EFLA OY	L-830-1					30/45W	KR631.1A
EFLA OY	L-830-4					100W	KR641.1A
EFLA OY	L-830-6					200W	KR651.1A
EFLA OY	L-830-10					300W	KR661.1A
EFLA OY	L-830-18					150W	KR646.1A
EFLA OY	L-830-3					65W	KR636.1A
EFLA OY	L-830-16					10/15W	KR621.1A
EFLA OY	L-830-17					20/25W	KR625.1A
EFLA OY	L-830-1					30/45W	KR531.1A
EFLA OY	L-830-3					65W	KR536.1A
EFLA OY	L-830-4					100W	KR541.1A
EFLA OY	L-830-18					150W	KR546.1A
EFLA OY	L-830-6					200W	KR551.1A
EFLA OY	L-830-10					300W	KR561.1A
INTEGRO, LLC.	L-830-4					100W	11683
INTEGRO, LLC.	L-830-6					200W	11685
INTEGRO, LLC.	L-830-16					10/15W	11717
INTEGRO, LLC.	L-830-18					150W	11730
INTEGRO, LLC.	L-830-2					30/45W	11681
INTEGRO, LLC.	L-830-5					100W	11684
INTEGRO, LLC.	L-830-7					200W	11686
INTEGRO, LLC.	L-830-10					300W	11736
INTEGRO, LLC.	L-830-1					30/45W	11680
INTEGRO, LLC.	L-830-3					65W	11682
INTEGRO, LLC.	L-830-17					20/25W	11729
INTEGRO, LLC.	L-830-11					300W	11760
THOMAS AND BETTS CORPORATION	L-830-3					65W	TA06566D-01; TA06566D-10
THOMAS AND BETTS CORPORATION	L-830-1					45W	TA045666-01; TA045666-10
THOMAS AND BETTS CORPORATION	L-830-2					45W	TA04526D-01; 10
THOMAS AND BETTS CORPORATION	L-830-1					45W	TA04566D-01; TA04566D-10
THOMAS AND BETTS CORPORATION	L-830-8					300W	TA300626-01; TA300626-10
THOMAS AND BETTS CORPORATION	L-830-9					300W	TA300226-01; TA300226-10
THOMAS AND BETTS CORPORATION	L-830-11					300W	TA300266-01; TA300266-10

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THOMAS AND BETTS CORPORATION	L-830-12					500W	TA500626-01; TA500626-10
THOMAS AND BETTS CORPORATION	L-830-13					500W	TA500226-01; TA500226-10
THOMAS AND BETTS CORPORATION	L-830-18					150W	TA150666-01; TA150666-10
THOMAS AND BETTS CORPORATION	L-830-14					500W	TA500666-01; TA500666-10
THOMAS AND BETTS CORPORATION	L-830-15					500W	TA500266-01; TA500266-10
THOMAS AND BETTS CORPORATION	L-830-16					10/15W	TA010666-01; TA010666-10
THOMAS AND BETTS CORPORATION	L-830-17					20/25W	TA025666-01; TA025666-10
THOMAS AND BETTS CORPORATION	L-830-19					150W	TA150266-01; TA150266-10
THOMAS AND BETTS CORPORATION	L-830-3					65W	TA065666-01; TA065666-10
THOMAS AND BETTS CORPORATION	L-830-6					200W	TA200666-01; TA200666-10
THOMAS AND BETTS CORPORATION	L-830-7					200W	TA200266-01; TA200266-10
THOMAS AND BETTS CORPORATION	L-830-4					100W	TA10066D-01; TA10066D-10
THOMAS AND BETTS CORPORATION	L-830-2					30/45W	TA045266-01; TA045266-10
THOMAS AND BETTS CORPORATION	L-830-5					100W	TA100266-01; TA100266-10
THOMAS AND BETTS CORPORATION	L-830-10					300W	TA300666-01; TA300666-10
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-830-16					10/15W	IT1-066-015-60
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-830-2					30/45W	IT1-066-045-60
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-830-4					100W	IT1-066-100-60
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-830-18					150W	IT1-066-150-60
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-830-6					200W	IT1-066-200-60
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-830-10					300W	IT1-066-300-60
L-831 Isolation Transformers 50Hz (FAA AC 150/5345-47C)							
ADB SAFEGATE BVBA	L-831-1					30/45W	1ST045665OS
ADB SAFEGATE BVBA	L-831-3					65W	1ST065665OS
ADB SAFEGATE BVBA	L-831-4					100W	1ST100665OS
ADB SAFEGATE BVBA	L-831-18					150W	1ST150665OS
ADB SAFEGATE BVBA	L-831-6					200W	1ST200665OS
ADB SAFEGATE BVBA	L-831-10					300W	1ST300665OS
EFLA OY	L-831-1					30/45W	KR631.1
EFLA OY	L-831-4					100W	KR641.1
EFLA OY	L-831-6					200W	KR651.1
EFLA OY	L-831-10					300W	KR661.1
EFLA OY	L-831-18					150W	KR646.1
EFLA OY	L-831-3					65W	KR636.1
EFLA OY	L-831-16					10/15W	KR621.1
EFLA OY	L-831-17					20/25W	KR625.1

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
EFLA OY	L-831-1					30/45W	KR531.1
EFLA OY	L-831-3					65W	KR536.1
EFLA OY	L-831-4					100W	KR541.1
EFLA OY	L-831-18					150W	KR546.1
EFLA OY	L-831-6					200W	KR551.1
EFLA OY	L-831-10					300W	KR561.1
INTEGRO, LLC.	L-831-4					100W	11683
INTEGRO, LLC.	L-831-3					65W	11712
INTEGRO, LLC.	L-831-18					150W	11734
INTEGRO, LLC.	L-831-1					30/45W	11710
INTEGRO, LLC.	L-831-6					200W	11715
INTEGRO, LLC.	L-831-19					150W	11731
THOMAS AND BETTS CORPORATION	L-831-2					30/45W	TA04526D-01; TA04526D-10
THOMAS AND BETTS CORPORATION	L-831-3					65W	TA06566D-01; TA06566D-10
THOMAS AND BETTS CORPORATION	L-831-11					300W	TA300265-01; TA300265-10
THOMAS AND BETTS CORPORATION	L-831-1					45W	TA045665-01; TA045665-10
THOMAS AND BETTS CORPORATION	L-831-2					45W	TA04566D-01; TA04566D-10
THOMAS AND BETTS CORPORATION	L-831-9					300W	TA300225-01; TA300225-10
THOMAS AND BETTS CORPORATION	L-831-12					500W	TA500625-01; TA500625-10
THOMAS AND BETTS CORPORATION	L-831-13					500W	TA500225-01; TA500225-10
THOMAS AND BETTS CORPORATION	L-831-14					500W	TA500665-01; TA500665-10
THOMAS AND BETTS CORPORATION	L-861-15					500W	TA500265-01; TA500265-10
THOMAS AND BETTS CORPORATION	L-831-16					10/15W	TA010665-01; TA010665-10
THOMAS AND BETTS CORPORATION	L-831-17					20/25W	TA025665-01; TA025665-10
THOMAS AND BETTS CORPORATION	L-831-18					150W	TA150665-01; TA150665-10
THOMAS AND BETTS CORPORATION	L-831-19					150W	TA150265-01; TA150265-10
THOMAS AND BETTS CORPORATION	L-831-3					65W	TA065665-01; TA065665-10
THOMAS AND BETTS CORPORATION	L-831-6					200W	TA200665-01;TA200665-10
THOMAS AND BETTS CORPORATION	L-831-7					200W	TA200265-01; TA200265-10
THOMAS AND BETTS CORPORATION	L-831-2					30/45W	TA045265-01; TA045265-10
THOMAS AND BETTS CORPORATION	L-831-4					100W	TA10066D-01; TA10066D-10
THOMAS AND BETTS CORPORATION	L-831-8					300W	TA300625-01; TA300625-10
THOMAS AND BETTS CORPORATION	L-831-5					100W	TA100265-01; TA100265-10
THOMAS AND BETTS CORPORATION	L-831-10					300W	TA300665-01; TA300665-10
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-831-16					10/15W	IT1-066-015-50
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-831-2					30/45W	IT1-066-045-50
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-831-4					100W	IT1-066-100-50
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-831-18					150W	IT1-066-150-50

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YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-831-6					200W	IT1-066-200-50
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-831-10					300W	IT1-066-300-50
L-847 Circuit Selector Switch (FAA AC 150/5345-5B)							
ADB SAFEGATE AMERICAS, LLC	L-847 1, 2, 3, 4	A, B				1, 2	44D4520-XXX0
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-847 1, 2, 3, 4	A, B				1	84700-X-66-X
LIBERTY AIRPORT SYSTEMS, INC.	L-847 1, 2, 3, 4	A, B				1, 2	SCS-XX-XX
LIBERTY AIRPORT SYSTEMS, INC.	L-847 1, 2, 3, 4	A, B				1, 2	SCS-XX-XX
L-849 Runway End Identifier Lights (FAA AC 150/5345-51B)							
ADB SAFEGATE AMERICAS, LLC	L-849I(L)		A				REIL-A1X0X011 (668)
ADB SAFEGATE AMERICAS, LLC	L-849V(L)		A				REIL-A2X0X011 (668)
ADB SAFEGATE AMERICAS, LLC	L-849I(L)		E				REIL-E1X0X011 (668)
ADB SAFEGATE AMERICAS, LLC	L-849V(L)		E				REIL-E2X0X011 (668)
ADB SAFEGATE AMERICAS, LLC	L-849I(L)		C				REIL-C1XXX010 (321)
ADB SAFEGATE AMERICAS, LLC	L-849V (L)		C				REIL-C2XXX010 (321)
ASTRONICS DME CORPORATION	L-849V(L)		E				P2-08-0001-002 (619)
ASTRONICS DME CORPORATION	L-849V(L)		A				P2-08-0001-102 (619)
ASTRONICS DME CORPORATION	L-849I(L)		A				L-849I-L-A-1 (738)
ASTRONICS DME CORPORATION	L-849I(L)		C				L-849I-L-C-1(738)
ASTRONICS DME CORPORATION	L-849I(L)		E				L-849I-L-E-1(738)
FLASH TECHNOLOGY LLC	L-849I		A, E				FTS 832 (157)
FLASH TECHNOLOGY LLC	L-849I		B, F				FTS 432 (75)
FLASH TECHNOLOGY LLC	L-849V		B, F				FTS 412 (75)
FLASH TECHNOLOGY LLC	L-849V		A, E				FTS 812 (157
STROBE APPROACH LIGHTING TECHNOLOGY	L-849V(L)		A				SAL1030V-A (525)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849V(L)		E				SAL1030-V-E (525)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I(L)		A				SAL1030-I-A (525)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I(L)		E				SAL1030-I-E (525)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I(L)		C				SAL1030-I-C (525)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I(L)		A, E				SAL 1030V (525)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849V		A				L849-V1-A; (282)

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STROBE APPROACH LIGHTING TECHNOLOGY	L-849V		E				L849-V1-E (282)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849V		B				L849-V1-B (287)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849V		F				L849-I-F (287)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I		A				L-849-I-A (282)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I		E				L-849-I-E (282)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I		B				L-849-I-B (287)
STROBE APPROACH LIGHTING TECHNOLOGY	L-849I		F				L-849-I-F (287)
L-850 Runway Inpavement Lights (FAA AC 150/5345-46D)							
ADB SAFEGATE AMERICAS, LLC	L-850A(L)	1, 2	2	1			DRC-A-2-XX-0-A-S-XXXXX (516)(517)
ADB SAFEGATE AMERICAS, LLC	L-850B(L)	1, 2	2	1			DTZ-A-2-WN-X-A-S-XXXXX (516)
ADB SAFEGATE AMERICAS, LLC	L-850T(L)	1, 2	2	1			DRC-A-2-RN-0-A-S-XXXXX (517)
ADB SAFEGATE AMERICAS, LLC	L-850C(L)	2	2	1			IREL-XXX0XX0 (499)(500)(501)(502)
ADB SAFEGATE AMERICAS, LLC	L-850D(L)	2	2	1			IREL-C4X0XX0 (499)(500); IREL-4BX0XX0 (499)(500); IREL-C0X0XX0 (499); IREL-40X0XX0 (500); IREL-0BX0XX0 (499); IREL-44X0XX0 (500)
ADB SAFEGATE AMERICAS, LLC	L-850C	2	3	1			44A6009-XXXX (123)
ADB SAFEGATE AMERICAS, LLC	L-850A	2	3	1			44A4817-X2X1 (124)(594)
ADB SAFEGATE AMERICAS, LLC	L-850F	2	3	1			44A5950-0211 (124)(594)
ADB SAFEGATE AMERICAS, LLC	L-850B	2	3	1			44A4763 (124)(594)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-850D	2	2	1			44A6656-01XX (318); 44A6656-21XX (318); 44A6656-31XX (318); 44A6656-20XX (318); 44A6656-30XX (318)
ADB SAFEGATE AMERICAS, LLC	L-850E	2	2	1			44A6248-1X10 (123)
ADB SAFEGATE BVBA	L-850A(L)	1, 2	2	1			DRC-A-2-XX-0-A-S-XXXXX (516)(517)
ADB SAFEGATE BVBA	L-850B(L)	1, 2	2	1			DTZ-A-2-WN-X-A-S-XXXXX (516)
ADB SAFEGATE BVBA	L-850T(L)	1, 2	2	1			DRC-A-2-RN-0-A-S-XXXXX (517)
AIRSAFE AIRPORT EQUIPMENT CO LTD	L-850A	1, 2	2	1			RCL-08-XXX-CC (220); RCL-08-XXX-CR (220); RCL-08-XXX-048-C (220) ; RCL-08-XXX-R (220)
AIRSAFE AIRPORT EQUIPMENT CO LTD	L-850B	1, 2	2	1			TDZ-08-X-048-C (220)
AIRSAFE AIRPORT EQUIPMENT CO LTD	L-850D	2	2	1			TAE-12-S-210-RR (164); TAE-12-R-210-GR (164); TAE-12-L-210-GR (164); THR-12-R-096-G (220); THR-12-L-096-G (220); END-12-105-R (164)
AIRSAFE AIRPORT EQUIPMENT CO LTD	L-850C	2	2	1			REL-12-L-210-CC(164); REL-12-L-210-CY(164); REL-12-L-210-YC(164); REL-12-L-210-CR(164); REL-12-L-210-RC(164); REL-12-R-210-CC(164); REL-12-R-210-CY(164); REL-12-R-210-YC(164); REL-12-R-210-CR(164); REL-12-R-210-RC(164)
ATG AIRPORTS LIMITED	L-850A(L)	1, 2	3	1			IR850A-11WW-110 (611); IR850A-12WN-110 (611); IR850A-21NW-110 (611); IR850A-11WR-110 (611)(612); IR850A-11RW-110 (612)(611); IR850A-12RN-110 (612); IR850A-21NR-110 (612)
ATG AIRPORTS LIMITED	L-850B(L)	1, 2	3	1			IR850B-23WB-110 (614); IR850B-32BW-110 (613); IR850B-13WB-110 (611); IR850B-31BW-110 (611)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850A	2	3	1			850A3-XX-12F-XX (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850B	2	3	1			850B3-C-12F-P1-X (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850A			1			850A3-CC-XX (219); 850A3-CR-XX (219); 850A3-Rx-XX (219); 850A3-Cx-XX (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850B			1			850B3-C-XX–X (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850C			1			850C3-XX-XX (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850F			1			850F3-XX (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850D	2	2	1			850D6-XX-XX (215)(400)

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CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850E	2	2	1			850E6-G (194)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850A(L)	2	3	1			850A-AP1-XX-F1-12S-XX-X-0 (589) (590)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850B(L)	2	3	1			850B-AP1-WN-F1-12X-XX-X-0 (590)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850A(L)	2	3	1			850A-AP1-XX-F1-8FS-XX-X-X (574) (575)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-850B(L)	2	3	1			850B-AP1-WN-F1-8FX-XX-X-X (575)
EMA TESISAT VE ENDUSTRIYEL	L-850B	1, 2	2	1			L850B-TDZ-3-1-48W (644)
EMA TESISAT VE ENDUSTRIYEL	L-850C	1, 2	2	1			L850C-REL-3-2-105W/W (164)
EMA TESISAT VE ENDUSTRIYEL	L-850D	1, 2	2	1			L850D-RTEL-3-1-105G (164)
EMA TESISAT VE ENDUSTRIYEL	L-850E	1, 2	2	1			L850E-ATLI-3-2-48G (644)
HELLA KGAA HUECK & CO.	L-850A(L)	1, 2	3	1			8NA 010.759-08 (452)(453)(457)(458); 8NA 010.759-09 (453)(457); 8NA 010.759-10 (452)(453)(457)(458); 8NA 010.759-11 (453)(457); 8NA 010.759-12 (452)(453)(457)(458); 8NA 010.759-13 (453)(457); 8NA 010.759-14 (452)(453)(457)(458); 8NA 010.759-15 (453)(457); 8NA 011.593-08 (452)(453)457)(458); 8NA 011.593.09 (452)(458); 8NA 011.593-10 (452)(453)(457)(458); 8NA 011.593-11 (452)(458); 8NA 011.593-12 (452)(453)(457)(458); 8NA 011.593-13 (452)(458); 8NA 011.593-14 (452)(453)(457)(458); 8NA 011.593-15 (452)(458)
HELLA KGAA HUECK & CO.	L-850B(L)	2	3	1			8NA 011.348-02 (453); 8NA 011.348-03 (453); 8NA 011.594-02 (458); 8NA 011.594-03 (458)
MULTI-ELECTRIC MANUFACTURING, INC.	L-850A(L)	1, 2	3	1			LRCL04-F-WW-XX-X-X (534); LRCL04-F-WR-2P-X-X(534)(535); LRCL04-F-WR-1P-X-X (534)(531); LRCL04-F-WS-1P-X-X (534); LRCL04-F-WM-1P-X-X (534); LRCL04-F-RS-1P-X-X (531); LRCL04-F-RM-1P-X-X (531); LRCL04-F-WW-XX-X-X (533); LRCL04-F-WR-XX-X-X (533)(532)(536)
MULTI-ELECTRIC MANUFACTURING, INC.	L-850D(L)	1, 2	3	1			LTHE04-F-GR-X-XX-X-X (539)(532); LTHE04-F-RR-L-XX-X-X (532); LTHE04-F-GS-X-1P-X-X (539); LTHE04-F-GM-X-1P-X-X (539)
MULTI-ELECTRIC MANUFACTURING, INC.	L-850E(L)	1, 2	3	1			LRTH04-F-X-X-X (539)
MULTI-ELECTRIC MANUFACTURING, INC.	L-850T(L)	1, 2	3	1			LRCL04-F-TS-1P-X-X (532); LRCL04-F-TM-1P-X-X (532)

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MULTI-ELECTRIC MANUFACTURING, INC.	L-850C(L)	1, 2	3	1			LRED04-F-WW-XX-X-X (533); LRED04-F-WY-XX-X-X (533)(538); LRED04-F-YW-XX-X-X (538)(533); LRED04-WR-XX-X-X (533)(536) LRED04-F-RW-XX-X-X (536)(533); LRED04-F-YR-XX-X-X (538)(536); LRED04-F-RY-XX-X-X (536)(538); LRED04-F-YG-XX-X-X (538)(537) LRED04-F-GY-XX-X-X (537)(538)
MULTI-ELECTRIC MANUFACTURING, INC.	L-850B(L)	1, 2	3	1			LTDZ04-F-X-X-X (533)
OCEM AIRFIELD TECHNOLOGY	L-850A	1, 2	3	1			RCLF-F-CC-090-XP-X-F (519); RCLF-F-CR-090-XP-X-F (519); RCLF-F-CM-045-1P-X-F (519); RCLF-F-RM-045-1P-X-F (519)
OCEM AIRFIELD TECHNOLOGY	L-850B	1, 2	3	1			TDZF-F-C-RI-045-X-F (519); TDZF-F-C-LI-045-X-F (519)
OCEM AIRFIELD TECHNOLOGY	L-850C	1, 2	3	1			SLRE-E-CCP-XP-200-O-F (520); SLRE-E-CPC-XP-200-O-F (520); SLRE-E-CPR-XP-200-O-F (520); SLRE-D-CPY-XP-200-O-F (520); SLRE-E-CRP-XP-200-O-F (520); SLRE-E-CYP-XP-200-O-F (520); SLRE-E-GPY-XP-200-O-F (520); SLRE-E-RPY-XP-200-O-F (520); SLRE-E-RYP-XP-200-O-F (520); SLRE-E-YCP-XP-200-O-F (520); SLRE-E-YPC-XP-200-O-F (520); SLRE-E-YPG-XP-200-O-F (520)
OCEM AIRFIELD TECHNOLOGY	L-850D	1, 2	3	1			SLRE-A-GRP-XP-200-O-F (520); SLRE-A-GXP-1P-100-O-F (520); SLRE-A-RPG-XP-200-O-F (520); SLRE-A-RPR-XP-200-O-F (520); SLRE-A-XPG-1P-100-O-F (520)
OCEM AIRFIELD TECHNOLOGY	L-850E	1, 2	3	1			SLTH-A-ST-200-O-F (520)
OCEM AIRFIELD TECHNOLOGY	L-850T	1, 2	3	1			RCLF-F-TM-100-1P-X-F (520)
OCEM AIRFIELD TECHNOLOGY	L-850A(L)	1, 2	3	1			LIRC-F-WW-XX-X-X-X (534); LIRC-F-WR-2P-X-X-X (534)(535); LIRC-F-WR-1P-X-X-X (534)(531); LIRC-F-WS-1P-X-X-X(534); LIRC-F-WM-1P-X-X-X (534); LIRC-F-RS-1P-X-X-X (531); LIRC-F-RM-1P-X-X-X (531); LIRL-F-WW-XX-X-X (533); LIRL-F-WR-XX-X-X (533)(532)(536); LIRL-F-WS-1P-X-X (533); LIRL-F-WM-1P-X-X (533); LIRL-F-RS-1P-X-X (532); LIRL-F-RM-1P-X-X (532)
OCEM AIRFIELD TECHNOLOGY	L-850T(L)	1, 2	3	1			LIRC-F-TS-1P-X-X-X(535); LIRC-F-TM-1P-X-X-X (535); LIRL-F-TS-1P-X-X (532); LIRL-F-TM-1P-X-X (532)
OCEM AIRFIELD TECHNOLOGY	L-850B(L)	1, 2	3	1			LIRD-F-X-X-X-X (534); LIRZ-F-X-X-X (533)

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OCEM AIRFIELD TECHNOLOGY	L-850C(L)	1, 2	3	1			LIRE-F-WW-XX-X-X (533); LIRE-F-WY-XX-X-X (533)(538); LIRE-F-YW-XX-X-X (538)(533); LIREF-WR-XX-X-X (533)(536); LIRE-F-RW-XX-X-X (536)(533); LIRE-F-YR-XX-X-X (538)(536); LIRE-F-RY-XX-X-X (536)(538); LIRE-F-YG-XX-X-X (538)(537); LIRE-F-GY-XX-X-X (537)(538)
OCEM AIRFIELD TECHNOLOGY	L-850D(L)	1, 2	3	1			LIRH-F-GR-X-XX-X-X (539)(532); LIRH-F-RR-L-XX-X-X (532); LIRH-F-GS-X-1P-X-X (539); LIRH-F-GM-X-1P-X-X (539)
OCEM AIRFIELD TECHNOLOGY	L-850E(L)	1, 2	3	1			LIRT-F-X-X-X (539)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850C	2	2	1			IHF-REDL-105-01-1 (164); IHF-REDL-105-02-1 (164); IHF-REDL-105-06-1 (164); IHF-REDL-105-07-1 (164); IHF-REDL-105-08-1 (164)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850D	2	2	1			IHF-RTHL-105-04-1 (164); IHF-RENL-105-05-1 (164)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850A	1, 2	3	1			IHG-RCLL-1-048-X-0X-X (216)
L-850 Runway Inpavement Lights (FAA AC 150/5345-46E)							
ADB SAFEGATE AMERICAS, LLC	L-850A(L)	2	3	1			IRCL-X11XX0 (503)(504)
ADB SAFEGATE AMERICAS, LLC	L-850B(L)	2	3	1			TDZL-X11X0 (503)
ADB SAFEGATE AMERICAS, LLC	L-850(T)	2	3	1			THL-1X0 (505)
ADB SAFEGATE AMERICAS, LLC	L-850A(L)	2	3	1			DRCX2XX0XX00XU0 (623); DRCX3XX0XX00XU0 (623); DRCX2XX0XX01XU0 (623); DRCX3XX0XX01XU0 (623)
ADB SAFEGATE AMERICAS, LLC	L-850B(L)	2	3	1			DTZX2WNXXX00XU0 (624); DTZX2WNXXX01XU0 (624)
ADB SAFEGATE AMERICAS, LLC	L-850T(L)	2	3	1			DTHX2RN0XMF11R0(720); DTHJ2RN0DMF00R0 (720)
ADB SAFEGATE SWEDEN AB	L-850E	1, 2	2	1			INL-RNS+2X105w+G+XX+1C+XX+L850E (164)
ADB SAFEGATE SWEDEN AB	L-850C	1, 2	2	1			INL-RE-2X105W+XX+XX+XX+XX+L850C (164)
ADB SAFEGATE SWEDEN AB	L-850A	1, 2	2	1			INL-RC+2x45W+XX+XX+ XX+L850A (192); INL-RTS+1x45W+X+XX+L850A (192)
ADB SAFEGATE SWEDEN AB	L-850B	1, 2	2	1			INL-RTX+1x45W+W+XX+L850B (192)
ADB SAFEGATE SWEDEN AB	L-850A(L)	1, 2	3	1			SafeLEDIQXRCI8BSSWWXC (620); SafeLEDIQXRCI8BSSWRXC (620)(621)
ADB SAFEGATE SWEDEN AB	L-850B(L)	1, 2	3	1			SafeLEDIQXRZI8UXS-W1C (620)
ADB SAFEGATE SWEDEN AB	L-850A(L)	1, 2	3	1			SafeLEDXRCI12BSSWW6.6A1C (690); SafeLEDXRCI12BSSWR6.6A1C (690)(691)
ADB SAFEGATE SWEDEN AB	L-850B(L)	1, 2	3	1			SafeLEDXRZI12UXSW6.6A1C (690)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE SWEDEN AB	L-850C(L)	1, 2	3	1			SafeLEDXREI12BCSWW6.6A1C (692)(696); SafeLEDXREI12BCSWY6.6A1C (692)(699); SafeLEDXREI12BCSYW6.6A1C (695)(696); SafeLEDXREI12BCSWR6.6A1C (692)(697); SafeLEDXREI12BCSRW6.6A1C (693)(696); SafeLEDXREI12BCSRY6.6A1C (693)(699); SafeLEDXREI12BCSYR6.6A1C (695)(697); SafeLEDXREI12BCSFY6.6A1C (694)(699); SafeLEDXREI12BCSYF6.6A1C (695)(698)
ADB SAFEGATE SWEDEN AB	L-850D(L)	1, 2	3	1			SafeLEDXRNI12USSR6.6A1C (700); SafeLEDXRNI12BSSRR6.6A1C (700); SafeLEDXRTI12ULSF6.6A1CL850D(L) (701); SafeLEDXRTI12URSF6.6A1CL850D(L) (703); SafeLEDXRTNI12BLSFR6.6A1CL850D(L) (700)(701); SafeLEDXRTNI12BRSFR6.6A1CL850D(L) (700)(703)
ADB SAFEGATE SWEDEN AB	L-850T(L)	1, 2	3	1			SafeLEDXRSI12USSR6.6A1C (704)
ASTRONICS DME CORPORATION	L-850A(L)	2	3	1			850A-L-X-WW-0-X(736); 850A-L-X-WR-0-X(734)(736); 850A-L-X-W-0-1(736); 850A-L-X-R-0-1(734)
ASTRONICS DME CORPORATION	L-850B(L)	2	3	1			850B-L-X-W-X-1(736)
ASTRONICS DME CORPORATION	L-850T(L)	2	3	1			850T-L-X-R-0-1(734)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850B	1	3	1			IHD-RTZL-2-048-1-01-1-X (216)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850B	2	3	1			IHD-RTZL-2-048-1-01-1-X (216)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850C(L)	1	2	1			IHF(L)-REDL-L-21-W/Y(742)(743)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850D(L)	1	2	1			IHF(L)-RTHL/RENL-L-21-G/R (744)(745)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850A(L)	2	3	1			IHH(L)-RCLL-C-21-W/R (754)(755)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-850B(L)	2	3	1			IHH(L)-RTZL-X-11-W (754)
L-852 Taxiway Inpavement Lights (FAA AC 150/5345-46D)							
ADB SAFEGATE AMERICAS, LLC	L-852S(L)	2	3	1			REL-1XX (420)
ADB SAFEGATE AMERICAS, LLC	L-852T(L)	2	3	1			ITEL-C11X (445); ITEL-C21X (445)
ADB SAFEGATE AMERICAS, LLC	L-852C	2	3	1			44A4764-XX1X (416); 44A4764-XX3X (416)
ADB SAFEGATE AMERICAS, LLC	L-852D	2	3	1			44A4765-XX1X (316); 44A4765-XX3X (316)
ADB SAFEGATE AMERICAS, LLC	L-852C(L)	2	3	1			ITCF-CX03X2 (570)(569)(615)
ADB SAFEGATE AMERICAS, LLC	L-852D(L)	2	3	1			ITCF-DX03X2 (596)(597)(598)(618)
ADB SAFEGATE AMERICAS, LLC	L-852L(K)	2	3	1			ITCF-KX03X2 (596)(598)(618)
ADB SAFEGATE AMERICAS, LLC	L-852A(L)	2	3	1			ITCF-AX03X2 (570)(604)(615)
ADB SAFEGATE AMERICAS, LLC	L-852B(L)	2	3	1			ITCF-BX03X2 (570)(604)(615)

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ADB SAFEGATE AMERICAS, LLC	L-852J(L)	2	3	1			ITCF-JX03X2 (570)(604)(615)
ADB SAFEGATE AMERICAS, LLC	L-852C			1			44A4827-3XX1 (317)
ADB SAFEGATE AMERICAS, LLC	L-852G	2	3	1			44A5875-211 (123); 44A5988-1211 (123)
ADB SAFEGATE AMERICAS, LLC	L-852S	2	3	1			44A5924-X11 (123); 44A5988-1211 (123)
ADB SAFEGATE AMERICAS, LLC	L-852G(L)	2	3	1			IRGS-X1X00 (426)
ADB SAFEGATE AMERICAS, LLC	L-852S(L)	2	3	1			IRGS-X1X00 (420)
ADB SAFEGATE BVBA	L-852C(L)	1, 2	3	1			DTSL2GG0BX00000(628); DTSL2YY0BX00000(627); DTSL3GG0BX00000(628); DTSL3YY0BX00000(627); DTSL2GY0BX00000(628)(627); DTSL3GY0BX00000(628)(627); DTSL2GN0BX00000(628); DTSL2YN0BX00000(627)
ADB SAFEGATE BVBA	L-852K(L)	1, 2	3	1			DTCL2GG3BX00000(628); DTCL2YY3BX00000(627); DTCL3GG3BX00000(628); DTCL3YY3BX00000(627); DTCL2GN3BX00000(628); DTCL2NG3BX00000(628); DTCL2YN3BX00000(627); DTCL2NY3BX00000(627)
ADB SAFEGATE BVBA	L-852C(L)	1, 2	3	1			DTSL2GG0DX00000(628); DTSL2YY0DX00000(627); DTSL3GG0DX00000(628); DTSL3YY0DX00000(627); DTSL2GY0DX00000(628)(627); DTSL3GY0DX00000(628)(627) DTSL2GN0DX00000(628); DTSL2YN0DX00000(627);
ADB SAFEGATE BVBA	L-852K(L)	1, 2	3	1			DTCL2GG3DX00000(628); DTCL2YY3DX00000(627); DTCL3GG3DX00000(628); DTCL3YY3DX00000(627); DTCL2GN3DX00000(628); DTCL2NG3DX00000(628); DTCL2YN3DX00000(627); DTCL2NY3DX00000(627)
ADB SAFEGATE SWEDEN AB	L-852C(L)	1, 2	3	1			SafeLEDXXTC-I-XNXXXXC (402)(403)
ADB SAFEGATE SWEDEN AB	L-852K(L)	1, 2	3	1			SafeLEDXXTC-I-XCXXXXC (402)(403)
ADB SAFEGATE SWEDEN AB	L-852T	1, 2	2	1			T: IN-OMA+1X45W+B (192)
ADB SAFEGATE SWEDEN AB	L-852C	1, 2	2	1			IN-TON+1x40W+XX+XX+L852C (191), IN-TTN+2x40W+XX+XX+2C+L852C (191); IN-SBN+1x40W+X+XX+L852C (191); ILP-TBN+Xx40W+XX+XX+L852C(191), ILP-TUN+1x40W+X+XX+L852C(191)
ADB SAFEGATE SWEDEN AB	L-852D	1, 2	2	1			IN-TOW+1x40W+GG+XX+L852D (191); IN-TOW+1x40W+YY+XX+L852D (191); IN-TTC+2x40W+GG+XX+L852D (191); IN-TTC+2x40W+YY+XX+L852D (191); IN-SBR+2x40W+X+XX+L852D (191); IN-SBL+2x40W+X+XX+L852D (191)
ADB SAFEGATE SWEDEN AB	L-852C	1, 2	3	1			ILP-TBN+Xx40W+XX+XX+L852C (191); ILP-TUN+1x40W+X+XX+L852C (191)

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ADB SAFEGATE SWEDEN AB	L-852K	1, 2	3	1			ILP-TBC+Xx40W+GG+XX+L852K (191); ILP-TBC+Xx40+YY+XX+L852K (191); ILP-TUX+1x40+X+XX+L852K (191)
ADB SAFEGATE SWEDEN AB	L-852G	1	2	1			INL-RG+1X105W+Y+LC+1C+L852G (164)
ADB SAFEGATE SWEDEN AB	L-852T(L)	1, 2	2	1			SafeLED-TE-I-O-B-1C-6.6A (564)
ADB SAFEGATE SWEDEN AB	L-852G(L)	1, 2	3	1			SafeLEDXRGLI8USSY1C-L852G(L)(714)
ADB SAFEGATE SWEDEN AB	L-852S(L)	1, 2	3	1			SafeLEDXSBI8USSR1C-L852S(L)(715)
ADB SAFEGATE SWEDEN AB	L-852G(L)	1, 2	3	1			SafeLEDXRGLI12USSY1C-L852G(L) (718)
ADB SAFEGATE SWEDEN AB	L-852S(L)	1, 2	3	1			SafeLEDXSBI12USSR1C-L852S(L) (719)
ASTRONICS DME CORPORATION	L-852T(L)	2	3	1			852T-L-X (444)
ASTRONICS DME CORPORATION	L-852A(L)			1			852A-L-X-XX-X-X (488)(489)
ASTRONICS DME CORPORATION	L-852B(L)			1			852B-L-X-XX-X-X (488)(489)
ASTRONICS DME CORPORATION	L-852C(L)			1			852C-L-X-XX-X-X (488)(489)
ASTRONICS DME CORPORATION	L-852D(L)			1			852D-L-X-XX-X-X (488)(489)(560)
ATG AIRPORTS INC.	L-852C(L)	1, 2	3	1			IR852C-22GG-XX0 (550); IR852C-22YY-XX0 (576); IR852C-26YB-XX0 (576); IR852C-62BY-XX0 (576); IR852C-26GB-XX0 (550); IR852C-62-BG-XX0 (550); IR852C-22-GY-XX0 (550)(576); IR852C-22-YG-XX0 (576)(550)
ATG AIRPORTS INC.	L-852D(L)	1, 2	3	1			IR852D-33GG-XX0 (577); IR852D-33YY-XX0 (578); IR852D-36YB-XX0 (578); IR852D-63BY-XX0 (578); IR852D-36GB-XX0 (577); IR852D-63-BG-XX0 (577)
ATG AIRPORTS INC.	L-852A(L)	1, 2	3	1			IR852A-22GG-XX0 (577); IR852A-22YY-XX0 (578); IR852A-26YB-XX0 (578); IR852A-62BY-XX0 (578); IR852A-26GB-XX0 (577); IR852A-62-BG-XX0 (577); IR852A-22-GY-XX0 (577)(578); IR852A-22-YG-XX0 (577)(578)
ATG AIRPORTS INC.	L-852B(L)	1, 2	3	1			IR852B-33GG-XX0 (577); IR852B-33YY-XX0 (578); IR852B-36YB-XX0 (578); IR852B-63BY-XX0 (578); IR852B-36GB-XX0 (577); IR852B-63-BG-XX0 (577)
ATG AIRPORTS INC.	L-852J(L)	1, 2	3	1			IR852J-44GG-XX0 (577); IR852J-55YY-XX0 (578); IR852J-56YB-XX0 (578); IR852J-65BY-XX0 (578); IR852J-46GB-XX0 (577); IR852J-64BG-XX0 (577)
ATG AIRPORTS INC.	L-852K(L)	1, 2	3	1			IR852K-44GG-XX0 (577); IR852K-55YY-XX0 (578); IR852K-56YB-XX0 (578); IR852K-65BY-XX0 (578); IR852K-46GB-XX0 (577); IR852K-64BG-XX0 (577)

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ATG AIRPORTS LIMITED	L-852C(L)	1, 2	3	1			IR852C-22GG-XX0 (607); IR852C-22YY-XX0 (608); IR852C-26YB-XX0 (608); IR852C-62BY-XX0 (608); IR852C-26GB-XX0 (607); IR852C-62BG-XX0 (607); IR852C-22GY-XX0 (607)(608); IR852C-22YG-XX0 (608)(607)
ATG AIRPORTS LIMITED	L-852D(L)	1, 2	3	1			IR852D-33GG-XX0 (609); IR852D-33YY-XX0 (610); IR852D-36YB-XX0 (610); IR852D-63BY-XX0 (610); IR852D-36GB-XX0 (609); IR852D-63-BG-XX0 (609)
ATG AIRPORTS LIMITED	L-852A(L)	1, 2	3	1			IR852A-22GG-XX0 (609); IR852A-22YY-XX0 (610); IR852A-26YB-XX0 (610); IR852A-62BY-XX0 (610); IR852A-26GB-XX0 (609); IR852A-62-BG-XX0 (609); IR852A-22GY-XX0 (609)(610); IR852A-22YG-XX0 (609)(610)
ATG AIRPORTS LIMITED	L-852B(L)	1, 2	3	1			IR852B-33GG-XX0 (609); IR852B-33YY-XX0 (610); IR852B-36YB-XX0 (610); IR852B-63BY-XX0 (610); IR852B-36GB-XX0 (609); IR852B-63-BG-XX0 (609)
ATG AIRPORTS LIMITED	L-852J(L)	1, 2	3	1			IR852J-44GG-XX0 (609); IR852J-55YY-XX0 (610); IR852J-56YB-XX0 (610); IR852J-65BY-XX0 (610); IR852J-46GB-XX0 (609); IR852J-64BG-XX0 (609)
ATG AIRPORTS LIMITED	L-852K(L)	1, 2	3	1			IR852K-44GG-XX0 (609); IR852K-55YY-XX0 (610); IR852K-56YB-XX0 (610); IR852K-65BY-XX0 (610); IR852K-46GB-XX0 (609); IR852K-64BG-XX0 (609)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852D	1, 2	3	1			852D6-XX-12F-XX (181)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852A			1			852A3-XX-12F-XX (181)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852B			1			852B3-XX-12F-XX (181)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852C			1			852C3-XX-12F-XX (181)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852G			1			852G3-Y-XXX-X (215)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852S	2	3	1			852S3-R-XXX-X (215)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852G	2	3	1			852GS3-YR-P2; 852GS3-Yx-P1
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852S	2	3	1			852GS3-YR-P2; 852GS3-XR-P1 (215)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852A	2	3	1			852A3-XX-PX (181)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852B	2	3	1			852B3-XX-PX (181)

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CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852C	2	3	1			852C3-XX-PX (181)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852D	2	3	1			852D3-XX-PX (181)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852T(L)	2	3	1			852T5-12X-1 (397) 852T5-12X (397)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852G(L)	2	2	1			G: 852G-7-YX-F1-12B-P1-X (468)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852A(L)	2	3	1			852A-7-XX-F1-XXX-X-X (469)(470)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852B(L)	2	3	1			852B-7-GG-F1-XXX-X-X (469); 852B-7-GO-F1-XXX-X-X (469); 852B-7-YY-F1-XXX-X-X (470); 852B-7-YO-F1-XXX-X-X (470)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852C(L)	2	3	1			852C-7-XX-F1-XXX-X-X (471)(472)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852D(L)	2	3	1			852D-7-GG-F1-XXX-X-X (469); 852D-7-GO-F1-XXX-X-X (469); 852D-7-YY-F1-XXX-X-X (470); 852D-7-YO-F1-XXX-X-X (470)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852E	2	3	1			852E3-12A (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852T	2	3	1			852T3-12A (219); 852T3-12B (219)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852A(L)	2	3	1			852A-AP1-XX-F1-12U (584)(585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852B(L)	2	3	1			852B-AP1-GN-F1-12U-XX-X-0 (584); 852B-AP1-YN-F1-12U-XX-X-0 (585); 852B-AP1-GG-F1-12U-XX-X-0 (584); 852B-AP1-YY-F1-12U-XX-X-0 (585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852C(L)	2	3	1			852C-AP1-XX-F1-12U-XX-X-0 (586) (587)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852D(L)	2	3	1			852D-AP1-GN-F1-12U-XX-X-0 (584); 852D-AP1-YN-F1-12U-XX-X-0 (585); 852D-AP1-GG-F1-12U-XX-X-0 (584); 852D-AP1-YY-F1-12U-XX-X-0 (585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852J(L)	2	3	1			852J-AP1-GN-F1-12U-XX-X-0 (584); 852J-AP1-YN-F1-12U-XX-X-0 (585); 852J-AP1-NG-F1-12U-XX-X-0 (584); 852J-AP1-NY-F1-12U-XX-X-0 (585); 852J-AP1-GG-F1-12U-XX-X-0 (584); 852J-AP1-YY-F1-12U-XX-X-0 (585)

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CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852K(L)	2	3	1			852K-AP1-GN-F1-12U-XX-X-0 (584); 852K-AP1-YN-F1-12U-XX-X-0 (585); 852K-AP1-NG-F1-12U-XX-X-0 (584); 852K-AP1-NY-F1-12U-XX-X-0 (585); 852K-AP1-GG-F1-12U-XX-X-0 (584); 852K-AP1-YY-F1-12U-XX-X-0 (585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852A(L)	2	3	1			852A-AP1-XX-F1-8FS-XX-X-X (584) (585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852B(L)	2	3	1			852B-AP1-GN-F1-8FS-XX-X-X (584); 852B-AP1-YN-F1-8FS-XX-X-X (585); 852B-AP1-GG-F1-8FS-XX-X-X (584); 852B-AP1-YY-F1-8FS-XX-X-X (585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852C(L)	2	3	1			852C-AP1-XX-F1-8FS-XX-X-X (586) (587)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852D(L)	2	3	1			852D-AP1-GN-F1-8FS-XX-X-X (584); 852D-AP1-YN-F1-8FS-XX-X-X (585); 852D-AP1-GG-F1-8FS-XX-X-X (584); 852D-AP1-YY-F1-8FS-XX-X-X (585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852J(L)	2	3	1			852J-AP1-GN-F1-8FL-XX-X-X (584); 852J-AP1-YN-F1-8FL-XX-X-X (585); 852J-AP1-NG-F1-8FR-XX-X-X (584); 852J-AP1-NY-F1-8FR-XX-X-X (585); 852J-AP1-GG-F1-8FC-XX-X-X (584); 852J-AP1-YY-F1-8FC-XX-X-X (585)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852K(L)	2	3	1			852K-AP1-GN-F1-8FL-XX-X-X (584); 852K-AP1-YN-F1-8FL-XX-X-X (585); 852K-AP1-NG-F1-8FR-XX-X-X (584); 852K-AP1-NY-F1-8FR-XX-X-X (585); 852K-AP1-GG-F1-8FC-XX-X-X (584); 852K-AP1-YY-F1-8FC-XX-X-X (585)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
HELLA KGAA HUECK & CO.	L-852C(L)	2	3	1			8NA 011.211-04 (454); 8NA 011.211-05 (454); 8NA 011.211-06 (454); 8NA 011.211-07 (454) ; 8NA 011.211-12 (454)(487); 8NA 011.211-13 (454)(487) 8NA 011.211-14 (454)(487); 8NA 011.211-15 (454)(487); 8NA 011.211-44 (487); 8NA 011.211-45 (487); 8NA 011.211-46 (487); 8NA 011.211-47 (487); 8NA 011.451-06 (454); 8NA 011.451-07 (454); 8NA 011.451-08 (487); 8NA 011.451-09 (487); 8NA 011.451-18 (487); 8NA 011.451-19 (487); 8NA 011.548-04 (454); 8NA 011.548-05 (454); 8NA 011.548-06 (454); 8NA 011.548-07 (454); 8NA 011.548-12 (454)(487); 8NA 011-548-13 (454)(487); 8NA 011.548-14 (454)(487); 8NA 011.548-15 (454)(487); 8NA 011.548-44 (487); 8NA 011.548-45 (487); 8NA 011.548-46 (487); 8NA 011.548-47 (487); 8NA 011.596-06 (454); 8NA 011.596-07 (454); 8NA 011.596-08 (487); 8NA 011.596-09 (487); 8NA 011.596-18 (487); 8NA 011.596-19 (487)
HELLA KGAA HUECK & CO.	L-852K(L)	2	3	1			8NA 011.261-04 (454); 8NA 011.261-05 (454); 8NA 011.261-06 (454); 8NA 011.261-07 (454); 8NA 011.261-44 (487); 8NA 011.261-45 (487); 8NA 011.261-46 (487); 8NA 011.261-47 (487); 8NA 011.549-04 (454); 8NA 011.549-05 (454); 8NA 011.549-06 (454); 8NA 011.549-07 (454); 8NA 011.549-44 (487); 8NA 011.549-45 (487) 8NA 011.549-46 (487); 8NA 011.549-47 (487); 8NA 012.126-00 (454); 8NA-012.126-01 (454); 8NA 012.126-02 (487); 8NA 012.126-03 (487)
HELLA KGAA HUECK & CO.	L-852D(L)	2	3	1			8NA 011.625-04 (463); 8NA 011.625-05 (463); 8NA 011.625-06 (463); 8NA 011.625-07 (463); 8NA 011.625-12 (463)(464); 8NA 011.625-13 (463)(464); 8NA 011.625-14 (463)(464); 8NA 011.625-15 (463)(464); 8NA 011.625-44 (463)(464); 8NA 011.625-45 (463)(464); 8NA 011.625-46 (463)(464); 8NA 011.625-47 (463)(464); 8NA 011.624-06 (463); 8NA 011.624-07 (463); 8NA 011.624-08 (464): 8NA 011.624-09 (464)
HELLA KGAA HUECK & CO.	L-852S(L)	2	3	1			8NA 011.451-10 (484); 8NA 011.451-11 (484); 8NA 011.596-10 (484); 8NA 011-596-11 (484)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
HELLA KGAA HUECK & CO.	L-852G(L)	2	3	1			8NA 011.518-04 (509); 8NA 011.518-05 (509); 8NA 011.518-06 (509); 8NA 011.518-07 (509); 8NA 012.052-04 (509); 8NA 012.052-05 (509); 8NA 012.052-06 (509); 8NA 012.052-07 (509); 8NA 011.518-10 (509); 8NA 011.518-11 (509); 8NA 012.052-10 (509); 8NA 012.052-11 (509)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852A(L)	1, 2	3	1			LTA0804-F-A-GG-XX-X-X-X (540); LTA0804-F-A-GY-XX-X-X-X (540)(541); LTA0804-F-A-YG-XX-X-X-X (541)(540); LTA0804-F-A-YY-XX-X-X-X (541); LTA0804-F-A-GS-1P-X-X-X (540); LTA0804-F-A-YS-1P-X-X-X (541); LTA0804-F-A-GM-1P-X-X-X (540); LTA0804-F-A-YM-1P-X-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852B(L)	1, 2	3	1			LTA0804-F-B-GG-XX-X-X-X (540); LTA0804-F-B-YY-XX-X-X-X (541); LTA0804-F-B-GS-1P-X-X-X (540); LTA0804-F-B-GM-1P-X-X-X (540); LTA0804-F-B-YS-1P-X-X-X (541); LTA0804-F-B-YM-1P-X-X-X (541); LTA0804-F-B-SG-1P-X-X-X (540); LTAC0804-F-B-MG-1P-X-X-X (540); LTA0804-F-B-SY-1P-X-X-X (541); LTA0804-F-B-MY-1P-X-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852C(L)	1, 2	3	1			LTA0804-F-C-GG-XX-X-X-X (540); LTA0804-F-C-GY-XX-X-X-X (540)(541); LTA0804-F-C-YG-XX-X-X-X (541)(540); LTA0804-F-C-YY-XX-X-X-X (541); LTA0804-F-C-GS-1P-X-X-X (540); LTA0804-F-C-GM-1P-X-X-X (540); LTA0804-F-C-YS-1P-X-X-X (541); LTA0804-F-C-YM-1P-X-X-X (541); LTA0804-F-C-SG-1P-X-X-X (540); LTA0804-F-C-MG-1P-X-X-X (540); LTA0804-F-C-SY-1P-X-X-X (541); LTA0804-F-C-MY-1P-X-X-X (541)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MULTI-ELECTRIC MANUFACTURING, INC.	L-852D(L)	1, 2	3	1			LTA0804-F-D-GG-XX-X-X-X (540); LTA0804-F-D-YY-XX-X-X-X (541); LTA0804-F-D-GS-1P-X-X-X (540); LTA0804-F-D-GM-1P-X-X-X (540); LTA0804-F-D-YS-1P-X-X-X (541); LTA0804-F-D-YM-1P-X-X-X (541); LTA0804-F-D-WS-1P-X-X-X (542); LTA0804-F-D-WM-1P-X-X-X (542) LTA0804-F-D-SG-1P-X-X-X (540); LTA0804-F-D-MG-1P-X-X-X (540); LTA0804-F-D-SY-1P-X-X-X (541); LTA0804-F-D-MY-1P-X-X-X (541) LTA0804-F-D-SW-1P-X-X-X (542); LTA0804-F-D-MW-1P-X-X-X (542)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852J(L)	1, 2	3	1			LTA0804-F-J-GG-XX-X-X-X (540); LTA0804-F-J-YY-XX-X-X-X (541); LTA0804-F-J-GS-1P-X-X-X (540); LTA0804-F-J-GM-1P-X-X-X (540) LTA0804-F-J-YS-1P-X-X-X (541); LTA0804-F-J-YM-1P-X-X-X (541); LTA0804-F-J-SG-1P-X-X-X (540); LTA0804-F-J-MG-1P-X-X-X (540) LTA0804-F-J-SY-1P-X-X-X (541); LTA0804-F-J-MY-1P-X-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852K(L)	1, 2	3	1			LTA0804-F-K-GG-XX-X-X-X (540); LTA0804-F-K-YY-XX-X-X-X (541); LTA0804-F-K-GS-1P-X-X-X (540); LTA0804-F-K-GM-1P-X-X-X (540) LTA0804-F-K-YS-1P-X-X-X (541); LTA0804-F-K-YM-1P-X-X-X (541); LTA0804-F-K-SG-1P-X-X-X (540); LTA0804-F-K-MG-1P-X-X-X (540) LTA0804-F-K-SY-1P-X-X-X (541); LTA0804-F-K-MY-1P-X-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852A(L)	1, 2	3	1			LTA1204-F-A-GG-XX-0-X-X (540); LTA1204-F-A-GY-XX-0-X-X (540)(541); LTA1204-F-A-YG-XX-0-X-X (541)(540); LTA1204-F-A-YY-XX-0-X-X (541); LTA1204-F-A-GS-1P-0-X-X (540); LTA1204-F-A-YS-1P-0-X-X (541); LTA1204-F-A-GM-1P-0-X-X (540); LTA1204-F-A-YM-1P-0-X-X (541)

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MULTI-ELECTRIC MANUFACTURING, INC.	L-852B(L)	1, 2	3	1			LTA1204-F-B-GG-XX-0-X-X (540); LTA1204-F-B-YY-XX-0-X-X (541); LTA1204-F-B-GS-1P-0-X-X (540); LTA1204-F-B-GM-1P-0-X-X (540); LTA1204-F-B-YS-1P-0-X-X (541); LTA1204-F-B-YM-1P-0-X-X (541); LTA1204-F-B-SG-1P-0-X-X (540); LTA1204-F-B-MG-1P-0-X-X (540); LTA1204-F-B-SY-1P-0-X-X (541); LTA1204-F-B-MY-1P-0-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852C(L)	1, 2	3	1			LTA1204-F-C-GG-XX-0-X-X (540); LTA1204-F-C-GY-XX-0-X-X (540)(541); LTA1204-F-C-YG-XP-0-X-X (541)(540); LTA1204-F-C-YY-XP-0-X-X (541); LTA1204-F-C-GS-1P-0-X-X (540); LTA1204-F-C-GM-1P-0-X-X (540); LTA1204-F-C-YS-1P-0-X-X (541); LTA1204-F-C-YM-1P-0-X-X (541); LTA1204-F-C-SG-1P-0-X-X (540); LTA1204-F-C-MG-1P-0-X-X (540); LTA1204-F-C-SY-1P-X-X (541); LTA1204-F-C-MY-1P-0-X-X (541); LTA1204-F-C-SY-1P-X-X (541); LTA1204-F-C-MY-1P-0-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852D(L)	1, 2	3	1			LTA1204-F-D-GG-XX-0-X-X (540); LTA1204-F-D-YY-XX-0-X-X (541); LTA1204-F-D-GS-1P-0-X-X (540); LTA1204-F-D-GM-1P-0-X-X (540); LTA1204-F-D-YS-1P-0-X-X (541); LTA1204-F-D-YM-1P-0-X-X (541); LTA1204-F-D-WS-1P-0-X-X (542); LTA1204-F-D-WM-1P-0-X-X (542); LTA1204-F-D-SG-1P-0-X-X (540); LTA1204-F-D-MG-1P-0-X-X (540); LTA1204-F-D-SY-1P-0-X-X- (541); LTA1204-F-D-MY-1P-0-X-X (541); LTA1204-F-D-SW-1P-0-X-X (542); LTA1204-F-D-MW-1P-0-X-X (542)

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MULTI-ELECTRIC MANUFACTURING, INC.	L-852J(L)	1, 2	3	1			LTA1204-F-J-GG-XX-X-X-X (540); LTA1204-F-J-YY-XX-X-X-X (541); LTA1204-F-J-GS-1P-X-X-X (540); LTA1204-F-J-GM-1P-X-X-X (540); LTA1204-F-J-YS-1P-X-X-X (541); LTA1204-F-J-YM-1P-X-X-X (541); LTA1204-F-J-SG-1P-X-X-X (540); LTA1204-F-J-MG-1P-X-X-X (540); LTA1204-F-J-SY-1P-X-X-X (541); LTA1204-F-J-MY-1P-X-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852K(L)	1, 2	3	1			LTA1204-F-K-GG-XX-0-X-X (540); LTA1204-F-K-YY-XX-0-X-X (541); LTA1204-F-K-GS-1P-0-X-X (540); LTA1204-F-K-GM-1P-0-X-X (540); LTA1204-F-K-YS-1P-0-X-X (541); LTA1204-F-K-YM-1P-0-X-X (541); LTA1204-F-K-SG-1P-0-X-X (540); LTA1204-F-K-MG-1P-0-X-X (540); LTA1204-F-K-SY-1P-0-X-X- (541); LTA1204-F-K-MY-1P-0-X-X (541)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852S(L)	1, 2	3	1			LTWS04-X-X (532)
MULTI-ELECTRIC MANUFACTURING, INC.	L-852T(L)	1, 2	3	1			LTO1704-F-X-X-X (543); LTO1804-F-0-X-X (543)
OCEM AIRFIELD TECHNOLOGY	L-852D	1, 2	3	1			TWCD-D-F-GG-XP-090-X-F (519); TWCD-D-F-YY-XP-090-X-F (519); TWCS-D-F-CM-045-X-F (519); TWCS-D-F-GG-045-X-F (519); TWCS-D-F-GM-045-X-F (519); TWCS-D-F-YM-045-X-F (519); TWCS-D-F-YY-045-X-F (519)
OCEM AIRFIELD TECHNOLOGY	L-852E	1, 2	3	1			TWOF-F-Y-045-X-F (519); TWOFXXX-F-Y-045-O-F (519)
OCEM AIRFIELD TECHNOLOGY	L-852G	1, 2	3	1			TWGLF-F-Y-100-X-F (520)
OCEM AIRFIELD TECHNOLOGY	L-852S	1, 2	3	1			TWSBF-F-R-100-X-F (520)
OCEM AIRFIELD TECHNOLOGY	L-852T	1, 2	3	1			TWOF-F-B-045-X-F (519); TWOFXXX-F-B-045-O-F (519)

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OCEM AIRFIELD TECHNOLOGY	L852A	1, 2	3	1			TWCD-A-F-GG-XP-060-X-F (541); TWCD-A-F-GY-XP-060-X-F (521); TWCD-A-F-YG-XP-060-X-F (521); TWCD-A-F-YY-XP-060-X-F (521); TWCS-A-F-GG-030-X-F (521); TWCS-A-F-GM-030-X-F (521); TWCS-A-F-GY-030-X-F (521); TWCS-A-F-YG-030-X-F (521); TWCS-A-F-YM-030-X-F (521); TWCS-A-F-YY-030-X-F (521)
OCEM AIRFIELD TECHNOLOGY	L-852B	1, 2	3	1			TWCD-B-F-GG-XP-060-X-F (521); TWCD-B-F-YY-XP-060-X-F (521); TWCS-B-F-GG-030-X-F (521); TWCS-B-F-GM-030-X-F (521); TWCS-B-F-YM-030-X-F (521); TWCS-B-F-YY-30-X-F (521)
OCEM AIRFIELD TECHNOLOGY	L-852C	1, 2	3	1			TWCD-C-F-GG-XP-090-X-F (519); TWCD-C-F-GY-XP-090-X-F (519); TWCD-C-F-YG-XP-090-X-F (519); TWCD-C-F-YY-XP-090-X-F (519); TWCS-C-F-GG-045-X-F (519); TWCS-C-F-GM-045-X-F (519); TWCS-C-F-GY-045-X-F (519); TWCS-C-F-YG-045-X-F (519); TWCS-C-F-YM-045-X-F (519); TWCS-C-F-YY-045-X-F (519)
OCEM AIRFIELD TECHNOLOGY	L-852J	1, 2	3	1			TWCD-J-F-GG-XP-060-X-F (521); TWCD-J-F-YY-XP-060-X-F (521); TWCS-J-F-GG-030-X-F (521); TWCS-J-F-GM-030-X-F (521); TWCS-J-F-MG-030-X-F (521); TWCS-J-F-MY-030-X-F (521); TWCS-J-F-YM-030-X-F (521); TWCS-J-F-YY-030-X-F (521)
OCEM AIRFIELD TECHNOLOGY	L-852K	1, 2	3	1			TWCD-K-F-GG-090-X-F (519); TWCD-K-F-YY-XP-090-X-F (519); TWCS-K-F-GG-045-X-F (519); TWCS-K-F-GM-045-X-F (519); TWCS-K-F-MG-045-X-F (519); TWCS-K-F-MY-045-X-F (519); TWCS-K-F-YM-045-X-F (519); TWCS-K-F-YY-045-X-F (519)

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OCEM AIRFIELD TECHNOLOGY	L-852A(L)	1, 2	3	1			LITC08-F-A-GG-XX-X-X-X (540); LITC08-F-A-GY-XX-X-X-X (540)(541); LITC08-F-A-YG-XX-X-X-X (541)(540); LITC08-F-A-YY-XX-X-X-X (541); LITC08-F-A-GS-1P-X-X-X (540); LITC08-F-A-YS-1P-X-X-X (541); LITC08-F-A-GM-1P-X-X-X (540); LITC08-F-A-YM-1P-X-X-X (541)
OCEM AIRFIELD TECHNOLOGY	L-852B(L)	1, 2	3	1			LITC08-F-B-GG-XX-X-X-X (540); LITC08-F-B-YY-XX-X-X-X (541); LITC08-F-B-GS-1P-X-X-X (540); LITC08-F-B-GM-1P-X-X-X (540) LITC08-F-B-YS-1P-X-X-X (541); LITC08-F-B-YM-1P-X-X-X (541); LITC08-F-B-SG-1P-X-X-X (540); LITC08-F-B-MG-1P-X-X-X (540) LITC08-F-B-SY-1P-X-X-X (541); LITC08-F-B-MY-1P-X-X-X (541)
OCEM AIRFIELD TECHNOLOGY	L-852C(L)	1, 2	3	1			LITC08-F-C-GG-XX-X-X-X (540); LITC08-F-C-GY-XX-X-X-X (540)(541); LITC08-F-C-YG-XX-X-X-X (541)(540); LITC08-F-C-YY-XX-X-X-X (541); LITC08-F-C-GS-1P-X-X-X (540); LITC08-F-C-GM-1P-X-X-X (540); LITC08-F-C-YS-1P-X-X-X (541); LITC08-F-C-YM-1P-X-X-X (541); LITC08-F-C-SG-1P-X-X-X (540); LITC08-F-C-MG-1P-X-X-X (540); LITC08-F-C-SY-1P-X-X-X (541); LITC08-F-C-MY-1P-X-X-X (541)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
OCEM AIRFIELD TECHNOLOGY	L-852D(L)	1, 2	3	1			LITC08-F-D-GG-XX-X-X-X (540); LITC08-F-D-YY-XX-X-X-X (541); LITC08-F-D-GS-1P-X-X-X (540); LITC08-F-D-GM-1P-X-X-X (540); LITC08-F-D-YS-1P-X-X-X (541); LITC08-F-D-YM-1P-X-X-X (541); LITC08-F-D-WS-1P-X-X-X (542); LITC08-F-D-WM-1P-X-X-X (542) LITC08-F-D-SG-1P-X-X-X (540); LITC08-F-D-MG-1P-X-X-X (540); LITC08-F-D-SY-1P-X-X-X (541); LITC08-F-D-MY-1P-X-X-X (541) LITC08-F-D-SW-1P-X-X-X (542); LITC08-F-D-MW-1P-X-X-X (542)
OCEM AIRFIELD TECHNOLOGY	L-852J(L)	1, 2	3	1			LITC08-F-J-GG-XX-X-X-X (540); LITC08-F-J-YY-XX-X-X-X (541); LITC08-F-J-GS-1P-X-X-X (540); LITC08-F-J-GM-1P-X-X-X (540); LITC08-F-J-YS-1P-X-X-X (541); LITC08-F-J-YM-1P-X-X-X (541); LITC08-F-J-SG-1P-X-X-X (540); LITC08-F-J-MG-1P-X-X-X (540); LITC08-F-J-SY-1P-X-X-X (541); LITC08-F-J-MY-1P-X-X-X (541)
OCEM AIRFIELD TECHNOLOGY	L-852K(L)	1, 2	3	1			LITC08-F-K-GG-XX-X-X-X (540); LITC08-F-K-YY-XX-X-X-X (541); LITC08-F-K-GS-1P-X-X-X (540); LITC08-F-K-GM-1P-X-X-X (540) LITC08-F-K-YS-1P-X-X-X (541); LITC08-F-K-YM-1P-X-X-X (541); LITC08-F-K-SG-1P-X-X-X (540); LITC08-F-K-MG-1P-X-X-X (540) LITC08-F-K-SY-1P-X-X-X (541); LITC08-F-K-MY-1P-X-X-X (541)
OCEM AIRFIELD TECHNOLOGY	L-852S(L)	1, 2	3	1			S: LITS-X-X (532);
OCEM AIRFIELD TECHNOLOGY	L-852T(L)	1, 2	3	1			LITE08-F-X-X-X (543); LITE18-F-0-X-X (543)
OCEM AIRFIELD TECHNOLOGY	L-852A(L)	1, 2	3	1			LITC12-F-A-GG-XX-0-X-X (540); LITC12-F-A-GY-XX-0-X-X (540)(541); LITC12-F-A-YG-XX-0-X-X (541)(540); LITC12-F-A-YY-XX-0-X-X (541); LITC12-F-A-GS-1P-0-X-X (540); LITC12-F-A-YS-1P-0-X-X (541); LITC12-F-A-GM-1P-0-X-X (540); LITC12-F-A-YM-1P-0-X-X (541)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
OCEM AIRFIELD TECHNOLOGY	L-852B(L)	1, 2	3	1			LITC12-F-B-GG-XX-0-X-X (540); LITC12-F-B-YY-XX-0-X-X (541); LITC12-F-B-GS-1P-0-X-X (540); LITC12-F-B-GM-1P-0-X-X (540) LITC12-F-B-YS-1P-0-X-X (541); LITC12-F-B-YM-1P-0-X-X (541); LITC12-F-B-SG-1P-0-X-X (540); LITC12-F-B-MG-1P-0-X-X (540); LITC12-F-B-SY-1P-0-X-X (541); LITC12-F-B-MY-1P-0-X-X (541)
OCEM AIRFIELD TECHNOLOGY	L-852C(L)	1, 2	3	1			LITC12-F-C-GG-XX-0-X-X (540); LITC12-F-C-GY-XX-0-X-X (540)(541); LITC12-F-C-YG-XP-0-X-X (541)(540); LITC12-F-C-YY-XP-0-X-X (541); LITC12-F-C-GS-1P-0-X-X (540); LITC12-F-C-GM-1P-0-X-X (540); LITC12-F-C-YS-1P-0-X-X (541); LITC12-F-C-YM-1P-0-X-X (541); LITC12-F-C-SG-1P-0-X-X (540); LITC12-F-C-MG-1P-0-X-X (540); LITC12-F-C-SY-1P-X-X (541); LITC12-F-C-MY-1P-0-X-X (541) LITC12-F-C-SY-1P-X-X (541); LITC12-F-C-MY-1P-0-X-X (541)
OCEM AIRFIELD TECHNOLOGY	L-852D(L)	1, 2	3	1			LITC12-F-D-GG-XX-0-X-X (540); LITC12-F-D-YY-XX-0-X-X (541); LITC12-F-D-GS-1P-0-X-X (540); LITC12-F-D-GM-1P-0-X-X (540); LITC12-F-D-YS-1P-0-X-X (541); LITC12-F-D-YM-1P-0-X-X (541); LITC12-F-D-WS-1P-0-X-X (542); LITC12-F-D-WM-1P-0-X-X (542); LITC12-F-D-SG-1P-0-X-X (540); LITC12-F-D-MG-1P-0-X-X (540); LITC12-F-D-SY-1P-0-X-X- (541); LITC12-F-D-MY-1P-0-X-X (541); LITC12-F-D-SW-1P-0-X-X (542); LITC12-F-D-MW-1P-0-X-X (542)
OCEM AIRFIELD TECHNOLOGY	L-852J(L)	1, 2	3	1			LITC12-F-J-GG-XX-X-X-X (540); LITC12-F-J-YY-XX-X-X-X (541); LITC12-F-J-GS-1P-X-X-X (540); LITC12-F-J-GM-1P-X-X-X (540); LITC12-F-J-YS-1P-X-X-X (541); LITC12-F-J-YM-1P-X-X-X (541); LITC12-F-J-SG-1P-X-X-X (540); LITC12-F-J-MG-1P-X-X-X (540); LITC12-F-J-SY-1P-X-X-X (541); LITC12-F-J-MY-1P-X-X-X (541)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
OCEM AIRFIELD TECHNOLOGY	L-852K(L)	1, 2	3	1			LITC12-F-K-GG-X-0-X-X (540); LITC12-F-K-YY-XX-0-X-X (541); LITC12-F-K-GS-1P-0-X-X (541); LITC12-F-K-GM-1P-0-X-X (540); LITC12-F-K-YS-1P-0-XX (541); LITC12-F-K-YM-1P-0-X-X (541); LITC12-F-K-SG-1P-0-X-X (540); LITC12-F-K-MG-1P-0-X-X (540); LITC12-F-K-SY-1P-0-X-X (541); LITC12-F-K-MY-1P-0-X-X (541)
OCEM AIRFIELD TECHNOLOGY	L-852G(L)	1, 2	3	1			LITG-F-X-X (538)
L-852 Taxiway Inpavement Lights (FAA AC 150/5345-46E)							
ADB SAFEGATE AMERICAS, LLC	L-852G(L)	2	3	1			IRGL-2X121 (426); IRGL-3X121(426)
ADB SAFEGATE AMERICAS, LLC	L-852D(L)	2	3				D2DXXYY0XXF0XU0 (659); D2DXXGG0XXF0XU0 (658) D2DXXYY0XXF1XU0 (659); D2DXXGG0XXF1XU0 (658) D2DXXYN0XXF0XU0 (659); D2DXXGN0XXF0XU0 (658) D2DXXYN0XXF1XU0 (659); D2DXXGN0XXF1XU0 (658) D2DXXWN0XXF0XU0 (666); D2DXXWW0XXF0XU0 (666) D2DXXWN0XXF1XU0 (666); D2DXXWW0XXF1XU0 (666) D2DXXWY0XXF0XU0 (659)(666); D2DXXWY0XXF1XU0 (658)(666)
ADB SAFEGATE AMERICAS, LLC	L-852C(L)	2	3				D2CXXYY0XXF0XU0 (663); D2CXXGG0XXF0XU0 (662) D2CXXYY0XXF1XU0 (663); D2CXXGG0XXF1XU0 (662) D2CXXYN0XXF0XU0 (663); D2CXXGN0XXF0XU0 (662) D2CXXYN0XXF1XU0 (663); D2CXXGN0XXF1XU0 (662) D2CXXYG0XXF0XU0 (663)(662); D2CXXYG0XXF1XU0 (663)(662);
ADB SAFEGATE AMERICAS, LLC	L-852B(L)	2	3				D2BXXYY0XXF0XU0 (665); D2BXXGG0XXF0XU0 (664) D2BXXYY0XXF1XU0 (665); D2BXXGG0XXF1XU0 (664) D2BXXYN0XXF0XU0 (665); D2BXXGN0XXF0XU0 (664) D2BXXYN0XXF1XU0 (665); D2BXXGN0XXF1XU0 (664)
ADB SAFEGATE AMERICAS, LLC	L-852A(L)	2	3				D2AXXYY0XXF0XU0 (663); D2AXXGG0XXF0XU0 (662) D2AXXYY0XXF1XU0 (663); D2AXXGG0XXF1XU0 (662) D2AXXYN0XXF0XU0 (663); D2AXXGN0XXF0XU0 (662) D2AXXYN0XXF1XU0 (663); D2AXXGN0XXF1XU0 (662) D2AXXYG0XXF0XU0 (663)(662); D2AXXYG0XXF1XU0 (663)(662);
ADB SAFEGATE AMERICAS, LLC	L-852	2	3	1			D2SX2RN0XXF0XU0 (713); D2SX2RN0XXF1XU0 (713) DREJ2RN0BMF01R0 (713); DREJ2RN0DMF00R0 (713)
ADB SAFEGATE AMERICAS, LLC	L-852G(L)	2	3	1			IRGL-XXX11 (426)
ADB SAFEGATE SWEDEN AB	L-852C(L)	1, 2	3	1			SafeLEDXTCI8UNSY6.6A1CL852C(L) (721); SafeLEDXTCI8BNSYY6.6A1CL852C(L) (721); SafeLEDXTCI8UNSF6.6A1CL852C(L) (723); SafeLEDXTCI8BNSFF6.6A1CL852C(L) (723); SafeLEDXTCI8BNSFY6.6A1CL852C(L) (721)(723)

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ADB SAFEGATE SWEDEN AB	L-852D(L)	1, 2	3	1			SafeLEDXTCI8UDSY6.6A1CL852D(L) (726); SafeLEDXTCI8BDSYY6.6A1CL852D(L) (726); SafeLEDXTCI8UDSF6.6A1CL852D(L) (728); SafeLEDXTCI8BDSFF6.6A1CL852D(L) (728)
ADB SAFEGATE SWEDEN AB	L-852K(L)	1, 2	3	1			SafeLEDXTCI8BCSFF6.6A1CL852K(L) (766)(767); SafeLEDXTCI8ULSF6.6A1CL852K(L) (766); SafeLEDXTCI8URSF6.6A1CL852K(L) (767); SafeLEDXTCI8BCSYY6.6A1CL852K(L) (768)(769); SafeLEDXTCI8ULSY6.6A1CL852K(L) (768); SafeLEDXTCI8URSY6.6A1CL852K(L) (769)
ADB SAFEGATE SWEDEN AB	L-852C(L)	1, 2	3	1			SafeLEDXTCI12UNSY6.6A1CL852C(L) (722); SafeLEDXTCI12BNSYY6.6A1CL852C(L) (722); SafeLEDXTCI12UNSF6.6A1CL852C(L) (724); SafeLEDXTCI12BNSFF6.6A1CL852C(L) (724); SafeLEDXTCI12BNSFY6.6A1CL852C(L) (722)(724)
ADB SAFEGATE SWEDEN AB	L-852D(L)	1, 2	3	1			SafeLEDXTCI12UDSY6.6A1CL852D(L) (727); SafeLEDXTCI12BDSYY6.6A1CL852D(L) (727); SafeLEDXTCI12UDSF6.6A1CL852D(L) (729); SafeLEDXTCI12BDSFF6.6A1CL852D(L) (729)
ATG AIRPORTS LIMITED	L-852T	1, 2	2	1			ZA292 (126)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-852T(L)	2	3	1			L-852T-AP1-12A-1 (397); L-852T-AP1-12A (397)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-852C	1, 2	3	1			IMB-TCLL(S)-X-040-X-0X-X-C (759)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-852K	1, 2	3	1			IMB-TCLL-(C)-X-040-2-01-X-L (759); IMB-TCLL-(C)-X-040-2-01-X-R (759); IMB-TCLL-(C)-X-040-1-03-1-L (759); IMB-TCLL-(C)-X-040-1-03-1-R (759); IMB-TCLL-(C)-X-040-1-04-1-L (759); IMB-TCLL-(C)-X-040-1-04-1-R (759)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-852C(L)	1, 2	3	1			IMB(L)-TCLL-S-XX-X/X-XX (757)(758)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-852K(L)	1, 2	3	1			IMB(L)-TCLL-C-2X-G/G-XX (757); IMB(L)-TCLL-C-11-G-XX (757); IMB(L)-TCLL-C-11-Y-XX (758)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-852T	2	2	1			ILC-TEDL-2-048-01 (760)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-852T(L)	2	2	1			ILD(L)-TEDL-1-001-01 (753)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-852S(L)	2	3	1			IHH(L)-STBL-C-11-R (756)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
L-853 Retroreflective Markers (FAA AC 150/5345-39D)							
FLEXSTAKE, INC.	L-853		Red Runway End				A650.5; A750.5
FLEXSTAKE, INC.	L-853		Green Runway Threshold				A650.5; A750.5
FLEXSTAKE, INC.	L-853		White Runway Edge				A650.5, A750.5 (14”)**
FLEXSTAKE, INC.	L-853		White Runway Edge				A651, A751 (19”)**
FLEXSTAKE, INC.	L-853		White Runway Edge				A652, A752 (24”)**
FLEXSTAKE, INC.	L-853		White Runway Edge				A652.5, A752.5 (30”)**
FLEXSTAKE, INC.	L-853		Blue Taxiway Edge				A650.5, A750.5 (14”)**
FLEXSTAKE, INC.	L-853		Blue Taxiway Edge				A651, A751 (19”)**
FLEXSTAKE, INC.	L-853		Blue Taxiway Edge				A652, A752 (24”)**
FLEXSTAKE, INC.	L-853		Blue Taxiway Edge				A652.5, A752.5 (30”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		Red Runway End				Safe-Hit SH614XXX-XR-12; Safe-Hit SH614XXX-XR-12C (14”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		Green Runway Threshold				Safe-Hit SH614XXX-XG-12; Safe-Hit SH614XXX-XG-12C (14”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		White Runway Edge				Safe-Hit SH614XXX-XS-12; Safe-Hit SH614XXX-XS-12C (14”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		White Runway Edge				Safe-Hit SH618XXX-XS-14; Safe-Hit SH618XXX-XS-14C (18”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		White Runway Edge				Safe-Hit SH624XXX-XS-14; Safe-Hit SH624XXX-XS-14C (24”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		White Runway Edge				Safe-Hit SH630XXX-XS-14; Safe-Hit SH630XXX-XS-14C (30”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		Blue Taxiway Edge				Safe-Hit SH614XXX-XB-12; Safe-Hit SH614XXX-XB-12C (14”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		Blue Taxiway Edge				Safe-Hit SH618XXX-XB-14; Safe-Hit SH618XXX-XB-14C (18”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		Blue Taxiway Edge				Safe-Hit SH624XXX-XB-14; Safe-Hit SH624XXX-XB-14C (24”)**
TRINITY HIGHWAY PRODUCTS LLC	L-853		Blue Taxiway Edge				Safe-Hit SH630XXX-XB-14; Safe-Hit SH630XXX-XB-14C (30”)**
VALLEY ILLUMINATORS	L-853		Red Runway End				AR-100 (14”)**

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VALLEY ILLUMINATORS	L-853		Green Runway Threshold				AR-100 (14”)**
VALLEY ILLUMINATORS	L-853		White Runway Edge				AR-100 (14” through 30”)**
VALLEY ILLUMINATORS	L-853		Blue Taxiway Edge				AR-100 (14” through 30”)**
L-854 Radio Controls (FAA AC 150/5345-49C)							
ADB SAFEGATE AMERICAS, LLC	I						RCE-1X1X
L-854 Radio Controls (FAA AC 150/5345-49D)							
RURAL ELECTRIC INC.	I						RDL854-1A
L-856 High Intensity Obstruction Lights, 40FPM (FAA AC 150/5345-43G)							
COOPER CROUSE HINDS	L-856(L)						CHB204 (486)**
COOPER CROUSE HINDS	L-856(L)						CHB205 (486)**
DIALIGHT CORPORATION	L-856(L)						D156-A33-SYS (447)**
FLASH TECHNOLOGY LLC	L-856(L)						FTB 224 (486)**
FLASH TECHNOLOGY LLC	L-856(L)						FTB 225 (486)**
ORGA B.V.	L-856(L)						L1000-856 (217)**
TECHNOSTROBE	L-856(L)						HIGH-W120 (398)**
L-856 High Intensity Obstruction Lights, 40FPM (FAA AC 150/5345-43H)							
DIALIGHT CORPORATION	L-856(L)						D266-A57-SYS (522)**
FLASH TECHNOLOGY LLC	L-856(L)						FTB 204 (486)**
FLASH TECHNOLOGY LLC	L-856(L)						FTB 205 (486)**
L-857 High Intensity Obstruction Lights, 60FPM (FAA AC 150/5345-43H)							
FLASH TECHNOLOGY LLC	L-857						FTB 208 (486)**
FLASH TECHNOLOGY LLC	L-857						FTB 207 (486)**
L-858 Runway and Taxiway Signs (FAA AC 150/5345-44J)							
AGM AIRFIELD GUIDANCESIGN	L-858Y,R,L	1, 2	2	2	1		I12GX.XXF (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y,R,L	1, 2	2	2	2		I22GX.XXF (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y,R,L	1, 2	2	2	3		I32GX.XXF (231)
AGM AIRFIELD GUIDANCESIGN	L-858B	1, 2	2	2	4		I42G1.0XF (231)
AGM AIRFIELD GUIDANCESIGN	L-858B, H	1, 2	2	2	5		I52G1.0XF (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y,R,L	2	4	2	1, 2, 3		I14NX.XXF; I24NX.XXF; I34NX.XXF
AGM AIRFIELD GUIDANCESIGN	L-858Y,R,L	1, 2	2	3	1		I12GX.XXF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y,R,L	1, 2	2	3	2		I22GX.XXF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y,R,L	1, 2	2	3	3		I32GX.XXF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858B	1, 2	2	3	4		I42G1.0XF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	5	2	1		I15CX.XXF (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	5	2	2		I25CX.XXF (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	5	2	3		I35CX.XXF (231)
AGM AIRFIELD GUIDANCESIGN	L-858B	1, 2	5	2	4		I45C1.0XF (231)

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AGM AIRFIELD GUIDANCESIGN	L-858B, H	1, 2	5	2	5		I55C1.0XF (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	5	3	1		I15CX.XXF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	5	3	2		I25CX.XXF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	5	3	3		I35CX.XXF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858B	1, 2	5	3	4		I45C1.0XF3 (231)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	2	4	2	1, 2, 3		D14NXXF; D24NXXF; D34NXXF; D23NXXF
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	2, 3	2	1, 2, 3		D12UXXF(11A); D13UXXF(11A)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	2, 3	2	1, 2, 3		D22UXXF(11A); D23UXXF(11A)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	1, 2	2, 3	2	1, 2, 3		D32UXXF(11A); D33UXXF(11A)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L	2	5	2	1, 2, 3		D15AXXF(11A); D25AXXF(11A); D35AXXF(11A)
AGM AIRFIELD GUIDANCESIGN	L-858B, H	1, 2	2, 3, 5	2	5		D52U1XF(11A); D53U1XF(11A); D54U1XF(11A)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	2	2	1, 2, 3		D12HXXF (462); D22HXXF (462); D32HXXF (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	3	2	1, 2, 3		D13HXXF (462); D23HXXF (462); D33HXXF (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	5	2	1, 2, 3		D15HXXF (462); D25HXXF (462); D35HXXF (462)
AGM AIRFIELD GUIDANCESIGN	L-858B, H(L)	1, 2	2, 3, 5	2	5		D52H1XF (462); D53H1XF (462); D55H1XF (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	2, 3, 5	2	1		I1XHX.XXF (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	2, 3, 5	2	2		I2XHX.XXF (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	2, 3, 5	2	3		I3XHX.XXF (462)
AGM AIRFIELD GUIDANCESIGN	L-858B(L)	1, 2	2, 3, 5	2	4		I4XH1.0XF (462)
AGM AIRFIELD GUIDANCESIGN	L-858B, H(L)	1, 2	2, 3, 5	2	5		I5XH1.0XF (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	2, 3, 5	3	1		I1XHX.XXF3 (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	2, 3, 5	3	2		I2XHX.XXF3 (462)
AGM AIRFIELD GUIDANCESIGN	L-858Y, R, L(L)	1, 2	2, 3, 5	3	3		I3XHX.XXF3 (462)
AGM AIRFIELD GUIDANCESIGN	L-858B(L)	1, 2	2, 3, 5	3	4		I4XH1.0XF3 (462)
AGM AIRFIELD GUIDANCESIGN	L-858B, H(L)	1, 2	2, 3, 5	3	5		I5XH1.0XF3 (462)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858Y, R, L	2	2, 3, 5	2	1, 2, 3		858XX-X-XX (151)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858Y, R, L(L)	2	2, 3, 5	2	1, 2, 3		858S5-1X-X-X (448); 858S5-2X-X-X (448);
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858Y, R, L(L)	2	2, 3, 5	2	1, 2, 3		858S5-3X-X-X (448)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858B(L)	2	2, 3, 5	2	4		858S5-4X-X-X (448)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858Y, R, L	2	4	2	1, 2, 3		858F4-X-X-X
L-858 Runway and Taxiway Signs (FAA AC 150/5345-44K)							
ADB SAFEGATE AMERICAS, LLC	L-858(L) Y, R, L	2	2, 3, 5	2	1		SR1X-7XX3XX0 (496)
ADB SAFEGATE AMERICAS, LLC	L-858(L) Y, R, L	2	2, 3, 5	3	1		SS1X-7XX3XX0 (496)
ADB SAFEGATE AMERICAS, LLC	L-858(L) Y, R, L	2	2, 3, 5	2	2		SR2X-7XX3XX0 (497)
ADB SAFEGATE AMERICAS, LLC	L-858(L) Y, R, L	2	2, 3, 5	3	2		SS2X-7XX3XX0 (497)
ADB SAFEGATE AMERICAS, LLC	L-858(L) Y, R, L	2	2, 3, 5	2	3		SR3X-7XX3XX0 (498)
ADB SAFEGATE AMERICAS, LLC	L-858(L) Y, R, L	2	2, 3, 5	3	3		SS3X-7XX3XX0 (498)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-858(L) B	2	2, 3, 5	2	4		SR4X-7XX3XX0 (496)
ADB SAFEGATE AMERICAS, LLC	L-858(L) B	2	2, 3, 5	3	4		SS4X-7XX3XX0 (496)
ADB SAFEGATE AMERICAS, LLC	L-858(L) B	2	2, 3, 5	2	5		SR5X-7XX3XX0 (498)
ADB SAFEGATE AMERICAS, LLC	L-858(L) B	2	2, 3, 5	3	5		SS5X-7XX3XX0 (498)
ADB SAFEGATE AMERICAS, LLC	L-858Y, R, L	2	2, 3, 5	2	1, 2, 3		SHXX-XXXXXXX (124)(594)
ADB SAFEGATE AMERICAS, LLC	L-858B	2	2, 3, 5	2	4, 5		SHXX-XXXXXXX (124)(594)
ADB SAFEGATE AMERICAS, LLC	L-858Y, R, L	2	2, 3, 5	3	1, 2, 3		SWXX-XXXXXXX (124)(594)
ADB SAFEGATE AMERICAS, LLC	L858B	2	2, 3, 5	3	4, 5		SWXX-XXXXXXX (124)(594)
ASTRONICS DME CORPORATION	L-858Y,R,L(L)	2	2,3,5	2	1		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B
ASTRONICS DME CORPORATION	L-858Y,R,L(L)	2	2,3,5	2	2		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B
ASTRONICS DME CORPORATION	L-858Y,R,L(L)	2	2,3,5	2	3		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ASTRONICS DME CORPORATION	L-858B(L)	2	2,3,5	2	4		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B
ASTRONICS DME CORPORATION	L-858B(L)	2	2,3,5	2	5		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B
ASTRONICS DME CORPORATION	L-858Y,R,L(L)	2	2,3,5	3	1		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B
ASTRONICS DME CORPORATION	L-858Y,R,L(L)	2	2,3,5	3	2		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ASTRONICS DME CORPORATION	L-858Y,R,L(L)	2	2,3,5	3	3		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B
ASTRONICS DME CORPORATION	L-858B(L)	2	2,3,5	3	5		L858-MX-1-2-X(709);B L858-MX-2-2-X(709);B L858-MX-3-2-X(709);B L858-MX-4-2-X(709);B L858-MX-5-2-X(709);B L858-MX-1-3-X(709);B L858-MX-2-3-X(709);B L858-MX-3-3-X(709);B L858-MX-5-3-X(709);B
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858Y, R, L(L)	1, 2	2, 3, 5	2	3		858S5-F-XX-X-X-XX (448)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858B(L)	1, 2	2, 3, 5	2	4		858S5-F-BF-X-X-XX (448)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858B(L)	1, 2	2, 3, 5	2	5		858S5-F-DM-X-X-XX (448)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858(L)	2	1	2, 3	1		858S-AP11X-XX-B-C-X-X-D-L-X (761)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858(L)	2	2	2, 3	2		858S-AP12X-XX-B-C-XX-D-L-X (761)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858(L)	2	3	2, 3	3		858S-AP13X-XX-B-C-XX-D-L-X (761)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858(L)	2	4	2, 3	4		858S-AP14X-XX-B-C-XX-D-L-X (761)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-858(L)	2	5	2, 3	5		858S-AP15X-XX-B-C-XX-D-L-X (761)
STANDARD SIGNS, INC.	L-858B(L)	1,2	2,3,5	3	4		D1L (442)
STANDARD SIGNS, INC.	L-858B	1,2	2,3	3	4		D1x (373)
STANDARD SIGNS, INC.	L-858B	1,2	5	3	4		D1P (11A)
STANDARD SIGNS, INC.	L-858B	1,2	5	3	4		D1Q (33)
STANDARD SIGNS, INC.	L-858B	1, 2	2, 3	2	4		D1x (373)
STANDARD SIGNS, INC.	L-858B	1, 2	2, 3	2, 3	5		DL1x (373)
STANDARD SIGNS, INC.	L-858Y, R, L	1, 2	2, 3	2	1		SXx (373)
STANDARD SIGNS, INC.	L-858Y, R, L	1, 2	2, 3	2, 3	2		MXx (373)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
STANDARD SIGNS, INC.	L-858Y, R, L	1, 2	2, 3	2, 3	3		LXx (373)
STANDARD SIGNS, INC.	L-858Y, R, L(L)	1,2	2, 3, 5	2	1		SXL (442)
STANDARD SIGNS, INC.	L-858Y, R, L(L)	1,2	2, 3, 5	2, 3	2		MXL (442)
STANDARD SIGNS, INC.	L-858Y, R, L(L)	1,2	2, 3, 5	2. 3	3		LXL (442)
STANDARD SIGNS, INC.	L-858B(L)	1,2	2, 3, 5	2	4		D1L (442)
STANDARD SIGNS, INC.	L-858B(L)	1,2	2, 3, 5	2, 3	5		DL1L (442)
STANDARD SIGNS, INC.	L-858B	1, 2	5	2	4		D1P (11A); D1Q (33)
STANDARD SIGNS, INC.	L-858B	1, 2	5	2, 3	5		DL1P (11A); DL1Q (33)
STANDARD SIGNS, INC.	L-858Y, R, L	1, 2	5	2	1		SXP (11A); SXQ (33)
STANDARD SIGNS, INC.	L-858Y, R, L	1, 2	5	2, 3	2		MXP (11A); MXQ (33)
STANDARD SIGNS, INC.	L-858Y, R, L	1, 2	5	2, 3	3		LXP (11A); LXQ (33)
STANDARD SIGNS, INC.	L-858Y, R, L, C		4	2	1, 2, 3		SUL-4; MUL-4; LUL-4 SUL-6; MUL-6; LUL-6
L-859 Lights, Flashing, Omnidirectional (FAA AC 150/5345-51B)							
FLASH TECHNOLOGY LLC	L-859V, I		F				FTS 417 (75); FTS 437 (75)
STROBE APPROACH LIGHTING TECHNOLOGY	L-859V		F				L849-V1-F (287)
STROBE APPROACH LIGHTING TECHNOLOGY	L-859I		F				L849-I-F (287)
L-861 Runway and Taxiway Elevated Lights, Medium Intensity (FAA AC 150/5345-46D)							
ADB SAFEGATE AMERICAS, LLC	L-861T(L)			1			ETES-1X10 (445); ETES-1X11 (445)
ADB SAFEGATE AMERICAS, LLC	L-861T(L)			1			ETES-1X30 (445); ETES-1X31 (445)
ADB SAFEGATE AMERICAS, LLC	L-861T(L)			1			ETES-6X10 (445); ETES-6X11 (445)
ADB SAFEGATE AMERICAS, LLC	L-861T(L)			1			ETES-6X30 (445); ETES-6X31 (445)
ADB SAFEGATE AMERICAS, LLC	L-861T(L)			1			EHP-B2XX0 (445)
ADB SAFEGATE AMERICAS, LLC	L-861T(L)			1			EHP-B1XX0 (445)
ADB SAFEGATE AMERICAS, LLC	L-861(L)			1			EMIL-1XXX0 (419); EMIL-2XXX0 (419) EMIL-3XXX0 (419); EMIL-4XXX0 (419); EMIL-5XXX0 (419); EMIL-BXXX0 (419) EMIL-HXXX0 (680)
ADB SAFEGATE AMERICAS, LLC	L-861E(L)			1			EMIL-7XXX0 (421)(422); EMIL-8XXX0 (421); EMIL-9XXX0 (422); EMIL-EXXX0 (603)(422); EMIL-FXXX0 (603); EMIL-GXXX0 (603)
AIRPORT LIGHTING COMPANY	L-861T(L)			1			216LEDXX-X (591)
AIRPORT LIGHTING COMPANY	L-861			1			216-45-Q-CC-XX (640); 216-45-Q-CC-XX-2 (640); 216-45-Q-CY-XX (640); 216-45-Q-CY-XX-2 (640); 216-45-Q-YY-XX (640); 216-45-Q-YY-XX-2 (640); 216-45-Q-YR-XX (640); 216-45-Q-YR-XX-2 (640); 216-45-Q-GY-XX (640); 216-45-Q-GY-XX-2 (640); 216-45-Q-CR-XX (640); 216-45-Q-CR-XX-2 (640);

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
AIRPORT LIGHTING COMPANY	L-861E			1			216-45-Q-RR-XX (640); 216-45-Q-RR-XX-2 (640); 216-45-Q-R-XX (640); 216-45-Q-R-XX-2 (640); 216-45-Q-GR-XX (640); 216-45-Q-GR-XX-2 (640); 216-45-Q-G-XX (640); 216-45-Q-G-XX-2 (640); 216-45-Q-BB-XX (640);
AIRPORT LIGHTING COMPANY	L-861T			1			216-45-Q-BB-XX-2 (640); 216-30-Q-BB-XX (661); 216-30-Q-BB-XX-2 (661); 216-30-I-BB-XX (670); 216-30-I-BB-XX-2 (670)
AIRPORT LIGHTING COMPANY	L-861(L)			1			ALC-861L-CC-XX-X (553); ALC-861L-CY-XX-X (553) ALC-861L-GY-XX-X (555); ALC-861L-RC-XX-X (553) ALC-861L-RY-XX-X (553); ALC-861L-YY-XX-X (553)
AIRPORT LIGHTING COMPANY	L-861E(L)			1			ALC-861L-GO-XX-X (554); ALC-861L-RR-XX-X (553); ALC-861L-RG-XX-X (556)
AIRPORT LIGHTING COMPANY	L-861T(L)			1			ALC-861L-BB-XX-X (552)
AIRSAFE AIRPORT EQUIPMENT CO LTD	L-861T(L)			1			EOL-TE-LED-066-B (593)
ASTRONICS DME CORPORATION	L-861(L)			1			861-L-W-XX (495); 861-L-Y-XX (495); 861-L-WY-XX (495); 861-L-WR-XX (495); 861-L-YR-XX (495); 861-L-GY-XX (494)(495)
ASTRONICS DME CORPORATION	L-861T(L)			1			861T-L-B-XX-X (682)
ASTRONICS DME CORPORATION	L-861E(L)			1			861E-L-GB-XX-X (495); 861E-L-RG-XX-X (494)(495); 861E-L-RR-XX-X (494);
ASTRONICS DME CORPORATION	L-861SE(L)			1			861SE-L-GB-XX-X (495); 861SE-L-RG-XX-X (494)(495)
ASTRONICS DME CORPORATION	L-861T(L)			1			861T-L-B-066-XX-6 (683); 861T-L-B-066-XX-7 (683)
ASTRONICS DME CORPORATION	L-861			1			L861-066-XX-45-XXM (681)
ASTRONICS DME CORPORATION	L-861E			1			L861E-066-XX-1-XXM (681)
ASTRONICS DME CORPORATION	L-861T			1			L861T-066-B-45-XXM (681)
ASTRONICS DME CORPORATION	L-861T			1			L861T-066-B-30-XXM (685)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861SE			1			SE: 8615-SGx-XX-X (254); 8615SGR-XX-X (254)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861T(L)			1			8615-T5-B-066-XX-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861			1			40938-CY-45-XX (17); 40939-CY-45-XX (530) 40938-C-45-XX (17); 40939-C-45-XX (530)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861E			1			40938-RG-45-XX (17); 40938-RR-45-XX (17) 40938-XG-45-XX (17); 40939-RG-45-XX (530) 40939-RR-45-XX (530); 40939-XG-45-XX (530)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861T			1			40938-B-45-XX (17); 40938-B-30-XX (18) 40939-B-45-XX (530); 40939-B-30-XX (529)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861(L)			1			861B-AP1-WY-1-XX-0-0 (653); 861B-AP1-WY-2-XX-0-0 (653); 861B-AP1-WY-1-XX-1-0 (653); 861B-AP1-WY-2-XX-1-0 (653); 861B-AP1-WR-1-XX-0-0 (653); 861B-AP1-WR-2-XX-0-0 (653); 861B-AP1-WR-1-XX-1-0 (653); 861B-AP1-WR-2-XX-1-0 (653); 861B-AP1-YR-1-XX-0-0 (653); 861B-AP1-YR-2-XX-0-0 (653); 861B-AP1-YR-1-XX-1-0 (653); 861B-AP1-YR-2-XX-1-0 (653); 861B-AP1-GY-1-XX-0-0 (656)(654); 861B-AP1-GY-2-XX-0-0 (656)(654); 861B-AP1-GY-1-XX-1-0 (656)(654); 861B-AP1-GY-2-XX-1-0 (656)(654)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861(L)			1			861M-AP1-WM-1-XX-0-0 (653); 861M-AP1-WM-2-XX-0-0 (653); 861M-AP1-WM-1-XX-1-0 (653); 861M-AP1-WM-2-XX-1-0 (653); 861M-AP1-YM-1-XX-0-0 (653); 861M-AP1-YM-2-XX-0-0 (653); 861M-AP1-YM-1-XX-1-0 (653); 861M-AP1-YM-2-XX-1-0 (653)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861E(L)			1			861E-AP1-RG-1-XX-0-0 (651)(657); 861E-AP1-RG-2-XX-0-0 (651)(657); 861E-AP1-RG-1-XX-1-0 (651)(657); 861E-AP1-RG-2-XX-1-0 (651)(657); 861E-AP1-RR-1-XX-0-0 (651); 861E-AP1-RR-2-XX-0-0 (651); 861E-AP1-RR-1-XX-1-0 (651); 861E-AP1-RR-2-XX-1-0 (651); 861E-AP1-GN-1-XX-0-0 (657); 861E-AP1-GN-2-XX-0-0 (657); 861E-AP1-GN-1-XX-1-0 (657); 861E-AP1-GN-2-XX-1-0 (657)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861SE(L)			1			861S-AP1-RG-1-XX-0-0 (652)(657); 861S-AP1-RG-2-XX-0-0 (652)(657); 861S-AP1-RG-1-XX-1-0 (652)(657); 861S-AP1-RG-2-XX-1-0 (652)(657); 861S-AP1-GN-1-XX-0-0 (657); 861S-AP1-GN-2-XX-0-0 (657); 861S-AP1-GN-1-XX-1-0 (657); 861S-AP1-GN-2-XX-1-0 (657)

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CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-861T(L)			1			861T-AP1-BA-1-XX-0-0 (655); 861T-AP1-BA-2-XX-0-0 (655); 861T-AP1-BA-1-XX-1-0 (655); 861T-AP1-BA-2-XX-1-0 (655);
FLIGHT LIGHT INC.	L-861			1			FL-861-C-45Q-14-1 (33); FL-861-CY-45Q-14-1 (33); FL-861-C-45-14-1 (634); FL-861-CY-45-14-1 (634)
FLIGHT LIGHT INC.	L-861E			1			FL-861-GR-45Q-14-1 (33); FL-861-GR-45-14-1 (634)
FLIGHT LIGHT INC.	L-861T			1			FL-861-B-30Q-14-1 (33); FL-861-B-45Q-14-1 (33) FL-861-B-45-14-1 (634)
MANAIRCO, INC.	L-861T(L)			1			7400 LED (579)(580)
MANAIRCO, INC.	L-861			1			7100(706); 7100Q(705); 7550(706); 7550Q(705)
MANAIRCO, INC.	L-861E			1			7250(706); 7250Q(705)
MANAIRCO, INC.	L-861T			1			7400(707); 7400Q(708)
OCEM AIRFIELD TECHNOLOGY	L-861T(L)			1			LETE-F 35-A-X-X (544); LETE-F 50-A-X-X (544); LETE-F 61-A-X-X (544)
POINT LIGHTING CORPORATION	L-861			1			PEL-50000-C-45T-14 (11A); PEL-50000-C-45Q-14 (33) PEL-50000-Y-45T-14 (11A); PEL-50000-Y-45Q-14 (33)
POINT LIGHTING CORPORATION	L-861E			1			PEL-50000-Gx-45T-14 (11A); PEL-50000-Gx-45Q-14 (33) PEL-50000-RG-45T-14 (11A); PEL-50000-RG-45Q-14 (33) PEL-50000-RR-45T-14 (11A); PEL-50000-RR-45Q-14 (33)
POINT LIGHTING CORPORATION	L-861T			1			PEL-50000-B-30T-14 (10A); PEL-50000-B-30Q-14 (31) PEL-50000-B-45T-14 (11A); PEL-50000-B-45Q-14 (33)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-861T(L)			1			ELB-TEDL-001-01 (660)
L-861 Runway and Taxiway Elevated Lights, Medium Intensity (FAA AC 150/5345-46E)							
ADB SAFEGATE AMERICAS, LLC	L-861SE			1			44A2090-16X1 (36); 44A2090-18X2 (36)
ADB SAFEGATE AMERICAS, LLC	L-861(L)			1			IMIL-11X0 (418); IMIL-12X0 (418); IMIL-21X0 (418) IMIL-22X0 (418); IMIL-31X0 (418); IMIL-32X0 (418) IMIL-41X0 (418); IMIL-42X0 (418); IMIL-51X0 (418) IMIL-52X0 (418)
ADB SAFEGATE AMERICAS, LLC	L-861E(L)			1			IMIL-71X0 (421)(422); IMIL-72X0 (421)(422) IMIL-81X0 (421); IMIL-82X0 (421); IMIL-91X0 (422) IMIL-92X0 (422)
ADB SAFEGATE AMERICAS, LLC	L-861T(L)			1			IMIL-D1X0 (571); IMIL-D2X0 (571)
ADB SAFEGATE AMERICAS, LLC	L-861E(L)			1			IMIL-A1X0 (421)(422); IMIL-B1X0 (421); IMIL-C1X0 (422); IMIL-A2X0 (421)(422); IMIL-B2X0 (421); IMIL-C2X0 (422);
ADB SAFEGATE AMERICAS, LLC	L-861			1			44C1081-21XX(747); 44C1081-61XX(33)(290); 44C1081-22XX(747); 44C1081-62XX(33)(290); 44C1081-63XX(33)(290); 44C1081-29XX(747); 44C1081-69XX(33)(290); 44C1081-6CXX(33)(290); 44C1081-6DXX(33)(290);
ADB SAFEGATE AMERICAS, LLC	L-861E			1			44C1081-66XX(33)(290); 44C1081-67XX(33)(290); 44C1081-6BXX(33)(290); 44C1081-6EXX(33)(290);

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-861T			1			44C1081-55XX(31)(291)
ADB SAFEGATE AMERICAS, LLC	L-861E(L)			1			EMIS2RR01S00X00(733); EMIS2RG01S00X00(732)(733); EMIS2NG01S00X00(732); EMIS2RR02S00X00(733); EMIS2RG02S00X00(732)(733); EMIS2NG02S00X00(732) EMIS2RR03S00X00(733); EMIS2RG03S00X00(732)(733); EMIS2NG03S00X00(732); EMIS2RR04S00X00(733); EMIS2RG04S00X00(732)(733); EMIS2NG04S00X00(732) EMIS2RR05S00X00(733); EMIS2RG05S00X00(732)(733); EMIS2NG05S00X00(732); EMIS2RR06S00X00(733); EMIS2RG06S00X00(732)(733); EMIS2NG06S00X00(732) EMIS2RR07S00X00(733); EMIS2RG07S00X00(732)(733); EMIS2NG07S00X00(732); EMIS2RR08S00X00(733); EMIS2RG08S00X00(732)(733); EMIS2NG08S00X00(732)
ADB SAFEGATE AMERICAS, LLC	L-861(L)			1			EMIS2XX01S00X00 (731); EMIS2YG01S00X00 (762)(763) EMIS2XX02S00X00 (731); EMIS2YG02S00X00 (762)(763) EMIS2XX03S00X00 (731); EMIS2YG03S00X00 (762)(763) EMIS2XX04S00X00 (731); EMIS2YG04S00X00 (762)(763) EMIS2XX05S00X00 (731); EMIS2YG05S00X00 (762)(763) EMIS2XX06S00X00 (731); EMIS2YG06S00X00 (762)(763) EMIS2XX07S00X00 (731); EMIS2YG07S00X00 (762)(763) EMIS2XX08S00X00 (731); EMIS2YG08S00X00 (762)(763)
ADB SAFEGATE AMERICAS, LLC	L-861SE(L)			1			EMIS2RG01SF0X00 (764)(765); EMIS2RG02SF0X00(764)(765); EMIS2RG03SF0X00 (764)(765); EMIS2RG04SF0X00 (764)(765); EMIS2RG05SF0X00 (764)(765); EMIS2RG06SF0X00 (764)(765); EMIS2RG07SF0X00 (764)(765); EMIS2RG08SF0X00 (764)(765) EMIS2NR01SF0X00 (764); EMIS2NR02SF0X00 (764); EMIS2NR03SF0X00 (764); EMIS2NR04SF0X00 (764); EMIS2NR05SF0X00 (764); EMIS2NR06SF0X00 (764); EMIS2NR07SF0X00 (764); EMIS2NR08SF0X00 (764); EMIS2NG01SF0X00 (765); EMIS2NG02SF0X00 (765); EMIS2NG03SF0X00 (765); EMIS2NG04SF0X00 (765); EMIS2NG05SF0X00 (765); EMIS2NG06SF0X00 (765); EMIS2NG07SF0X00 (765); EMIS2NG08SF0X00 (765)
ADB SAFEGATE SWEDEN AB	L-861E			11			EL-EAH+45W+G+NPS+L861E (440)
ADB SAFEGATE SWEDEN AB	L-861E			1			EL-EAH+45W+GR+NPS+L861E (440)
ADB SAFEGATE SWEDEN AB	L-861E			1			EL-EAH+45W+RR+NPS+L861E (440)
ADB SAFEGATE SWEDEN AB	L-861SE			1			EL-EAH+100W+G+NPS+L861SE (152); EL-EAH+100W+GR+NPS+L861SE (152)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE SWEDEN AB	L-861			1			EL+EAM+NPS+45W+W+1C+L861 (137); EL+EAM+NPS+45W+Y+1C+L861 (137); EL+EAM+NPS+45W+WY+1C+L861 (137); EL+EAM+NPS+45W+WR+1C+L861 (137); EL+EAM+NPS+45W+YR+1C+L861 (137); EL+EAM+NPS+45W+GY+1C+L861 (137)
ADB SAFEGATE SWEDEN AB	L-861E			1			EL+EAM+NPS+45W+R+1C+L861E (137)
ADB SAFEGATE SWEDEN AB	L-861T			1			EL+EAM+NPS+45W+B+1C+L861T (137)
ADB SAFEGATE SWEDEN AB	L-861T(L)			1			SafeLED-TE-E-O-B-NPS-6.6A (528)
MULTI-ELECTRIC MANUFACTURING, INC.	L-861T(L)			1			LTE-F-XX-A-X-X (544)
MULTI-ELECTRIC MANUFACTURING, INC.	L-861SE			1			6370SE-GO-XX (21)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-861T			1			ELC-TEDL-045-01(33)
L-862 Runway Elevated Lights, High Intensity (FAA AC 150/5345-46D)							
ADB SAFEGATE AMERICAS, LLC	L-862			1			44A2071-2X11(21); 44A2071-2X21(21) 44A2071-2X31(21); 44A2071-2X71(21) 44A2071-411X(90); 44A2071-4211(90) 44A2071-412X(90); 44A2071-4221(90) 44A2071-413X(90); 44A2071-4231(90) 44A2071-417X(90); 44A2071-4271(90)
ADB SAFEGATE AMERICAS, LLC	L-862E			1			44A2071-2X11(21); 44A2071-2X21(21) 44A2071-2X31(21); 44A2071-2X71(21) 44A2071-411X(90); 44A2071-4211(90) 44A2071-412X(90); 44A2071-4221(90) 44A2071-413X(90); 44A2071-4231(90) 44A2071-417X(90); 44A2071-4271(90)
ADB SAFEGATE AMERICAS, LLC	L-862(L)			1			EREL-2XX31SXXX02 (671)(672)(673)(674); EREL-2XX32SXXX02 (671)(672)(673)(674); EREL-2XX33SXXX02 (671)(672)(673)(674) EREL-2XX35SXXX02 (671)(672)(673)(674); EREL-2XX36SXXX02 (671)(672)(673)(674); EREL-2XX37SXXX02 (671)(672)(673)(674)
ADB SAFEGATE AMERICAS, LLC	L-862E(L)			1			EREL-2XXX1SXXX02 (673)(674); EREL-2XXX2SXXX02 (673)(674); EREL-2XXX3SXXX02 (673)(674); EREL-2XXX5SXXX02 (673)(674); EREL-2XXX6SXXX02 (673)(674); EREL-2XXX7SXXX02 (673)(674)
ADB SAFEGATE BVBA	L-862(L)			1			EREX-2XXX-XXX-0000(479)(480)(481)(482)
ADB SAFEGATE BVBA	L-862E(L)			1			EREX-2XXX-XXX-0000(481)(482)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE BVBA	L-862(L)			1			EREX-2XX31SXXX02 (671)(672)(673)(674); EREX-2XX32SXXX02 (671)(672)(673)(674); EREX-2XX33SXXX02 (671)(672)(673)(674) EREX-2XX35SXXX02 (671)(672)(673)(674); EREX-2XX36SXXX02 (671)(672)(673)(674); EREX-2XX37SXXX02 (671)(672)(673)(674)
ADB SAFEGATE BVBA	L-862E(L)			1			EREX-2XXX1SXXX02 (673)(674); EREX-2XXX2SXXX02 (673)(674); EREX-2XXX3SXXX02 (673)(674); EREX-2XXX5SXXX02 (673)(674); EREX-2XXX6SXXX02 (673)(674); EREX-2XXX7SXXX02 (673)(674)
ASTRONICS DME CORPORATION	L-862			1			L-862-120-WW-XX (36); L-862-120-WY-XX (36); L-862-YW-XX (36); L-862-150-WW-XX (391); L-862-150-WY-XX (391); L-862-150-YW-XX (391); L-862-150-GY-XX (391); L-862-150-YG-XX (391); L-862-150-RW-XX (391); L-862-150-WR-XX (391);
ASTRONICS DME CORPORATION	L-862E			1			L-862E-200-BRL-XX (392); L-862E-200-GRX-XX (392); L-862E-200-GBX-XX (392)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-862			1			8625-ECC-XX-XXX (135)(136)(254); 8625-ECY-XX-XXX (135)(136)(254); 8625-EYC-XX-XXX (135)(136)(254); 8625-ECR-XX-XXX (135); 8625-ERC-XX-XXX (135); 8625-TYG-XX-XXX(136); 8625-TGY-XX-XXX (136); 8625-ERY-XX-XXX (135); 8625-EYR-XX-XXX (135)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-862E			1			8625-TRG-XX-XXX (136); 8625-TGR-XX-XXX (136); 8625-SRR-XX-XXX (136); 8625-TGx-XX-XXX (136); 8625-TxG-XX-XXX (136)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-862			1			8624X-E-CC-120-XX (254); 8624X-E-CY-120-XX (254); 8624X-E-YC-120-XX (254); 8624X-E-CR-120-XX (254); 8624X-E-RC-120-XX (254) 8624X-E-CC-150-XX (135); 8624X-E-CY-150-XX (135); 8624X-E-YC-150-XX (135); 8624X-E-CR-150-XX (135); 8624X-E-RY-150-XX (135); 8624X-E-YR-150-XX (135); 8624X-E-RC-150-XX (135)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-862E			1			8624X-T-RG-200-XX (136); 8624X-T-GR-200-XX (136)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
OCEM AIRFIELD TECHNOLOGY	L-862			1			FP150-F-CC-150 (153); FP150-F-CR-150 (153); FP150-F-CY-150 (153); FP150-F-GY-150 (153); FP150-F-RC-150 (153); FP150-F-RY-150 (153); FP150-F-YC-150 (153); FP150-F-YG-150 (153); FP150-F-YR-150 (153)
OCEM AIRFIELD TECHNOLOGY	L-862S			1			FAU-SB-100-P-001 (127)
OCEM AIRFIELD TECHNOLOGY	L-862E(L)			1			LERE-F-T-RG-14-A-X-0 (546)(549); LERE-F-T-GR-14-A-X-0 (549)(546); LERE-F-T-RR-14-A-X-0 (546); LERE-F-T-MG-14-A-X-0 (549); LERE-F-T-GM-14-A-X-0 (549)
OCEM AIRFIELD TECHNOLOGY	L-862(L)			1			LERE-F-E-WW-14-A-X-0 (548); LERE-F-E-WW-20-A-X-0 (548) LERE-F-E-WY-14-A-X-0 (548)(545); LERE-F-E-WY-20-A-X-0 (548)(545); LERE-F-E-YW-14-A-X-0 (545)(548); LERE-F-E-YW-20-A-X-0 (545)(548); LERE-F-E-WR-14-A-X-0 (548)(546); LERE-F-E-WR-20-A-X-0 (548)(546); LERE-F-E-RW-14-A-X-0 (546)(548); LERE-F-E-RW-20-A-X-0 (546)(548); LERE-F-E-YR-14-A-X-0 (545)(546); LERE-F-E-YR-20-A-X-0 (545)(546); LERE-F-E-RY-14-A-X-0 (546)(545); LERE-F-E-RY-20-A-X-0 (546)(545 LERE-F-E-GY-14-A-X-0 (549)(545); LERE-F-E-GY-20-A-X-0 (549)(545); LERE-F-E-YG-14-A-X-0 (545)(549); LERE-F-E-YG-20-A-X-0 (545)(549)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-862			1			EHB-REDL-150-01(21)
L-862 Runway Elevated Lights, High Intensity (FAA AC 150/5345-46E)							
ADB SAFEGATE AMERICAS, LLC	L-862(L)			1			EREX-2XXX-XXX-0000(479)(480)(481)(482)
ADB SAFEGATE AMERICAS, LLC	L-862E(L)			1			EREX-2XXX-XXX-0000(481)(482)
ADB SAFEGATE AMERICAS, LLC	L862(L)			1			EREX-2XX31SXXX02 (671)(672)(673)(674); EREX-2XX32SXXX02 (671)(672)(673)(674); EREX-2XX33SXXX02 (671)(672)(673)(674) EREX-2XX35SXXX02 (671)(672)(673)(674); EREX-2XX36SXXX02 (671)(672)(673)(674); EREX-2XX37SXXX02 (671)(672)(673)(674)

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ADB SAFEGATE AMERICAS, LLC	L862E(L)			1			EREX-2XXX1SXXX02 (673)(674); EREX-2XXX2SXXX02 (673)(674); EREX-2XXX3SXXX02 (673)(674); EREX-2XXX5SXXX02 (673)(674); EREX-2XXX6SXXX02 (673)(674); EREX-2XXX7SXXX02 (673)(674)
ADB SAFEGATE AMERICAS, LLC	L-862S			1			44A5877-X (153)
ADB SAFEGATE SWEDEN AB	L-862			1			EL-EAH+150W+WY+NPS+L862 (153); EL-EAH+150W+RY+NPS+L862 (153)
ADB SAFEGATE SWEDEN AB	L-862			1			EL-EAH+150W+WW+NPS+L862 (153); EL-EAH+150W+WR+NPS+L862 (153)
ADB SAFEGATE SWEDEN AB	L-862			1			EL-EAH+150W+GY+NPS+L862 (153)
ADB SAFEGATE SWEDEN AB	L-862E			1			EL-EAH+150W+G+NPS+L862E (153); EL-EAH+150W+GR+NPS+L862E (153); EL-EAH+150W+RR+NPS+L862E (153)
ADB SAFEGATE SWEDEN AB	L-862S			1			EL-ATS+105W+R+NPS+L862S (153)
ADB SAFEGATE SWEDEN AB	L-862S(L)			1			SafeLED-X-SB-E-U-S-R-6.6A-1C-L862S(L)
ADB SAFEGATE SWEDEN AB	L-862(L)			1			SafeLEDXREEOWW6.6AX (686); SafeLEDXREEOWY6.6AX (687); SafeLEDXREEOYW6.6AX (687); SafeLEDXREEOWR6.6AX (688); SafeLEDXREEORW6.6AX (688); SafeLEDXREEOYR6.6AX (689); SafeLEDXREEORY6.6AX (689)
ADB SAFEGATE SWEDEN AB	L-862E(L)			1			SafeLEDXRTNEBRFR6.6A1C (730)(739); SafeLEDXRTNEBLRF6.6A1C (730)(739); SafeLEDXRNEBSRR6.6A1C(730); SafeLEDXRTEUSF6.6A1C(739); SafeLEDXRNEUSR6.6A1C(730)
AIRPORT LIGHTING COMPANY				1			216SE-1-120-RG-XX(642);216SE-1-120-RG-XX-2(642); 216SE-1-120-GO-XX(642); 216SE-1-120-GO-XX-2(642); 216SE-1-120-RR-XX(642);216SE-1-120-RR-XX-2(642);
AIRPORT LIGHTING COMPANY				1			213Q-1-120-CC-XX (642); 213Q-1-120-CC-XX-2 (642); 213Q-1-120-CY-XX (642); 213Q-1-120-CY-XX-2 (642); 213Q-1-120-CR-XX (642); 213Q-1-120-CR-XX-2 (642) 213Q-1-120-RY-XX (642); 213Q-1-120-RY-XX-2 (642); 213Q-1-120-GY-XX (642); 213Q-1-120-GY-XX-2 (642); 213Q-1-150-CC-XX (684); 213Q-1-150-CC-XX-2 (684); 213Q-1-150-CY-XX (684); 213Q-1-150-CY-XX-2 (684); 213Q-1-150-CR-XX (684); 213Q-1-150-CR-XX-2 (684); 213Q-1-150-GY-XX (684); 213Q-1-150-GY-XX-2 (684); 213Q-1-150-YR-XX (684); 213Q-1-150-YR-XX-2 (684)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
AIRPORT LIGHTING COMPANY				1			213Q-1-200-RR-XX (641); 213Q-1-200-RR-XX-2 (641); 213Q-1-200-RO-XX (641); 213Q-1-200-RO-XX-2 (641); 213Q-1-200-RG-XX (641); 213Q-1-200-RG-XX-2 (641); 213Q-1-200-GO-XX (641); 213Q-1-200-GO-XX-2 (641)
MULTI-ELECTRIC MANUFACTURING, INC.	L-862			1			6370-R-WW-XX-A-3 (21)(36); 6370-R-WA-XX-A-3 (36); 6370-R-WR-XX-A-3 (21); 6370-R-GA-XX-A-3 (36)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-862E			1			EHA-RTHL-200-03-1 (66)
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-862S			1			EHA-STBL-100-02-01 (152)
ADB SAFEGATE BVBA	L-862S(L)			1			ETSS2RN00SF0000 (735); ETSS2RN00MF0000 (735)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-862S			1			862S-XX (153)
MULTI-ELECTRIC MANUFACTURING, INC.	L-862E			1			6370-T-RG-XX-A-3 (90); 6370-T-GR-XX-A-3 (90); 6370-T-RR-XX-A-3 (90); 6370-T-OG-XX-A-3 (90); 6370-T-GO-XX-A-3 (90); 6370-T-OR-XX-A-3 (90); 6370-T-RO-XX-A-3 (90)
L-864 Lights, Obstruction, Red 20-40 FPM (FAA AC 150/5345-43G)							
AVLITE SYSTEMS	L-864						AV-OL-FL864-12-R (643); AV-OL-FL864-UM-R (643)
COOPER CROUSE HINDS	L-864						CHB314 (260)
COOPER CROUSE HINDS	L-864						CHB324 (260)
COOPER CROUSE HINDS	L-864						CHB302R (260); CHB302D (260)
DIALIGHT CORPORATION	L-864(L)						D464-A13-001 (413); D464-B13-001 (413); D464R13-001 (460)
DIALIGHT CORPORATION	L-864(L)						D1RW-B-13-008 (412);
DIALIGHT CORPORATION	L-864(L)						D464-A13-001GPS (413)
DIALIGHT CORPORATION	L-864(L)						D1RW-C13-008 (412); D1RW-C13-008SP (412)
DIALIGHT CORPORATION	L-864(L)						D464-A54-001(413)
DIALIGHT CORPORATION	L-864(L)						D1RWC13180-SYS (605)
DIALIGHT CORPORATION	L-864(L)						D564-A13-001-GPS (523); D564-A13-001 (523); D564-A13-002-GPS (675); D564-A15-002-GPS (675); D564-B13-001 (523)
FARLIGHT LLC	L-864(L)						NV-L864LED (483)
FLASH TECHNOLOGY LLC	L-864						FTB 324 (260)
FLASH TECHNOLOGY LLC	L-864						FTB 224 (486)
FLASH TECHNOLOGY LLC	L-864						FTB 225 (260)
FLASH TECHNOLOGY LLC	L-864						FTB 314 (260)
FLASH TECHNOLOGY LLC	L-864(L)						FTS 370d (474); FTS 370d IR (626) FTS 370d 48VDC (474); FTS 370d IR 48VDC (626) FTS 370d 24VDC (474); FTS 370d IR 24VDC (626) FTS 370r (510)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
FLASH TECHNOLOGY LLC	L-864(L)						FTS 370i (476)
FLASH TECHNOLOGY LLC	L-864(L)						FTS 361X (485); FTS 361X IR (625)
FLASH TECHNOLOGY LLC	L-864(L)						FTS 370i (595); FTS 370i IR (595)
FLASH TECHNOLOGY LLC	L-864(L)						FTS 2301 (616); FTS 2301 IR (625)
INTERNATIONAL TOWER LIGHTING, LLC	L-864(L)						ILS-D1RW-008 (412); ILS-D1RW-008SP (412)
INTERNATIONAL TOWER LIGHTING, LLC	L-864(L)						IFH-1700-000 (446); IFH-1710-000 (446)
INTERNATIONAL TOWER LIGHTING, LLC	L-864						BCN-0300-000 (588)
INTERNATIONAL TOWER LIGHTING, LLC	L-864(L)						ILS-3600-000 (635); ILS-3600-0IR (636)
ORGA B.V.	L-864(L)						L450-864 (459); L450-864G (459); L450-864/865(-G) (459)
ORGA B.V.	L-864(L)						L550-864-(G) (646); L550-864-30-(G) (646); L550-864-40-(G) (646)
OTL SOLUTION	L-864(L)						OTL-900 (617)
POINT LIGHTING CORPORATION	L-864(L)						PFB-37001-R-1 (436); PFB-37001-R-1-EX (436) PFB-37002-R-2 (436); PFB-37001-R-2-EX (436) PFB-37001-R-3 (436); PFB-37001-R-3-EX (436) PFB-37001-R-4 (436); PFB-37001-R-4-EX (436)
QUANTEC NETWORKS GMBH	L-864(L)						11093 (508)
TECHNOSTROBE	L-864(L)						LED-RED-Standard (473)
TECHNOSTROBE	L-864(L)						LED-B-HYBRID-G3 (573)
TWR LIGHTING, INC.	L-864(L)						LEDBEACON3 (493)
TWR LIGHTING, INC.	L-864(L)						LEDBEACON2 (296)
TWR LIGHTING, INC.	L-864(L)						E-1DBSL (296)
UNIMAR INC	L-864(L)						DLS(X)-008 (412); DLS(X)-008SP (412)
UNIMAR INC	L-864(L)						USL40X (413)
UNIMAR INC	L-864(L)						DLS(X)-029R (526)
UNIMAR INC	L-864(L)						USL50X (523)
L-864 Lights, Obstruction, Red 30 FPM (FAA AC 150/5345-43H)							
DIALIGHT CORPORATION	L-864(L)						D1RWC13009SYS (526); D1RWC13409SYS (527) D1RWC14409SYS (527); D1RWC17009SYS (526); D1RWC17409SYS (527); D1CWC13409SYS (676); D1CWC14409SYS (676)
DIALIGHT CORPORATION	L-864(L)						D266-A57-SYS (522)
FLASH TECHNOLOGY LLC	L-865						FTB 302D (133)
FLASH TECHNOLOGY LLC	L-864(L)						FTS 371 AC (750); FTS 371 SMART AC (750)
HUGHEY & PHILLIPS, LLC	L-864(L)						50-0002-001 (491) 50-0005-001 (492) 50-0002-010 (716) 50-0005-010 (717)

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
HUGHEY & PHILLIPS, LLC	L-864						FG-2009B (144); FG-3000B (144)
INTERNATIONAL TOWER LIGHTING, LLC	L-864						ILS-3400 (334)
OBSTA	L-864(L)						113724 (647); 113724I (647); 113710U (647); 113756U (647); 113714U (647); 113725U (648); 113725UI (648); 113712U (648) 113715U (648); 113758U (648)
L-865 Lights, Obstruction, White 40 FPM (FAA AC 150/5345-43G)							
COOPER CROUSE HINDS	L-865						CHB310 (133)
COOPER CROUSE HINDS	L-865						CHB302D (133)
COOPER CROUSE HINDS	L-865						CHB324 (133)
COOPER CROUSE HINDS	L-865						CHB302 (133)
DIALIGHT CORPORATION	L-865(L)						D1RW-C13-008 (412); D1RW-C13-008SP (412) D165-C13-008 (415)
DIALIGHT CORPORATION	L-865(L)						D1RW-B13-008 (412);
DIALIGHT CORPORATION	L-865(L)						D165-C13-009 (524)
DIALIGHT CORPORATION	L-865(L)						D1RWC13180-SYS (605)
FLASH TECHNOLOGY LLC	L-865						FTB 302 (133); FTB 302D (133)
FLASH TECHNOLOGY LLC	L-865						FTB 310 (133) FTB 324 (133)
FLASH TECHNOLOGY LLC	L-865(L)						FTS 370d (474); FTS 370d IR(626); FTS 370d 48VDC (474); FTS 370d IR 48VDC (626); FTS 370d 24VDC (474); FTS 370d IR 24VDC (626)
FLASH TECHNOLOGY LLC	L-865(L)						FTS370w (475)
INTERNATIONAL TOWER LIGHTING, LLC	L-865(L)						ILS-D1RW-008 (412); ILS-D1RW-008SP (412)
INTERNATIONAL TOWER LIGHTING, LLC	L-865(L)						ILS-3600-000 (635); ILS-3600-0IR (636); ILS-2600-000 (637); ILS-2600-0IR (638)
ORGA B.V.	L-865(L)						L450-865(-G) (466); L450-864/865(-G) (466)
ORGA B.V.	L-865(L)						L-550-865-(G) (645)
OTL SOLUTION	L-865						OTL-900 (617)
POINT LIGHTING CORPORATION	L-865						PSB-38001-MA-16 (581)
TECHNOSTROBE	L-865(L)						LED-B-HYBRID-G3 (573)
TWR LIGHTING, INC.	L-865						D-1LVS (240)
TWR LIGHTING, INC.	L-865						E-1DBSL (296)
UNIMAR INC	L-865(L)						DLS(X)-008 (412); DLS(X)-008SP (412) WLS(X)-008 (412); WLS(X)-008SP (412)
UNIMAR INC	L-865(L)						DLS(X)-029R (526); WLS(X)-029 (526)
L-865 Lights, Obstruction, White 40 FPM (FAA AC 150/5345-43H)							

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DIALIGHT CORPORATION	L-865(L)						D1RWC13009SYS (526); D1RWC13409SYS (527) D1RWC14409SYS (527); D1RWC17009SYS (526); D1RWC17409SYS (527); D1CWC13409SYS (676); D1CWC14409SYS (676)
FLASH TECHNOLOGY LLC	L-865						FTB 304 (486)
FLASH TECHNOLOGY LLC	L-865						FTB 305 (486)
FLASH TECHNOLOGY LLC	L-865						FTB 310C (133)
HUGHEY & PHILLIPS, LLC	L-865(L)						50-0003-001 (490) 50-0005-001 (492) 50-0005-010 (717) 50-0003-010 (490)
HUGHEY & PHILLIPS, LLC	L-865						FG-2000B (144); FG-3000B (144)
INTERNATIONAL TOWER LIGHTING, LLC	L-865						ILS-3400 (334); ILS-2400 (334)
OBSTA	L-865(L)						113723U (648); 113723UI (648); 113711U (648) 113757U (648); 113713U (648); 113725U (648); 113725UI (648); 113715U (648); 113758U (648); 113712U(648);
L-866 Lights, Obstruction, White 60 FPM (FAA AC 150/5345-43G)							
DIALIGHT CORPORATION	L-866(L)						D1RW-L13-008 (435)
INTERNATIONAL TOWER LIGHTING, LLC	L-866(L)						ILS-3600-CAT(635); ILS-3600-CAT-IR (636); ILS-2600-CAT (637); ILS-2600-CAT-IR(638)
UNIMAR INC	L-866(L)						DCLSX-008 (435); WCLSX-008 (435)
L-866 Lights, Obstruction, White 60 FPM (FAA AC 150/5345-43H)							
FLASH TECHNOLOGY LLC	L-866						FTB 310 (133)
FLASH TECHNOLOGY LLC	L-866(L)						FTS 370w (475); FTS 370d (474)
HUGHEY & PHILLIPS, LLC	L-866(L)						50-004-001; 50-004-002; 50-004-003 (490); 50-0012-001; 50-0012-002; 50-0012-003 (492)
L-867 Light Bases, Non-load Bearing (FAA AC 150/5345-42F)							
AIRPORT LIGHTING EQUIPMENT INC.	L-867						1224Q; 12242Q-SS; 12S-EXT; L867-ER-B-S; L867B-CP-B-S
AIRPORT LIGHTING EQUIPMENT INC.	L-867						(BASE); 16242X-X; (EXT) 16-S-EXT; (SPACER) L867D-ER-D-S; (CVR) L867-CP-D-S
L-867 Light Bases, Non-load Bearing (FAA AC 150/5345-42G)							
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-867 BASE	IA			B		ALB-L867-12-24-1A-C4-XX
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-867 COVER PLATE	IA			B		BCP-L867-12-09-S
L-867 Light Bases, Non-load Bearing (FAA AC 150/5345-42H)							
JAQUITH INDUSTRIES, INC.	L-867 BASE	IB			B		ACS20XXXXXXXXXXPCC; ACS21XXXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-867 EXT	IB			B		AES2XXXX
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IB			B		AKS10XXXX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IB			B		ATS2006XX
JAQUITH INDUSTRIES, INC.	L-867 BASE	IB			D		ACS63XXXXXXXXX; ACS60XXXXXXXXXPCC
JAQUITH INDUSTRIES, INC.	L-867 EXT	IB			D		AES6XXXX
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IB			D		AKS20XXXX
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IB			D		ATS6003XX
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IB			E		AKS70XXXX
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IB			E		ATS7003XX
JAQUITH INDUSTRIES, INC.	L-867 BASE	IB			B		ACB20XXXXXXXXXVKPCC; ACB21XXXXXXXXXVK
JAQUITH INDUSTRIES, INC.	L-867 EXT	IB			B		AEB2XXXXVK
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IB			B		AK10XXXXVK
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IB			B		ATB2006XXVK
JAQUITH INDUSTRIES, INC.	L-867 BASE	IB			D		ACB63XXXXXXXXXVK; ACB60XXXXXXXXXVKPCC
JAQUITH INDUSTRIES, INC.	L-867 EXT	IB			D		AEB6XXXXVK
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IB			D		AK20XXXXVK
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IB			D		ATB6003XXVK
JAQUITH INDUSTRIES, INC.	L-867 BASE	IB			E		ACB67XXXXXXXXXVK
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IB			E		AK70XXXXVK
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IB			E		ATB7003XXVK
MILLERBERND MANUFACTURING COMPANY	L-867 BASE	IA			B		127ACC(X)PCC; 127ACG(X)PCC; 127CC(X); 127CG(X)
MILLERBERND MANUFACTURING COMPANY	L-867 EXT	IA			B		127E(X)
MILLERBERND MANUFACTURING COMPANY	L-867 CONV RING	IA			B		128CR(X)
MILLERBERND MANUFACTURING COMPANY	L-867 COVER PLATE	IA			B		127L(X)
MILLERBERND MANUFACTURING COMPANY	L-867 SPACER RINGS	IA			B		127S(X)
MILLERBERND MANUFACTURING COMPANY	L-867 MUD PLATE	IA			B		127M1025

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MILLERBERND MANUFACTURING COMPANY	L-867 BASE	IA			D		167ACC(X)PCC; 167ACG(X)PCC; 167CC(X); 167CG(X)
MILLERBERND MANUFACTURING COMPANY	L-867 EXT	IA			D		167E(X)
MILLERBERND MANUFACTURING COMPANY	L-867 CONV RING	IA			D		17A0125
MILLERBERND MANUFACTURING COMPANY	L-867 COVER PLATE	IA			D		167L(X)
MILLERBERND MANUFACTURING COMPANY	L-867 SPACER RINGS	IA			D		167S(X)
MILLERBERND MANUFACTURING COMPANY	L-867 MUD PLATE	IA			D		167M1425
MILLERBERND MANUFACTURING COMPANY	L-867 BASE	IA			E		247ACC(X)PCC; 247ACG(X)PCC; 247CC(X); 247CG(X)
MILLERBERND MANUFACTURING COMPANY	L-867 EXT	IA			E		247E(X)
MILLERBERND MANUFACTURING COMPANY	L-867 COVER PLATE	IA			E		247L(X)
MILLERBERND MANUFACTURING COMPANY	L-867 SPACER RINGS	IA			E		247S(X)
MILLERBERND MANUFACTURING COMPANY	L-867 MUD PLATE	IA			E		247M215
MILLERBERND MANUFACTURING COMPANY	L-867 BASE	IB			B		127ACC(X)PCCSS; 127ACG(X)PCCSS; 127CC(X)SS; 127CG(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 EXT	IB			B		127E(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 CONV RING	IB			B		128CR(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 COVER PLATE	IB			B		127L(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 SPACER RINGS	IB			B		127S(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 BASE	IB			D		167ACC(X)PCCSS; 167ACG(X)PCCSS; 167CC(X)SS; 167CG(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 EXT	IB			D		167E(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 CONV RING	IB			D		17A0125SS
MILLERBERND MANUFACTURING COMPANY	L-867 COVER PLATE	IB			D		167L(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 SPACER RINGS	IB			D		167S(X)SS

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MILLERBERND MANUFACTURING COMPANY	L-867 BASE	IB			E		247ACC(X)PCCSS; 247ACG(X)PCCSS; 247CC(X)SS; 247CG(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 EXT	IB			E		247E(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 COVER PLATE	IB			E		247L(X)SS
MILLERBERND MANUFACTURING COMPANY	L-867 SPACER RINGS	IB			E		247S(X)SS
JAQUITH INDUSTRIES, INC.	L-867 BASE	IA			B		AC20XXXXXXXXXPCC; AC21XXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-867 EXT	IA			B		AE2XXXX
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IA			B		AK10XXXX
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IA			B		AT2006XX
JAQUITH INDUSTRIES, INC.	L-867 MUD PLATE	IA			B		AM5417
JAQUITH INDUSTRIES, INC.	L-867 BASE	IA			D		AC63XXXXXXXXX; AC60XXXXXXXXXPCC
JAQUITH INDUSTRIES, INC.	L-867 EXT	IA			D		AE6XXXX
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IA			D		AK20XXXX
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IA			D		AT6003XX
JAQUITH INDUSTRIES, INC.	L-867 MUD PLATE	IA			D		AM5527
JAQUITH INDUSTRIES, INC.	L-867 BASE	IA			E		AC67XXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-867 EXT	IA			E		AE7XXXX
JAQUITH INDUSTRIES, INC.	L-867 COVER PLATE	IA			E		AK70XXXX
JAQUITH INDUSTRIES, INC.	L-867 SPACER RINGS	IA			E		AT7003XX
JAQUITH INDUSTRIES, INC.	L-867 MUD PLATE	IA			E		AM5727
L-868 Light Bases, Load Bearing (FAA AC 150/5345-42F)							
AIRPORT LIGHTING EQUIPMENT INC.	L-868						1224-2-S; 1224-2-SS; 1224-1B; 4420SS; 4714-R; 4419F-X; 2419-F; 2419F-X-SS; 2419F-SS-1B; 1224-2-EXT; 5402-Y; L-868-GR-B-S; L868B-CP-B-S
L-868 Light Bases, Load Bearing (FAA AC 150/5345-42G)							
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-868 BASE	IA			B		ALB-L868-12-24-1A-C4-XX
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-868 COVER PLATE	IA			B		BCP-L868-12-19-S
L-868 Light Bases, Load Bearing (FAA AC 150/5345-42H)							

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JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IA			A		AF0802XX; AF0802XXY; AR0824; AR0821XX; AR0821XXY
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IA			B		AF5402XX; AF5402XXY; AR5411XX; AR5424; AR5421XX; AR5422XX; AR5421XXY; AR5424AL
JAQUITH INDUSTRIES, INC.	L-868 ADAPT PLATE	IA			B		AF543412; AA122820
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IA			C		AF5502XX; AF5502XXY; AF5702XXY; AR5511XX; AR5524; AR5521XX; AR5521XXY; AR5721XX; AR5721XXY
JAQUITH INDUSTRIES, INC.	L-868 ADAPT PLATE	IA			C		AA251520MKE; AA251520; AA251220; AA251220CDE
JAQUITH INDUSTRIES, INC.	L-868 BASE	IA			A		AC08XXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IA			A		AC40XXXXXXXXX (bottom); AE4703M (middle); AF0XXXX (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IA			A		AX0XXXX
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IA			A		AK80XXXX
JAQUITH INDUSTRIES, INC.	L-868 MUD PLATE	IA			A		AM5017; AM5027
JAQUITH INDUSTRIES, INC.	L-868 BASE	IA			B		AC24XXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IA			B		AC44XXXXXXXXX (bottom); AE4704M (middle); AF2XXXX (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IA			B		AX2XXXX
JAQUITH INDUSTRIES, INC.	L-868 CONV RING	IA			B		AA5423; AA5413
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IA			B		AK40XXXX
JAQUITH INDUSTRIES, INC.	L-868 MUD PLATE	IA			B		AM5417; AM5427
JAQUITH INDUSTRIES, INC.	L-868 BASE	IA			C		AC35XXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IA			C		AC45XXXXXXXXX (bottom); AE4705M (middle); AF3XXXX (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IA			C		AX3XXXX
JAQUITH INDUSTRIES, INC.	L-868 CONV RING	IA			C		AA5523; AA5513
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IA			C		AK50XXXX
JAQUITH INDUSTRIES, INC.	L-868 MUD PLATE	IA			C		AM5527; AM5517
JAQUITH INDUSTRIES, INC.	L-868 BASE	IB			A		ACB08XXXXXXXXXVK

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JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IB			A		ACB40XXXXXXXXXXVK (bottom); AEB4703MVK (middle); AFB0XXXXVK (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IB			A		AXB0XXXXVK
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IB			A		AK80XXXXVK
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IB			A		AF0802XXVK; AF0802XXYVK; AR0821XXVK; AR0821XXYVK; AR0824VK
JAQUITH INDUSTRIES, INC.	L-868 BASE	IB			B		ACB24XXXXXXXXXXVK
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IB			B		ACB44XXXXXXXXXXVK (bottom); AEB4704MVK (middle); AFB2XXXXVK (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IB			B		AXB2XXXXVK
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IB			B		AK40XXXXVK
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IB			B		AF5402XXVK; AF5402XXYVK; AR5411XXVK; AR5421XXVK; AR5422XXVK; AR5424VK; AR5421XXYVK
JAQUITH INDUSTRIES, INC.	L-868 BASE	IB			C		ACB35XXXXXXXXXXVK
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IB			C		ACB45XXXXXXXXXXVK (bottom); AEB4705MVK (middle); AFB3XXXXVK (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IB			C		AXB3XXXXVK
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IB			C		AK50XXXXVK
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IB			C		AF5502XXVK; AF5502XXYVK; AF5702XXYVK; AR5511XXVK; AR5521XXVK; AR5512XXVK; AR5524VK; AR5721XXYVK
JAQUITH INDUSTRIES, INC.	L-868 BASE	IB			A		ACS08XXXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IB			A		ACS40XXXXXXXXXX (bottom); AES4703M (middle); AFS0XXXX (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IB			A		AXS0XXXX
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IB			A		AKS80XXXX
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IB			A		AFS0802XX; AFS0802XXY; ARS0821XX; ARS0821XXY; ARS0824
JAQUITH INDUSTRIES, INC.	L-868 BASE	IB			B		ACS24XXXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IB			B		ACS44XXXXXXXXXX (bottom); AES4704M (middle); AFS2XXXX (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IB			B		AXS2XXXX
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IB			B		AKS40XXXX

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IB			B		AFS5402XX; AFS5402XXY; AFS5434XX; ARS5411XX; ARS5421XX; ARS5422XX; ARS5424; ARS5421XXY
JAQUITH INDUSTRIES, INC.	L-868 BASE	IB			C		ACS35XXXXXXXXX
JAQUITH INDUSTRIES, INC.	L-868 BASE MULTI-SECTION	IB			C		ACS45XXXXXXXXX (bottom); AES4705M (middle); AFS3XXXX (top)
JAQUITH INDUSTRIES, INC.	L-868 EXT	IB			C		AXS3XXXX
JAQUITH INDUSTRIES, INC.	L-868 COVER PLATE	IB			C		AKS50XXXX
JAQUITH INDUSTRIES, INC.	L-868 SPACER RINGS	IB			C		AFS5502XX; AFS5502XXY; AFS5702XXY; ARS5511XX; ARS5521XX; ARS5521XXY; ARS5524; ARS5721XX; ARS5721XXY
MILLERBERND MANUFACTURING COMPANY	L-868 BASE	IA			A		88CC(X); 88CG(X); 88CGY(X)
MILLERBERND MANUFACTURING COMPANY	L-868 BASE MULTI-SECTION	IA			A		88BSC(X) (bottom); 88BSG(X) (bottom); 88MS(X) (middle); 88TS(X) (top)
MILLERBERND MANUFACTURING COMPANY	L-868 EXT	IA			A		88E(X); 108E(X)
MILLERBERND MANUFACTURING COMPANY	L-868 CONV RIN	IA			A		88CR(X)
MILLERBERND MANUFACTURING COMPANY	L-868 COVER PLATE	IA			A		88L(X)
MILLERBERND MANUFACTURING COMPANY	L-868 SPACER RINGS	IA			A		88S(X); 88SY(X); 88F(X); 88SMB(X); 88FY(X); 108S(X)
MILLERBERND MANUFACTURING COMPANY	L-868 MUD PLATE	IA			A		88M0625; 88M0725; 108M0825; 108M0925
MILLERBERND MANUFACTURING COMPANY	L-868 BASE	IA			B		128CC(X); 128CG(X); 128CGY(X); 128CGT(X); 128CCT(X)
MILLERBERND MANUFACTURING COMPANY	L-868 BASE MULTI-SECTION	IA			B		128BSC(X) (bottom); 128BSG(X) (bottom); 128MS(X) (middle); 128TS(X) (top)
MILLERBERND MANUFACTURING COMPANY	L-868 EXT	IA			B		128E(X)
MILLERBERND MANUFACTURING COMPANY	L-868 CONV RIN	IA			B		127CR(X); 178A0125; 158A0125
MILLERBERND MANUFACTURING COMPANY	L-868 COVER PLATE	IA			B		128L(X)
MILLERBERND MANUFACTURING COMPANY	L-868 SPACER RINGS	IA			B		128S(X); 128SY(X); 128F(X); 128FY(X); 128SMB(X)
MILLERBERND MANUFACTURING COMPANY	L-868 MUD PLATE	IA			B		128M1125; 128M1025

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MILLERBERND MANUFACTURING COMPANY	L-868 BASE	IA			C		158CC(X); 158CG(X); 158CGY(X); 158CCT(X); 158CGT(X)
MILLERBERND MANUFACTURING COMPANY	L-868 BASE MULTI-SECTION	IA			C		158BSC(X) (bottom); 158BSG(X) (bottom); 158MS(X) (middle); 158TS(X) (top)
MILLERBERND MANUFACTURING COMPANY	L-868 EXT	IA			C		158E(X)
MILLERBERND MANUFACTURING COMPANY	L-868 CONV RIN	IA			C		158CR(X)
MILLERBERND MANUFACTURING COMPANY	L-868 COVER PLATE	IA			C		158L(X)
MILLERBERND MANUFACTURING COMPANY	L-868 SPACER RINGS	IA			C		158S(X); 158SY(X); 158F(X); 158SMB(X); 158FY(X)
MILLERBERND MANUFACTURING COMPANY	L-868 MUD PLATE	IA			C		158M1425; 158M1325
MILLERBERND MANUFACTURING COMPANY	L-868 BASE	IB			A		88CC(X)SS; 88CG(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 BASE MULTI-SECTION	IB			A		88BSC(X)SS (bottom); 88BSG(X)SS (bottom); 88MS(X)SS (middle); 88TS(X)SS (top)
MILLERBERND MANUFACTURING COMPANY	L-868 EXT	IB			A		88E(X)SS; 108E(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 CONV RING	IB			A		88CR(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 COVER PLATE	IB			A		88L(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 SPACER RINGS	IB			A		88S(X)SS; 88SY(X)SS; 88F(X)SS; 88SMB(X)SS; 88FY(X)SS; 108S(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 BASE	IB			B		128CC(X)SS; 128CG(X)SS; 128CGT(X)SS; 128CCT(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 BASE MULTI-SECTION	IB			B		128BSC(X)SS (bottom); 128BSG(X)SS (bottom); 128MS(X)SS (middle); 128TS(X)SS (top)
MILLERBERND MANUFACTURING COMPANY	L-868 EXT	IB			B		128E(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 CONV RING	IB			B		127CR(X)SS; 178A0125SS; 158A0125SS
MILLERBERND MANUFACTURING COMPANY	L-868 COVER PLATE	IB			B		128L(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 SPACER RINGS	IB			B		128S(X)SS; 128SY(X)SS; 128F(X)SS; 128FY(X)SS; 128SMB(X)SS

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
MILLERBERND MANUFACTURING COMPANY	L-868 BASE	IB			C		158CC(X)SS; 158CG(X)SS; 158CCT(X)SS; 158CGT(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 BASE MULTI-SECTION	IB			C		158BSC(X)SS (bottom); 158BSG(X)SS (bottom); 158MS(X)SS (middle); 158TS(X)SS (top)
MILLERBERND MANUFACTURING COMPANY	L-868 EXT	IB			C		158E(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 CONV RING	IB			C		158CR(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 COVER PLATE	IB			C		158L(X)SS
MILLERBERND MANUFACTURING COMPANY	L-868 SPACER RINGS	IB			C		158S(X)SS; 158SY(X)SS; 158F(X)SS; 158SMB(X)SS; 158FY(X)SS
L-880 / L-881 Precision Approach Path Indicators (PAPI) (FAA AC 150/5345-28G)							
ADB SAFEGATE AMERICAS, LLC	L-880(L)	1, 2	B				LPLF-B40000 (606)
ADB SAFEGATE AMERICAS, LLC	L-880(L)	1, 2	A				LPLF-A40100 (606); LPLF-A40200 (606); LPLF-A40300 (606)
ADB SAFEGATE AMERICAS, LLC	L-880	1, 2	A				PAPA-40X0 (164)
ADB SAFEGATE AMERICAS, LLC	L-880	1, 2	B				PAPB-4000 (164)
ADB SAFEGATE AMERICAS, LLC	L-880	1, 2	A				44A4733-1X2X (66)
ADB SAFEGATE AMERICAS, LLC	L-880	1, 2	B				44A5860-211X (66)
AIRPORT LIGHTING COMPANY	L-880	2	A				880-V-2 (385)
AIRPORT LIGHTING COMPANY	L-880	2	B				880-C-2 (385)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-880	1, 2	A				880A2A-X (289); 880A3A-X (289)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-880	1, 2	B				880A2B-X (289); 880A3B-X (289)
ADB SAFEGATE AMERICAS, LLC	L-881(L)	I, II	B				LPLF-B20000 (606)
ADB SAFEGATE AMERICAS, LLC	L-881(L)	I, II	A				LPLF-A20100 (606); LPLF-A20200 (606); LPLF-A20300 (606)
ADB SAFEGATE AMERICAS, LLC	L-881	I, II	A				PAPA-20X0 (164)
ADB SAFEGATE AMERICAS, LLC	L-881	I, II	B				PAPB-2000 (164)
ADB SAFEGATE AMERICAS, LLC	L-881	I, II	A				44A4733-2X2X (66)
ADB SAFEGATE AMERICAS, LLC	L-881	I, II	B				44A5860-221X (66)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-881	I, II	A				881A2A-X (289); 881A3A-X (289)
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-881	I, II	B				881A2B-X (289); 881A3B-X (289)
AIRPORT LIGHTING COMPANY	L-881	II	A				881-V-2 (385)
AIRPORT LIGHTING COMPANY	L-881	II	B				881-C-2 (385)
L-884 Power and Control Unit for Land and Hold Short Lighting Systems (FAA AC 150/5345-54B)							

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
ADB SAFEGATE AMERICAS, LLC	L-884		I				44A6011-XX;
ADB SAFEGATE AMERICAS, LLC	L-884		II				4A6012-XX
L-885 Lights, Obstruction, Red, 60FPM (FAA AC 150/5345-43G)							
DIALIGHT CORPORATION	L-885(L)						D1RW-L13-008 (435) catenary system
INTERNATIONAL TOWER LIGHTING, LLC	L-885(L)						ILS-3600-CAT (635); ILS-3600-CAT-IR (636*)
UNIMAR INC	L-885(L)						DCLSX-008 (435)
L-885 Lights, Obstruction, Red, 60FPM (FAA AC 150/5345-43H)							
FLASH TECHNOLOGY LLC	L-885(L)						FTS 370r (510); FTS 370d (474)
FLASH TECHNOLOGY LLC	L-885(L)						FTS 371 AC (750); FTS 371 SMART AC (750)
HUGHEY & PHILLIPS, LLC	L-885(L)						50-013-001; 50-013-002; 50-013-003 (491); 50-0012-001; 50-0012-002; 50-0012-003 (492)
L-890 Airport Lighting Control and Monitoring System (FAA AC 150/5345-56B)							
ADB SAFEGATE AMERICAS, LLC	L-890		A-CONTROL ONLY; B-BASIC MONITORING; C-ADVANCED MONITORING; D-SMGCS READY	A-PRESET FAILSAFE; B-LAST STATE FAILSAFE			MONITORING (A, B, C, D): ALCMS-AY; ALCMS-BY; ALCMS-CY; ALCMS-DY; FAIL SAFE: (A, B): ALCMSXA; ALCMS-XB
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-890		A-CONTROL ONLY; B-BASIC MONITORING; C-ADVANCED MONITORING; D-SMGCS READY	A-PRESET FAILSAFE; B-LAST STATE FAILSAFE			L-890X-X
CROUSE HINDS AIRPORT LIGHTING PRODUCTS	L-890		A-CONTROL ONLY; B-BASIC MONITORING; C-ADVANCED MONITORING	A-PRESET FAILSAFE; B-LAST STATE FAILSAFE			890G1X-A, B, C: 890G1A-X; B-X

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
LIBERTY AIRPORT SYSTEMS, INC.	L-890		A-CONTROL ONLY; B-BASIC MONITORING; C-ADVANCED MONITORING; D-SMGCS READY	A-PRESET FAILSAFE; B-LAST STATE FAILSAFE			L-890-A-A; A-B; L-890-B-A; B-B; L-890-C-A; C-B; L-890-D-A; D-B; L-890-X-A; L-890-X-B
LIBERTY AIRPORT SYSTEMS, INC.	L-890		A-CONTROL ONLY; B-BASIC MONITORING; C-ADVANCED MONITORING; D-SMGCS READY	A-PRESET FAILSAFE; B-LAST STATE FAILSAFE			L-890-A-A; A-B; L-890-B-A; B-B; L-890-C-A; C-B; L-890-D-A; D-B; L-890-XA; L-890-X-B
RURAL ELECTRIC INC.	L-890		A-CONTROL ONLY; B-BASIC MONITORING	A-PRESET FAILSAFE; B-LAST STATE FAILSAFE			MONITORING OPTIONS: CONTROL ONLY(A): L-890-A-A BASIC(B): L-890-B-A; L-890-B-B FAIL-SAFE OPTIONS: PRESET(A): L-890-A-A; L-890-B-A LAST STATE(B): L-890-A-B; L-890-B-B
YOUYANG AIRPORT LIGHTING EQUIPMENT INC.	L-890		A-CONTROL ONLY; B-BASIC MONITORING; C-ADVANCED MONITORING; D-SMGCS READY	A-PRESET FAILSAFE; B-LAST STATE FAILSAFE			ALCMS-L890-X-X
L-891 / L-892 Low Impact Resistant (LIR) Structures (FAA AC 150/5345-45C)							
POLLITE LTD	L-891		1, 2				GFP01/S; GFP01/CA1.2; GFP01/CA1.5; GFP01/CA2.7; GFP01/CA3; GFP01/CA4.5; GFP01/CA5.4; GFP01/CA6
POLLITE LTD	L-891		1, 2, 3				GFP02/S; GFP02/CA1.2; GFP02/CA1.5; GFP02/CA2.7; GFP02/CA3; GFP02/CA4.5; GFP02/CA5.4; GFP02/CA6

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MFG	FAA type	CLASS	STYLE	MODE	SIZE	RATING	CAT NO
EXEL OYJ	L-891		1				D51; D86; D86L; D106; D106L
EXEL OYJ	L-891		1, 2				L400
EXEL OYJ	L-891		1, 2, 3				L500
EXEL OYJ	L-892		1				L500
JAQUITH INDUSTRIES, INC.	L-891		1				MG-20
JAQUITH INDUSTRIES, INC.	L-891		2				MG-30
JAQUITH INDUSTRIES, INC.	L-891		3				MG-40
JAQUITH INDUSTRIES, INC.	L-892		1				MS-20
MILLARD TOWERS LTD. (FRANGIPOLE)	L-891		1				MG-20
MILLARD TOWERS LTD. (FRANGIPOLE)	L-891		2				MG-30
MILLARD TOWERS LTD. (FRANGIPOLE)	L-891		3				MG-40
MILLARD TOWERS LTD. (FRANGIPOLE)	L-892		1				MS-20
L-893 Lighted Visual Aid to Indicate Temporary Runway Closure (FAA AC 150/5345-55A)							
HALI-BRITE INC.	L-893						RCM-D (649)
NAC DYNAMICS, LLC.	L-893(L)						DY3000-893L(710)
L-894 Elevated Light Covers (FAA AC 150/5345-42H)							
JAQUITH INDUSTRIES, INC.	L-894	IA	L-867B		1.5"		AP1835G
JAQUITH INDUSTRIES, INC.	L-894	IA	L-867B		1.5"		AP1935G
JAQUITH INDUSTRIES, INC.	L-894	IA	L-867D		1.5"		AP2835G
L-895 Elevated Light Stake Mounting (FAA AC 150/5345-42H)							
JAQUITH INDUSTRIES, INC.	L-895	IA			2"		AW2202
JAQUITH INDUSTRIES, INC.	L-895	IA			1.5"		AW2205

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LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
10	6.6A/T10/1P	30		6.6	GE, Sylvania, Philips
10A	6.6A/T10/1P	30		6.6	GE
10C	6.6A/T10/1P	30		6.6	Philips
11A	6.6A/T10/P	45		6.6	GE
11B	6.6A/T10/P	45		6.6	Sylvania
11C	6.6A/T10/P	45		6.6	Philips
16	20058	120		6.6	CROUSE HINDS ALP
17	40732	45		6.6	CROUSE HINDS ALP
18	40737	30		6.6	CROUSE HINDS ALP
21	EWR 11427	150		6.6	GE
31	EXL	30		6.6	GE
32A	116A21/TS	116	120		GE
32B	116A21/TS	116	120		Philips
32C	116A21/TS	116	130		Philips
33	EXM	45		6.6	GE
36	EVV	120		6.6	GE
66	64382	200		6.6	Osram
75	3843	Xenon			Flash Technology
87	Q500PAR56/NSP	500	120		GE
88	Q1000PAR64/NSP	1000	120		GE
90	EZL	200		6.6	GE
97	64346	100		6.6	Osram
123	2990.40.900	105		6.6	ADB SAFEGATE BVBA
124	2990.40.827	48		6.6	OSRAM
126	SLC 008065	48		6.6	OSRAM
127	64341	100		6.6	OSRAM
133	8384329				Flash Technology
135	40925	150		6.6	CROUSE HINDS ALP
136	20172	200		6.6	CROUSE HINDS ALP
137	64317	45		6.6	Osram
144	12S006022	Xenon			HUGHEY & PHILLIPS
147	120PAR38/WFL50	120	120		Sylvania Capsylite
151	20590	62		6.6	CROUSE HINDS ALP
152	HLX64342	100		6.6	Osram
153	HLX64361-Z	150		6.6	Osram
157	9017	Xenon			Flash Technology
160	SLC 008075	105		6.6	ATG
163	64338	48		6.6	Osram
164	64339	105		6.6	Osram
165	STFLSHTB6	Xenon			Advanced Strobe Products
166	STFLSHTB7	Xenon			Advanced Strobe Products
167	8777	420		3.2	Flash Technology
174	860-1R01	LED			Dialight
175	21116	48		6.6	GE
181	21127	32		6.6	GE
189	8384308	Xenon			Flash Technology
190	M60-38	150			Sylvania
193	PKX30d	45		6.6	Philips
194	21169	62		6.6	GE
195	MH175W/U/MED	175			VENTURE
196	10047-2138	100		6.6	Osram

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
208	VENTURE PULSE START	400	120		VENTURE
211	44A6227	LED			ADB SAFEGATE AMERICAS, LLC
213	MR-16	105			OSRAM
215	21128	105		6.6	OSRAM
216	21496	48		6.6	SYLVANIA
217	XFT 200	Xenon			ORGA
219	21116	48		6.6	OSRAM
220	64337 A45-15	45		6.6	OSRAM
224	760.2179	30		6.6	OCEM SpA
225	760.2186	48		6.6	OCEM SpA
226	59036	75	120		SYLVANIA
231	GE MR-16 EXT	50	12		GE
232	860-1R03	LED	12		Dialight
233	860-1R05	LED	24		Dialight
234	860-1R04	LED	48		Dialight
235	55041	30		6.6	SYLVANIA
236	55048	45		6.6	SYLVANIA
239	50397 BLUE	LED		6.6	CROUSE HINDS ALP
240	STFLSHTB5	Xenon			ADVANCED STROBE PRODUCTS
249	64320	45		6.6	Osram
251	6134 EXM	45		6.6	Philips
252	UHI-150 DM/A/UVP	150	120		USHIO
253	UHI-150 DW/A/UVP	150	120		USHIO
254	20058	120		6.6	GE
255	48A0382-2 LUXEON LED	LED	120		ADB SAFEGATE AMERICAS, LLC
256	44A6355-10 BLUE	LED		6.6	ADB SAFEGATE AMERICAS, LLC
260	8384309	Xenon			FLASH TECHNOLOGY
263	8671301	Xenon			FLASH TECHNOLOGY
265	0100-3752	LED	120		HALIBRITE
267	48A0009	69	120		ADB SAFEGATE AMERICAS, LLC
268	1413.05.100 GREEN	LED		6.6	ADB SAFEGATE AMERICAS, LLC
269	1413.05.110 YELLOW	LED		6.6	ADB SAFEGATE AMERICAS, LLC
273	48A0078 PAR 38	120			Sylvania
274	48A0375	100			Regent
276	150/CL RF OPTION GE	150	120		CROUSE HINDS ALP
277	10047-2882 GE Par 38	250	120		CROUSE HINDS ALP
278	40600536R RED	LED			AUTOMATIC POWER
279	10047-2888	45			OSRAM
281	PL10630-F-8	LED			POINT LIGHTING
282	55-00145 PAR 56	Xenon			STROBE APPROACH LIGHTING TECHNOLOGY
283	LIGHTHEAD 120	LED	120		FARLIGHT
284	LIGHTHEAD 240	LED	240		FARLIGHT
285	6102	40		6.6	Philips
286	6116	100		6.6	Philips
287	55-00211 HELICAL	Xenon			STROBE APPROACH LIGHTING TECHNOLOGY
289	58750	200		6.6	OSRAM

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
290	64320	45		6.6	OSRAM
291	64322	30		6.6	OSRAM
292	760.2190	105		6.6	OSRAM
293	760.2191	48		6.6	OSRAM
294	116A21/TS-120V	116	120		GE
296	LA-RO-36-1-O1	LED			ORGA
297	STD 05006	LED	120		TWR
298	21312	LED		6.6	CROUSE HINDS ALP
300	860-1R02	LED	220		Dialight
304	D164 1010	LED	120		Dialight
306	LED-T	LED		6.6	AIRPORT LIGHTING
308	21355	LED		6.6	CROUSE HINDS ALP
309	21354	LED		6.6	CROUSE HINDS ALP
310	21317	LED		6.6	CROUSE HINDS ALP
311	21318	LED		6.6	CROUSE HINDS ALP
312	6110	40		6.6	Philips
315	2990.40.827	48		6.6	SLI
316	44A5911	30		6.6	OSRAM
317	2990.48.360	45		6.6	OSRAM
318	48A0386	62		6.6	GE
319	H29316-1	LED		6.6	ATG
320	H29316-2	LED		6.6	ATG
321	44A6672	LED		6.6	ADB SAFEGATE AMERICAS, LLC
326	3400-0133 PAR 38 25 DEG	90			PHILIPS
328	44A6702-1	LED			ADB SAFEGATE AMERICAS, LLC
329	44A6722	LED			ADB SAFEGATE AMERICAS, LLC
331	Luxeon LXHL-FB-3C	LED			ASTRONICS DME Corporation
333	9200-026	LED	120	6.6A	Hali-Brite
334	FH0-3400-000	Xenon	120		ITL
335	6138	48		6.6	Philips
337	D264-1011	LED	120/240		DIALIGHT
338	D264-1013	LED	120/240		DIALIGHT
341	48A0396/3 White	LED	120		ADB SAFEGATE AMERICAS, LLC
342	6128	120		6.6	Philips
343	LED2.0 56 WHITE	LED			AGM
345	48A0400-GRN	LED			ADB SAFEGATE AMERICAS, LLC
346	48A0400-YLW	LED			ADB SAFEGATE AMERICAS, LLC
347	48A0401-GRN	LED			ADB SAFEGATE AMERICAS, LLC
348	48A0401-YLW	LED			ADB SAFEGATE AMERICAS, LLC
349	LIGHTHEAD 12-48VDC	LED	12-48		FARLIGHT
350	CMH150TU/942/G12	150			GE
351	150.3142Y	LED			OCEM
352	150.3143G	LED			OCEM
353	150.3155Y	LED			OCEM
354	150.3156G	LED			OCEM
355	150.3072G	LED			OCEM
356	150.3095Y	LED			OCEM
357	150.3092Y	LED			OCEM
358	150.3154G	LED			OCEM
359	150.3152Y	LED			OCEM

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
360	150.3153G	LED			OCEM
361	150.3161Y	LED			OCEM
362	150.3162Y	LED			OCEM
363	150.3035B	LED			OCEM
364	150.3108W	LED			OCEM
365	150.3074R	LED			OCEM
366	150.3116R	LED			OCEM
367	150.3091G	LED			OCEM
369	150.3215 LED BLUE	LED			OCEM
370	48A0404-YLW	LED			ADB SAFEGATE AMERICAS, LLC
371	LXHL-LB3C-LED	LED			FARLIGHT
372	8083-0014R	LED			AUTOMATIC POWER
373	10V/20W Quartz	20	10		WAMCO
375	D1RWFH04 4 TIER	LED			DIALIGHT
376	D1RWFH06 6 TIER	LED			DIALIGHT
377	RTO1R06 RED	LED			DIALIGHT
378	RTO1R07 RED	LED			DIALIGHT
379	RTO1R08 RED	LED			DIALIGHT
381	D1RWFH03 3 TIER	LED			DIALIGHT
382	7654H	45		6.6	PHILIPS
383	9696 PHILIPS	120		6.6	PHILIPS
384	XRCRED-L1-0000-00M01	LED			ITL
385	64339A	105		6.6	OSRAM
386	6105	105		6.6	PHILIPS
389	10047-2993	116	130		GE
390	116A21TS8M	116	120		SYLVANIA
391	11427-EWR	150		6.6	GE
392	10099-EVV	200		6.6	GE
394	Farlight LED3 Beacon 24/48VDC	LED	24/48		Farlight
395	48A0382/5 Green	LED			ADB SAFEGATE AMERICAS, LLC
396	HH512	116	120		H & H
397	21478 Blue	LED			CROUSE HINDS ALP
398	FXQSL-103-8	Xenon	120		Perkin Elmer
399	LH116120ASYL	116	120		HUGHEY & PHILIPS
400	21474	48		6.6	Osram
402	SG9625G1 GREEN	LED			ADB SAFEGATE SWEDEN AB
403	SG9625Y1 YELLOW	LED			ADB SAFEGATE SWEDEN AB
404	48A0400-WHT	LED			ADB SAFEGATE AMERICAS, LLC
405	B42182 BLUE	LED			YOUYANG
410	CMH150/TU/830/G12	150	120		GE
411	LXML-PD01-0040 LUXEON REBEL 40LUMEN RED	LED			AUSTIN INSULATORS
412	D1RW1018 RED & WHITE 1 TIER	LED	120-240		DIALIGHT
413	D464-1011 RED 1 TIER	LED	120-240		DIALIGHT
414	13950	LED	48		OBSTA

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
415	D165-1018 WHITE 1 TIER LED	LED	120-240		DIALIGHT
416	64331-FL MR16	30		6.6	OSRAM
418	44A6967/1X0 6 EA WHITE	LED			ADB SAFEGATE AMERICAS, LLC
419	44A6950/1X0 6 EA WHITE	LED			ADB SAFEGATE AMERICAS, LLC
420	48A0415 4 EA RED	LED			ADB SAFEGATE AMERICAS, LLC
421	44A7062/20 1 EA RED	LED			ADB SAFEGATE AMERICAS, LLC
422	44A7062/10 1 EA GREEN	LED			ADB SAFEGATE AMERICAS, LLC
423	0100-3866 RED	LED			HALI-BRITE
424	6303 PHILIPS PK30d	45		6.6	PHILIPS
425	64361	150		6.6	OSRAM
426	48A0415-TYLW 4ea	LED			ADB SAFEGATE AMERICAS, LLC
427	9200-0032 8 Red	LED	120		HALI-BRITE
428	9200-0033 8 Red	LED	12VDC		HALI-BRITE
429	9200-0034 8 Red	LED		6.6	HALI-BRITE
430	9200-0035 8 Red	LED	120		HALI-BRITE
431	9200-0036 8 Red	LED	12VDC		HALI-BRITE
432	9200-0037 8 Red	LED		6.6	HALI-BRITE
433	50547	LED			CROUSE HINDS ALP
434	3400-0100		120		Regent
435	D1RW1018CAT Red & White 1 tier CAT	LED			DIALIGHT
436	PL10834-R	LED			POINT LIGHTING
438	RTOCR07 IR RED LED VAC	LED	120-240		DIALIGHT
439	RTOCR08 IR RED LED VDC	LED	12-48		DIALIGHT
440	64319Z Pk30d	45		6.6	Osram
441	48A0396-2 Luxeon Red	LED			ADB SAFEGATE AMERICAS, LLC
442	LED	LED		6.6	Standard Signs
443	9200-0040 Orange	LED	120		HALI-BRITE
444	LXML-PB01-0040 LUXEON	LED		6.6	ASTRONICS DME Corporation
445	48A0427/BLU	LED		6.6	ADB SAFEGATE AMERICAS, LLC
446	LED-LXML-PD01-0040	LED			ITL
447	D156-1021 White	LED			DIALIGHT
448	62288	LED		6.6	CROUSE HINDS ALP
449	45-0001-001a	LED	95-277		HUGHEY & PHILLIPS
450	9011118000	LED			aquasignal
451	D264-1016	LED	24/48		DIALIGHT
452	792.160.00 RED	LED		6.6	HELLA
453	792.045.00 WHITE	LED		6.6	HELLA
454	187.494-10 GREEN	LED		6.6	HELLA
456	RTO1R18	LED	12-48		DIALIGHT
457	187.493-10 RED	LED		6.6	HELLA
458	187.493-00 WHITE	LED		6.6	HELLA
459	16676	LED	120-240		ORGA

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
460	D4641017 Red 1 tier IR	LED	120-240		DIALIGHT
461	PL10901-R-F	LED			POINT LIGHTING
462	C7-LEDV2	LED		6.6	AGM
463	190.054-10 Green	LED		6.6	HELLA
464	191.060-00 Yellow	LED		6.6	HELLA
465	45-0002-001a	LED	10-48		HUGHEY & PHILLIPS
466	018096 White	LED			ORGA
467	100PAR38/IRC/FL25	100	120		PHILLIPS
468	21529	LED	21	6.6	CROUSE HINDS ALP
469	21547-1 GREEN	LED	9	6.6	CROUSE HINDS ALP
470	21547-2 YELLOW	LED	9	6.6	CROUSE HINDS ALP
471	21547-3 GREEN	LED	3	6.6	CROUSE HINDS ALP
472	21547-4 YELLOW	LED	3	6.6	CROUSE HINDS ALP
473	BE-226-234	LED			TECHNOSTROBE
474	1370155 R/W	LED			FLASH
475	1370145 W	LED			FLASH
476	1370180 R	LED			FLASH
477	45-0001-001	LED			HUGHEY & PHILLIPS
478	45-0002-001	LED			HUGHEY & PHILLIPS
479	1593.15.800 White	LED		6.6	ADB SAFEGATE AMERICAS, LLC
480	1593.15.840 Yellow	LED		6.6	ADB SAFEGATE AMERICAS, LLC
481	1593.15.810 Green	LED		6.6	ADB SAFEGATE AMERICAS, LLC
482	1593.15.820 Red	LED		6.6	ADB SAFEGATE AMERICAS, LLC
483	FAR1012RO	LED			FARLIGHT
484	190.054-00	LED		6.6	HELLA
485	1370165 RED	LED			FLASH
486	4587703	Xenon			FLASH
487	191.316-00 YELLOW	LED		6.6	HELLA
488	A1-03-0235-004	LED		6.6	ASTRONICS DME Corporation
489	A1-03-0235-002	LED		6.6	ASTRONICS DME Corporation
490	51-0008-001	LED	48		HUGHEY & PHILLIPS
491	51-0054-001	LED			HUGHEY & PHILLIPS
492	51-0060-001 RED & WHITE	LED			HUGHEY & PHILLIPS
493	4060-0625R	LED			TWR
494	A1-14-0086-001	LED		6.6	ASTRONICS DME Corporation
495	A1-14-0086-002	LED		6.6	ASTRONICS DME Corporation
496	48A0442-16	LED		6.6	ADB SAFEGATE AMERICAS, LLC
497	48A0442-24	LED		6.6	ADB SAFEGATE AMERICAS, LLC
498	48A0442-32	LED		6.6	ADB SAFEGATE AMERICAS, LLC
499	48A0431GRN	LED		6.6	ADB SAFEGATE AMERICAS, LLC
500	48A0431RED	LED		6.6	ADB SAFEGATE AMERICAS, LLC
501	48A0431WHT	LED		6.6	ADB SAFEGATE AMERICAS, LLC
502	48A0431YLW	LED		6.6	ADB SAFEGATE AMERICAS, LLC
503	48A0419/WHT	LED		6.6	ADB SAFEGATE AMERICAS, LLC
504	48A0419/RED3	LED		6.6	ADB SAFEGATE AMERICAS, LLC
505	48A0419/RED5	LED		6.6	ADB SAFEGATE AMERICAS, LLC
506	10047-3100	116	130		CROUSE HINDS ALP
507	LMP-116W-125-DUR	116	125		ITL
508	LXM2-PH01-0070 PHILIPS	LED			QUANTEC

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
509	192.737-00 YELLOW	LED		6.6	HELLA
510	1370135	LED			FLASH
515	FAR1012RO	LED			FARLIGHT
516	4072.24.920 WHITE	LED		6.6	ADB SAFEGATE AMERICAS, LLC
517	4072.24.920 RED	LED		6.6	ADB SAFEGATE AMERICAS, LLC
518	RGL-18	LED		6.6	AIRPORT LIGHTING CO
519	760.2186	48		6.6	SYLVANIA 21497
520	760.2190	105		6.6	SYLVANIA 21499
521	760.2181	30		6.6	SYLVANIA MR16
522	D2661019FH	LED			DIALIGHT
523	D5641011 RED 1 Tier	LED			DIALIGHT
524	D1651019 WHITE	LED			DIALIGHT
525	1030LED	LED			STROBE APPROACH LIGHTING TECHNOLOGY
526	D1RW-1019 DUAL	LED			DIALIGHT
527	D1RW-1020 DUAL	LED			DIALIGHT
528	SafeLED-TE-E-O-B-NPS-6.6A-1C	LED		6.6	ADB SAFEGATE SWEDEN AB
529	10047-1493	30		6.6	GE
530	10047-1497	45		6.6	NARVA
531	150.4075 RED	LED		6.6	OCEM
532	150.4044 RED	LED		6.6	OCEM
533	150.3980 WHITE	LED		6.6	OCEM
534	150.3398 WHITE	LED		6.6	OCEM
535	150.3399 RED	LED		6.6	OCEM
536	150.4076 RED	LED		6.6	OCEM
537	150.4164 GREEN	LED		6.6	OCEM
538	150.3979 YELLOW	LED		6.6	OCEM
539	150.3928 GREEN	LED		6.6	OCEM
540	150.3957 GREEN	LED		6.6	OCEM
541	150.4048 YELLOW	LED		6.6	OCEM
542	150.4166 WHITE	LED		6.6	OCEM
543	150.3525 BLUE	LED		6.6	OCEM
544	150.4089 BLUE	LED		6.6	OCEM
545	150.4061 YELLOW	LED		6.6	OCEM
546	150.4062 RED	LED		6.6	OCEM
548	150.4060 WHITE	LED		6.6	OCEM
549	150.4063 GREEN	LED		6.6	OCEM
550	IRIS200-LED01 GREEN	LED		6.6	atg
551	137210 Red LED	LED	24Vdc		FLASH TECHNOLOGY
552	861LEDMOD-BB	LED		6.6	AIRPORT LIGHTING CO
553	861LEDMOD-CC	LED		6.6	AIRPORT LIGHTING CO
554	861LEDMOD-GO	LED		6.6	AIRPORT LIGHTING CO
555	861LEDMOD-GY	LED		6.6	AIRPORT LIGHTING CO
556	861LEDMOD-RG	LED		6.6	AIRPORT LIGHTING CO
557	861LEDMOD-RR	LED		6.6	AIRPORT LIGHTING CO
558	44A7237	LED		6.6	ADB SAFEGATE AMERICAS, LLC
559	238519	83	120		PHILIPS
560	A1-03-0235-001	LED		6.6	ASTRONICS DME Corporation
561	44A7395	LED			ADB SAFEGATE AMERICAS, LLC
562	44A0440-1	LED		6.6	ADB SAFEGATE AMERICAS, LLC

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
563	F1370215	LED		6.6	FLASH TECHNOLOGY
564	SG9625B2	LED		6.6	ADB SAFEGATE SWEDEN AB
565	AV-OL-F810-12-R RED	LED			AVLITE
566	AV-OL-F810-12-RIR	LED			AVLITE
567	AV-OL-F810-UM-R RED	LED			AVLITE
568	AV-OL-F810-UM-RIR	LED			AVLITE
569	48A0444-GRN-300	LED		6.6	ADB SAFEGATE AMERICAS, LLC
570	48A0444-YLW-495	LED		6.6	ADB SAFEGATE AMERICAS, LLC
571	44A0772 BLUE	LED		6.6	ADB SAFEGATE AMERICAS, LLC
573	BE-226-235/236 W/R	LED			TECHNOSTROBE
574	21671-R Red	LED		6.6	CROUSE HINDS ALP
575	21671-W WHITE	LED		6.6	CROUSE HINDS ALP
576	IRIS200-LED03 YELLOW	LED		6.6	atg
577	IRIS200-LED09 GREEN	LED		6.6	atg
578	IRIS200-LED11 YELLOW	LED		6.6	atg
579	M550-1C	LED		6.6	MANAIRCO
580	M550-1R	LED		6.6	MANAIRCO
581	PL10569-1	Xenon			ADVANCED STROBE PRODUCTS
582	1370216	LED			FLASH TECHNOLOGY
583	1370211	LED			FLASH TECHNOLOGY
584	21683-1 Green	LED	9	6.6	CROUSE HINDS ALP
585	21683-2 Yellow	LED	9	6.6	CROUSE HINDS ALP
586	21683-3 Green	LED	3	6.6	CROUSE HINDS ALP
587	21683-4 Yellow	LED	3	6.6	CROUSE HINDS ALP
589	21671-R-12 Red	LED		6.6	CROUSE HINDS ALP
590	21671-W-12 WHITE	LED		6.6	CROUSE HINDS ALP
591	216LED1-LED	LED		6.6	AIRPORT LIGHTING CO
592	LMP-0LTE-300	LED			ITL
593	44521-04	LED		6.6	AIRSAFE
594	2990.40.827	48		6.6	KLS
595	1370175	LED			FLASH TECHNOLOGY
596	48A0443-GRN-640	LED		6.6	ADB SAFEGATE AMERICAS, LLC
597	48A0443-WHT-640	LED		6.6	ADB SAFEGATE AMERICAS, LLC
598	48A0443-YLW-640	LED		6.6	ADB SAFEGATE AMERICAS, LLC
599	44A7234/Y1	LED		6.6	ADB SAFEGATE AMERICAS, LLC
601	9200-0038	LED			HALI-BRITE
602	9200-0039	LED			HALI-BRITE
603	44A7062/31 RED	LED		6.6	ADB SAFEGATE AMERICAS, LLC
604	48A0444-GRN-495	LED		6.6	ADB SAFEGATE AMERICAS, LLC
605	D1RWFH180	LED			DIALIGHT
606	44A7274-20	LED			ADB SAFEGATE AMERICAS, LLC
607	IRIS200-LED31 GREEN	LED		6.6	atg
608	IRIS200-LED33 YELLOW	LED		6.6	atg
609	IRIS200-LED39 GREEN	LED		6.6	atg

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
610	IRIS200-LED41 YELLOW	LED		6.6	atg
611	IRIS200-LED51 WHITE	LED		6.6	atg
612	IRIS200-LED52 RED	LED		6.6	atg
613	IRIS200-LED54 WHITE LED LEFT	LED		6.6	atg
614	IRIS200-LED55 WHITE LED RIGHT	LED		6.6	atg
615	48A0444-YLW-300	LED		6.6	ADB SAFEGATE AMERICAS, LLC
616	1370169	LED			FLASH
618	48A0443-YLW-500	LED		6.6	ADB SAFEGATE AMERICAS, LLC
619	A3-06-3116-001	LED			ASTRONICS DME Corporation
620	SG17111W1 WHITE	LED		6.6	ADB SAFEGATE SWEDEN AB
621	SG17112R1 RED	LED		6.6	ADB SAFEGATE SWEDEN AB
622	LMP-0LTE-300-IR	LED			ITL
623	44A7479 1100-3 White & 44A7479 700-3 Red	LED		6.6	ADB SAFEGATE AMERICAS, LLC
624	44A74791100-3 White	LED		6.6	ADB SAFEGATE AMERICAS, LLC
625	1370040 Red	LED			FLASH
626	1370158 Red & White	LED			FLASH
627	1593.17.000 YELLOW	LED		6.6	ADB SAFEGATE AMERICAS, LLC
628	1593.17.010 GREEN	LED		6.6	ADB SAFEGATE AMERICAS, LLC
629	45666	320			GE
630	PL11102-R-F RED	LED			POINT LIGHTING
631	PL11110-R-F RED	LED			POINT LIGHTING
632	PL10993	LED			POINT LIGHTING
633	83PAR/HIR+/FL25	83	120		GE
634	7654H	45		6.6	NARVA
635	ITL-3600-ENG	LED	100-240		ITL
636	ITL-3600-ENG-IR	LED	100-240		ITL
637	ITL-2600-ENG	LED	100-240		ITL
638	ITL-2600-EBG-IR	LED	100-240		ITL
639	50637 804E-AP1	LED		6.6	CROUSE HINDS ALP
640	101Q	45		6.6	GE EXM
641	105	200		6.6	GE EZL
642	103	120		6.6	GE EVV
643	PCA-1305	3	12-48V		AVLITE
644	64337	48		6.6	GE
645	XQE AWT White	LED	120		ORGA ORGA
646	XQE RED	LED	120		ORGA ORGA
647	113760	LED			OBSTA
648	113761U	LED			OBSTA
649	424985	83	120		HALI-BRITE
650	04713	100	120		HALI-BRITE
651	50646-R RED	LED		6.6	CROUSE HINDS ALP
652	50649-R2 RED	LED		6.6	CROUSE HINDS ALP

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
653	50643 WHITE	LED		6.6	CROUSE HINDS ALP
654	50669-Y YELLOW	LED		6.6	CROUSE HINDS ALP
655	50667-1 BLUE	LED		6.6	CROUSE HINDS ALP
656	60646-G GREEN	LED		6.6	CROUSE HINDS ALP
657	60649-G2 GREEN	LED		6.6	CROUSE HINDS ALP
658	44A7479 1000-3 GREEN	LED		6.6	ADB SAFEGATE AMERICAS, LLC
659	44A7479 700-3 YELLOW	LED		6.6	ADB SAFEGATE AMERICAS, LLC
660	122-208A	LED		6.6	YOUYANG
661	100Q	30		6.6	GE
662	44A7479 160-1 Green	LED		6.6	ADB SAFEGATE AMERICAS, LLC
663	44A7479 195-1 Yellow	LED		6.6	ADB SAFEGATE AMERICAS, LLC
664	44A7479 195-2 Green	LED		6.6	ADB SAFEGATE AMERICAS, LLC
665	44A7479 160-2 Yellow	LED		6.6	ADB SAFEGATE AMERICAS, LLC
666	44A7479 1000-3 White	LED		6.6	ADB SAFEGATE AMERICAS, LLC
667	48A0353	150		6.6	Osram
668	44A7302	LED		6.6	ADB SAFEGATE AMERICAS, LLC
669	A1-14-0086-004	LED		6.6	ASTRONICS DME Corporation
670	100	30		6.6	AIRPORT LIGHTING CO
671	1593.15.895 White	LED		6.6	ADB SAFEGATE AMERICAS, LLC
672	1593.15.880 Yellow	LED		6.6	ADB SAFEGATE AMERICAS, LLC
673	1593.15.865 Green	LED		6.6	ADB SAFEGATE AMERICAS, LLC
674	1593.15.870 Red	LED		6.6	ADB SAFEGATE AMERICAS, LLC
675	D564-1012 RED 1 TIER	LED			DIALIGHT
676	D1CW-1020 DUAL IR	LED			DIALIGHT
677	0306318-2	LED			CROUSE HINDS ALP
678	0306318-3	LED			CROUSE HINDS ALP
679	0306254-1	LED	2.25		CROUSE HINDS ALP
680	44A6950/7X0 LED	LED		6.6	ADB SAFEGATE AMERICAS, LLC
681	11482-EXM	45		6.6	ASTRONICS DME Corporation
682	A1-03-0235-007 Blue	LED		6.6	ASTRONICS DME Corporation
683	LXHL-FB3C	LED		6.6	ASTRONICS DME Corporation
684	104	150		6.6	AIRPORT LIGHTING COMPANY
685	11478-EXL	30	6.6		ASTRONICS DME Corporation
686	SG18470W5; SG18415WW1	LED		6.6	ADB SAFEGATE SWEDEN AB
687	SG18416WY1;SG184 7 1Y4;SG18416WY1	LED		6.6	ADB SAFEGATE SWEDEN AB
688	SG18417WR1; SG18470W5; SG18472R7	LED		6.6	ADB SAFEGATE SWEDEN AB
689	SG18432YR1 ; SG18471Y4; SG18472R7	LED		6.6	ADB SAFEGATE SWEDEN AB
690	SG18499W2	LED		6.6	ADB SAFEGATE SWEDEN AB

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
691	SG18500R2	LED		6.6	ADB SAFEGATE SWEDEN AB
692	SG18534W3	LED		6.6	ADB SAFEGATE SWEDEN AB
693	SG18535R3	LED		6.6	ADB SAFEGATE SWEDEN AB
694	SG18536G2	LED		6.6	ADB SAFEGATE SWEDEN AB
695	SG18537Y2	LED		6.6	ADB SAFEGATE SWEDEN AB
696	SG18545W4	LED		6.6	ADB SAFEGATE SWEDEN AB
697	SG18546R4	LED		6.6	ADB SAFEGATE SWEDEN AB
698	SG18547G3	LED		6.6	ADB SAFEGATE SWEDEN AB
699	SG18548Y3	LED		6.6	ADB SAFEGATE SWEDEN AB
700	SG18533R5	LED		6.6	ADB SAFEGATE SWEDEN AB
701	SG-18540G4	LED		6.6	ADB SAFEGATE SWEDEN AB
703	SG18542G6	LED		6.6	ADB SAFEGATE SWEDEN AB
704	SG18538R6	LED		6.6	ADB SAFEGATE SWEDEN AB
705	GN 45W EXM 6.6A	45		6.6	GENESIS
706	GN 45W EXM 6.6A T10P	45		6.6	GENESIS
707	GN 30W EXM 6.6A	30		6.6	GENESIS
708	GN 30W EXM 6.6A T10P	30		6.6	GENESIS
709	A1-14-0093-001	LED		6.6	ASTRONICS DME Corporation
710	NAC-LXL01-1030-H-A- T	LED			NAC DYNAMICS, LLC.
712	0306318-1	LED			CROUSE HINDS ALP
713	44A7479 1000-3 Red	LED		6.6	ADB SAFEGATE AMERICAS, LLC
714	SG18599Y5	LED		6.6	ADB SAFEGATE SWEDEN AB
715	SG18600R8	LED		6.6	ADB SAFEGATE SWEDEN AB
716	51-0054-003	LED	48		HUGHEY & PHILLIPS
717	51-0060-003	LED	48		HUGHEY & PHILLIPS
718	SG18601Y6	LED		6.6	ADB SAFEGATE SWEDEN AB
719	SG18602R9	LED		6.6	ADB SAFEGATE SWEDEN AB
720	44A7479 700-3 Red	LED		6.6	ADB SAFEGATE AMERICAS, LLC
721	SG18927Y7	LED		6.6	ADB SAFEGATE SWEDEN AB
722	SG18930Y8	LED		6.6	ADB SAFEGATE SWEDEN AB
723	SG18929G8	LED		6.6	ADB SAFEGATE SWEDEN AB
724	SG18932G9	LED		6.6	ADB SAFEGATE SWEDEN AB
725	101Q	45		6.6	AIRPORT LIGHTING CO
726	SG18952Y9	LED		6.6	ADB SAFEGATE SWEDEN AB
727	SG18954Y10	LED		6.6	ADB SAFEGATE SWEDEN AB
728	SG18953G10	LED		6.6	ADB SAFEGATE SWEDEN AB
729	SG18955G11	LED		6.6	ADB SAFEGATE SWEDEN AB
730	SG18646R10	LED		6.6	ADB SAFEGATE SWEDEN AB
731	44A7606 1700-1 WHT	LED		6.6	ADB SAFEGATE AMERICAS, LLC
732	44A7606 285-2 GRN	LED		6.6	ADB SAFEGATE AMERICAS, LLC
733	44A7606 400-1 RED	LED		6.6	ADB SAFEGATE AMERICAS, LLC
734	A3-06-3122-002	LED		6.6	ASTRONICS DME Corporation
735	1593.18.462 Red	LED		6.6	ADB SAFEGATE BVBA
736	A3-06-3122-001	LED		6.6	ASTRONICS DME Corporation
738	A3-06-3116-002	LED	3		ASTRONICS DME Corporation
739	SG18947G7	LED		6.6	ADB SAFEGATE SWEDEN AB
742	111-503K	LED		6.6	YOUYANG AIRPORT LIGHTING
743	111-503L1	LED		6.6	YOUYANG AIRPORT LIGHTING

LAMP DESCRIPTIONS

LAMP	DESIGNATION	WATTS	VOLTS	AMPS	Lamp Manufacturer
744	111-503M1	LED		6.6	YOUYANG AIRPORT LIGHTING
745	111-503N1	LED		6.6	YOUYANG AIRPORT LIGHTING
746	48A0443-GRN-500	LED		6.6	ADB SAFEGATE AMERICAS, LLC
747	48A0007	45		6.6	Narva
748	48A0444/GRN/300	LED		6.6	ADB SAFEGATE AMERICAS, LLC
749	48A0444/GRN/350	LED		6.6	ADB SAFEGATE AMERICAS, LLC
750	1371010	LED	120-240		FLASH TECHNOLOGY
751	1119011 with IR	LED			FLASH TECHNOLOGY
752	1119010	LED			FLASH TECHNOLOGY
753	122-208A	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
754	111-503F2	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
755	111-503G2	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
756	111-503D2	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
757	111-503A2	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
758	111-503B2	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
759	111-200A	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
760	111-227B	LED		6.6	YOUYANG AIRPORT LIGHTING EQUIPMENT INC
761	62438	LED		6.6	CROUSE HINDS ALP
762	44a7606 800-1 GRN	LED		6.6	ADB SAFEGATE AMERICAS, LLC
763	44A7606 1100-1 WHT	LED		6.6	ADB SAFEGATE AMERICAS, LLC
764	44A7606 1000-1 RED	LED		6.6	ADB SAFEGATE AMERICAS, LLC
765	44A7606 700-2 GRN	LED		6.6	ADB SAFEGATE AMERICAS, LLC
766	SG19153G12	LED		6.6	ADB SAFEGATE SWEDEN AB
767	SG19158G13	LED		6.6	ADB SAFEGATE SWEDEN AB
768	SG19154Y12	LED		6.6	ADB SAFEGATE SWEDEN AB
769	SG19159Y13	LED		6.6	ADB SAFEGATE SWEDEN AB

ADDRESS LIST OF CERTIFIED AIRPORT LIGHTING EQUIPMENT MANUFACTURERS

Certified Airport Lighting Equipment Manufacturers	U.S Representative
ADB Safegate Americas, LLC 977 Gahanna Pkwy PO Box 30829 Columbus, OH 43230-0829 Tel: (614) 861 -1304	
ADB Safegate bvba Leuvensesteenweg 585 B 1930 Zaventem Belgium Tel: (032) 2 722 17 11	**ADB Safegate Americas, LLC** 977 Gahanna Pkwy PO Box 30829 Columbus, OH 43230-0829 Tel: (614) 861 -1304
ADB Safegate Sweden AB Djurhagegatan 19 Malmo Sweden 213 76	**Safegate Airport Systems Inc** 7101 Northland Circle Suite 110 Brooklyn Park, MN 55428 Tel: (763) 535-9299 www.safegate.com
AGM Airfield Guidancesign Mfrs Inc 108 Fairgrounds Dr. Suite 8 Manlius, NY 13104 Tel: (315) 682-6707 Fax: (315) 682-6758	
Airport Lighting Company 108 Fairgrounds Dr. Manlius, NY 13104 Tel (315) 682-6460 Fax: (315) 682-6469	
Airport Lighting Equipment Inc 208 H Street Rupert, ID 83350 Tel (208) 436-0513 Fax (208) 436-3492	
Airsafe Airport Equipment Co Ltd Room 27AB Dongtai Bldg No 309 Tanggu Rd Shanghai 200080 PRC	**Kwon HyoSup** 13974 Rockland Village Dr #302 Chantilly, VA 20151 Tel (703) 980-0157
Astronics DME Corporation 6830 NW, 16th Terrace Fort Lauderdale, FL 33309 Tel: (954) 975 2100 Fax: (954) 979 3313	
ATG Airports Inc. 7857 Drew Circle #11 Fort Myers, FL33967 Tel: (239) 985-9406 Fax: (239) 985-9435 http://www.atgairports.com	

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Austin Insulators Inc. 7510 Airport Rd Mississauga, ON L4T 2H5, Canada Tel: (905) 405-1144	
Avlite Systems 11 Industrial Drive Somerville, Victoria 3912 Australia Tel: 61 0 3 5977 6128	**Sealite USA LLC (dba Avlite Systems)** 61 Business Park Drive Tilton, NH 03276 Tel (603) 737-1310
Conductores Monterrey S.A. de C.V/ Viakon Avenue Conductores No. 505 Ote Col. Constituyentes de Queretaro San Nicholas de Los Garza Nuevo Leon 66493 Mexico Tel: 5281 8030 8053	
Controlled Power, Inc. 17909 Bothell Everett Hwy SE Suite 102 Bothell, WA 98012 Tel: (425) 485 1778 Fax: (425) 485 0658 www.controlledpowerinc.com	
Cooper Crouse Hinds Wolf & 7th North Sts. Syracuse, NY 13208 Tel: (315) 477 5709, Fax: (315) 477 5118	
Crouse-Hinds Airport Lighting Products 1200 Kennedy Road Windsor, Connecticut 06095 Tel: (860) 683-4300	
Dialight Corporation 1501 Rt. 34 South Farmingdale, NJ 07727 Tel: (732)-919-3119 Fax: (732)-751-5778 www.dialight.com	
Draka Cableteq USA. 1 Tamaqua Blvd. PO Box 347 Schuylkill Haven, PA 17972 Tel: (570) 385-4381 Fax: (570) 385 1092 www.drakausa.com	

Certified Airport Lighting Equipment Manufacturers	U.S Representative
EFLA Oy Kipinatie 3 06150 Porvoo, Finland Tel: 358 (0) 204 76 2367 www.efla.net	**Godfrey Systems International, Inc. (G.S.I. Inc.)** 3051 Pine Street Clearwater, FL 33763-0914 Tel (727) 799-4916 Fax (727) 724-0212 www.gsilight.com, gsiinc@knology.net
EMA Tesisat ve Endustriyel Cihazlar Sanayi ve Ticaret A.S. Yesilca Mah. OtoSanayi Sitesi Aytekin Sokak o. 7 4. Levent Istanbul Turkey Tel: 90 212 279 5159	**Aegean International Trading LLC** 6118 Talavera Court Alexandria VA 22310 Tel 703 231 8540
Exel Composites Oyj Muovilaaksontie 2 F1-82110 Heinavaara, Finland Tel: 358 (0)20 754 1200 Fax: 358 (0)20 754-1330	**Godfrey Systems International, Inc. (G.S.I. Inc.)** 3051 Pine Street Clearwater, FL 33763-0914 Tel (727) 799-4916 Fax (727) 724-0212 www.gsilight.com, gsiinc@knology.net
Farlight LLC 846 Watson Ave Unit C Wilmington, CA 90744 Tel: (310) 830 0181 Fax: (310) 830 9066	
Flash Technology LLC 332 Nichol Mill Lane Franklin, TN 37067 Tel: (615) 503-2000 Fax: (615) 261-2600	
Flexstake Inc. 2150 Andrea Lane Fort Myers, FL 33912 Tel (941) 481-3539	
Flight Light, Inc. 2708 47th Ave Sacramento, CA 95822 http://www.flightlight.co	
Hali-Brite, Inc. 925 First Street SW Crosby, MN 56441	
Hella KGaA Hueck & Co. Rixbecker 75, Lippstadt, 59552 Germany Tel: 49 2841 38 5540	**Hella Corporate Center USA Inc.** (Matt McAmmond) 43811 Plymouth Oaks Blvd. Plymouth, MI, 48170-2539

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Hughey & Phillips, LLC 240 W Twain Ave Urbana, OH 43078 Tel: (937)-652-3500 Fax: (937) 652 3508	
Integro LLC 30 Peter Court New Britain, Connecticut 06051 Tel: (860) 832-8960 Fax: (860) 832-8965 www.Integro-USA.com	
International Tower Lighting, LLC 1001 Centre Pointe Drive, Suite A La Vergne, TN 37086 USA	
Jaquith Industries Inc. 600 East Brighton Avenue P.O. Box 780 Syracuse, New York 13205 Tel (315) 478-5700	
Liberty Airport Systems, Inc. 3375 North Service Rd, Unit C-5 Burlington, Ontario Canada L7N 3G2 Tel (905) 631 1597 Fax: (905) 631 5387	
Manairco, Inc. 28 Mansfield Industrial Park Mansfield, Ohio 44903 Tel: (419) 524-2121	
Millard Towers Ltd. (Frangipole) 300 White Street Coburg Ontario K9A 1X1	
Millerbernd Manufacturing Company 622 6th Street South Winsted, MN 55395	
Multi-Electric Manufacturing, Inc 4223-43 West Lake Street Chicago, Illinois 60624 Tel: (773) 722-1900 Fax: (773) 722-5694	
NAC Dynamics, LLC. 16110 Flight Path Drive Brooksville, FL 34604 Tel: (727) 538-8744 http://www.airportnac.com	

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Nehring Electrical Works Company PO Box 965 813 East Locust Street De Kalb, IL 60115 Tel: (800) 435-4481 Fax: (815) 756-7048 www.info@nehringwire.com	
Nexans Energy USA Inc. 25 Oakland Ave. Chester, NY 10918 Tel 1-845-469-1428 Fax 1-845-469-1406	
OBSTA 2, rue Troyon 92316 Sevres France Tel: 33 1 41 23 50 10	**OBSTA** 10108 USA Today Way Miramar, FL 33025 Tel: (954) 430 6310 (800) 248-3548 Fax: (954)-430-7785 www.obsta.us 1pecourt@obsta.us
OCEM Airfield Technology **a division of Energy Technology S.r.l.** Via Della Solidarieta 2/1 40056 Valsamoggia Localita Crespellano Bologna Italy Tel: 39 051 665 6611 Fax: 39 051 665 6099 www.ocem.com	**Multi Electric Mfg Inc.** 4223-43Weast Lake St Chicago, IL 60624
The Okonite Company 102 Hilltop Road PO Box 340 Ramsey, NJ 07445 Tel: (201) 825 0300 Fax: (201) 327 0273	
Orga B.V. Strickledeweg 13 3125 At Schiedam The Netherlands Tel: (011) 31 10 415 0333 Fax: (011) 31 10 437 8445	**Orga Manufacturing Inc.** PO Box 5719 Kingwood, TX 77325 Tel: (281) 358-2544 Fax: (281) 358-0788
Point Lighting Corporation P.O. Box 686 Simsbury, Connecticut 06070 Tel: (860) 243-0600, (800) 900-0433 Fax: (860) 243-0665	

Certified Airport Lighting Equipment Manufacturers	U.S Representative
Pollite LTD 38 Borough Rd Darlington DL1 1SW UK Tel: 44 1325 355433	Robert R Caggiano 45 Clarken Dr West Orange, NJ 07052 Tel (973) 271-8431
Prysmian Power Cables and Systems USA, LLC 710 Industrial Dr Lexington, SC 29072 Tel: (803) 951-4048 Fax: (803) 951-4091	
Quantec Networks GmbH Rieselwiese 1 38690 Vienenburg GERMANY	Pfannenberg Inc. 68 Ward Rd Lancaster, NY 14086 Tel: 716 685 6866 Blaine Witt
Rural Electric Inc. 9502 E Main St Mesa, AZ 85207 Tel: (480) 986-1488 Fax: (480) 984-0319 http://ruralelectric.com/	
Strobe Approach Lighting Technology 108 Fairgrounds Drive Manlius, NY 13104 Tel: 603 598 4100 Fax 603 598 4198	
Southwire Co. One Southwire Dr. Carrollton, GA 30119 Tel: (770) 832-5092	
Standard Signs Inc 9115 Freeway Drive Macedonia, OH 44056 Tel: (330) 467-2030 Fax: (330-467 2076	
Synergy Cables Ltd. Sapirim Industrial Park Eshel Street 1 P.O.B. 102 Sderot 8701002 Israel Phone: 972 8 680 9409	**Synergy Cable USA Ltd** 2030 Powers Ferry Rd Suite 280 Atlanta, GA 30339 Tel (770) 226-9898 Fax: (770) 984-2191
Thomas & Betts Corporation 12 Southland Road Ormond Beach, FL 32174	
Technostrobe 65 Herbert O'Connell Coteau-du-Lac QC J10P 1B0 Canada Tel: 450 763 2097	

ATTACHMENT D

AC 150/5370-15
AIRSIDE APPLICATIONS FOR ARTIFICIAL TURF

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U.S. Department
of Transportation

Federal Aviation Administration

Advisory Circular

Subject: AIRSIDE APPLICATIONS FOR ARTIFICIAL TURF	**Date:** 9/29/2007 **Initiated by:** AAS-100	**AC No:** 150/5370-15 **Change:**

1. PURPOSE. This Advisory Circular (AC) provides guidance for the planning, design, installation, and maintenance of aviation grade artificial turf in areas adjacent to the operational areas of an airport.

2. BACKGROUND. Specially designed artificial turf systems are available for use on airports in areas normally planted with natural turf. These systems can mitigate localized erosion problems caused by jet blast, poor drainage, and vehicle loads. The Federal Aviation Administration (FAA) conducted a study to investigate the ability of these systems to resist jet blast, weather effects, and contaminants (fuel, deicing chemicals, hydraulic fluids); to support vehicle loads; and to be skid and fire resistant. At the time of the study, there were only two suppliers/installers of artificial turf for airside applications.

The study included an informal survey of airports that have test installations of these systems. The results of the survey indicate the main reason for the use of artificial turf instead of natural turf is to mitigate soil erosion, which creates potentially damaging debris. Secondary considerations for use of artificial turf were found to be abatement of turf management/low maintenance, wildlife control, and visual enhancement. Research in investigating airside applications for artificial turf is incomplete. Sufficient data are not available to report on the specific long-term operational performance and cost effectiveness of these systems, but indications are that artificial turf systems can be cost effective in comparison to the other solutions evaluated by the airports that have used the systems to address specific problem areas.

3. APPLICATION. The FAA recommends the guidelines and standards in this AC for artificial turf. This AC does not constitute a regulation and in general is not mandatory. However, use of these guidelines is mandatory for artificial turf funded under the Airport Improvement Program (AIP) or Passenger Facility Charge (PFC) Program. Mandatory terms such as “must” used herein apply only to those who purchase artificial turf using AIP or PFC funds. Artificial turf can be considered a substitute for natural turf although it is not cost effective for all applications. Artificial turf systems that meet the requirements of this AC can be used at locations adjacent to taxiway and apron pavement where the use of natural turf has resulted in repeated soil erosion, where natural turf is impractical (e.g. paved islands), or where natural turf has unusually high costs associated with its maintenance.

4. PLANNING. Sufficient data are not available on the performance of artificial turf in the case of high-speed veer-offs to consider its use along runways, runway ends, and high-speed

taxiways. Such use requires approval by the FAA Office of Airport Safety and Standards through the responsible FAA Airports Regional/District Office.

5. ARTIFICIAL TURF SYSTEM DESIGN REQUIREMENTS. Airside artificial turf systems must meet the following minimum design standards. The design standards must be successfully tested prior to the installation of an airside artificial turf system.

a. Jet Blast. The artificial turf system must be designed and installed so it will not become displaced or damaged from expected aircraft jet blast. For artificial turf located in safety areas, under normal operating conditions, there must be less than 5-percent migration or evacuation of infill material for the artificial turf system. Anchors, seams, and ballast integrity must be confirmed through wind tunnel test procedures at various jet blast angles and with varied engine types and speeds. An anchor pull test must be performed after installation is complete for each type of anchor used.

Critical factors to be demonstrated	• Integrity of anchoring system • Integrity of joints • Stability of ballast at various jet blast angles
Laboratory tests	Wind tunnel testing
Field testing/post-installation	• Quality assurance • Anchor pull test
References	Respective aircraft manufacturers' manuals, usually titled Airplane Characteristics for Planning Purposes

The procedure described in Chapter 4 and Appendix C of research report DOT/FAA/AR-06/23, *Airside Applications for Artificial Turf*, is an acceptable procedure to evaluate jet blast resistance. The report is available on the FAA website at www.tc.faa.gov/its/worldpac/techrpt/ar06-23.pdf.

The following table shows the recommended profiles for evaluating the artificial turf system.

RECOMMENDED PROFILES FOR EVALUATING
AIRCRAFT JET BLAST RESISTANCE

Average at 40 feet		Average at 75 feet	
12 repetitions for 1 month		12 repetitions for 1 month	
Time (sec)	Power (%)	Time (sec)	Power (%)
0	85	0	85
240	85	180	85
250	90	190	90
375	90	280	90
380	85	290	85
565	85	470	85
580	100	485	100
595	100	495	100
600	85	510	85
Note: Power is expressed in terms of percentage of take-off thrust			

b. Load-Bearing Capacity. The artificial turf system must be constructed on a prepared surface capable of supporting the occasional passage of the heaviest aircraft using the adjacent pavement and support the occasional passage of the heaviest anticipated traffic (e.g. maintenance, snow removal, and ARFF vehicles) without structural damage to the aircraft or vehicles and without rupturing, tearing, or shearing the material, seams, or connections to anchor systems. It must be designed to perform satisfactorily under all local weather, temperature, and soil conditions. Surface deformations in excess of 3 inches or that allow shoving or wrinkles in the material will require immediate inspection and repair.

Critical factors to be demonstrated	• Turf must not shear or pull from the anchoring system under design wheel loading. • System must maintain its integrity when subjected to design traffic loads.

c. Drainage Characteristics. The artificial turf system must be designed and installed so water does not accumulate on the surface or cause other drainage problems. Heavy precipitation must not wash/flush any infill material from the turf surface. Pre-installation testing must include measuring surface runoff drainage coefficients and permeability. Testing must conform to the German Institute for Normalization (DIN) 18-035 Part 6, *Water Permeability of Synthetic Turf Systems and Permeable Bases*.

Critical factors to be demonstrated	Heavy precipitation must not wash/flush any infill material from the turf surface.
Laboratory tests	Testing must conform to the German Institute for Normalization (DIN) 18-035 for the turf product prior to installation.
Field tests	DIN 18-035

Longitudinal and transverse grade requirements for airside surfaces can be found in FAA AC 150/5300-13, *Airport Design*.

d. Skid Resistance. The artificial turf must not have properties inferior to natural grass under wet/dry and above/below freezing conditions. Pre-installation testing must conform to ASTM C 1028, *Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method*. In-field /post-installation testing must conform to ASTM C 1028.

Critical factors to be demonstrated	The turf must not have properties inferior to natural grass under wet/dry and above/below freezing conditions.
Laboratory tests	Conform to ASTM C 1028, *Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.*
Field testing/post-installation	• Quality assurance procedure followed. • Tests in accordance with ASTM C 1028.

Chapter 4 of research report DOT/FAA/AR-06/23, *Airside Applications for Artificial Turf*, contains limited results from test method ASTM C 1028 for materials that have been installed at airports.

e. Durability. Installed material must maintain its integrity when maintained in accordance with the manufacturer's recommendations. Pre-installation testing must include ASTM D 4632, *Standard Test Method for Grab Breaking Load and Elongation of Geotextiles*, and ASTM D 1435, *Standard Practice for Outdoor Weathering of Plastics.*

Critical factors to be demonstrated	• Limited visual degradation may occur over the life expectancy of the turf product. The system must maintain its integrity when subjected to extended exposure to UV Light. • If rolls or extended lengths of material are joined, it must be demonstrated that the strength of joints is equal to or greater than the material being joined and that strength is maintained throughout the expected life of the system.
Laboratory tests	ASTM D 4632, *Standard Test Method for Grab Breaking Load and Elongation of Geotextiles,* and ASTM D 1435, *Standard Practice for Outdoor Weathering of Plastics*.
Field testing/post-installation	Quality assurance procedure followed.

f. Artificial Turf Infill. All artificial turf systems must incorporate a non-flammable infill system, preferably sand. The gradation of the infill material must not fall outside the gradation limits provided for winter operations sand contained in FAA AC 150/5200-30, *Airport Winter Safety and Operations.*

6. MATERIAL CHARACTERISTICS. Artificial turf products must meet the following requirements:

a. Flammability. Artificial turf products must have documented flammability testing to ensure the material does not emit toxic fumes when enflamed. Tests must demonstrate the turf is easily extinguishable with conventional firefighting materials.

Pre-installation testing must conform to ASTM D 4804, *Standard Test Method for Determining the Flammability Characteristics of Non-Rigid Solid Plastics*. A cone calorimeter for smoke analysis test must be performed prior to installation. The manufacturer must provide documentation of burn tests for acceptance.

Critical factors to be demonstrated	• Easily extinguishable with conventional fire fighting materials. • Does not emit toxic fumes when enflamed.
Laboratory tests	• Conform to ASTM E 84/ NFPA 251, *Standard Methods of Tests of Fire Resistance of Building Construction and Material.* • ASTM D 4804, *Standard Test Method for Determining the Flammability Characteristics of Non-Rigid Solid Plastics.* • A cone calorimeter for smoke analysis.

b. Chemical Resistance. Artificial turf products must endure extensive chemical resistance tests prior to being approved for airport use. The tests must conform to ASTM D 4632, *Standard Test Method for Grab Breaking Load and Elongation of Geotextiles*. The product must be resistant to deterioration due to prolonged exposure to the following elements by comparative testing of original and aged specimens.

(1) Aircraft and Runway/Taxiway Deicing Chemicals.

(2) Aircraft Fuels.

(3) Hydraulic Fluids.

(4) Lubricating Oils.

(5) Salt.

(6) Occasional Exposure to Herbicides.

c.

Critical factors to be demonstrated	The product must be resistant to deterioration due to prolonged exposure and comparative testing of original and aged specimens.

Resistance to Ultraviolet Rays. Limited visual degradation may occur over the life expectancy of the turf product. Turf chemical compounds must be pre-tested in accordance with ASTM G 90-98, *Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight*, and ASTM WK572, *Specification for Durability of Turf Reinforcement Mats to Laboratory Accelerated Weathering*.

d. Wildlife. Artificial turf systems must be designed and installed to offer no source of food, water, or shelter for animals, including but not limited to reptiles, rodents, and birds.

e. Plant Growth. Artificial turf systems must be designed and installed to prevent unintended plant growth from penetrating up through the turf backing. Artificial turf systems must be designed to withstand periodic applications of chemicals intended to prevent or eradicate plant growth.

f. Turf Infill. Materials used as an artificial turf infill must not support combustion and must not exceed the gradation requirements for winter operation sand found in AC 150/5200-30, *Airport Winter Safety and Operations*. The infill material must be designed to allow occasional exposure to herbicides.

7. DESIGN SUBMITTAL. The artificial turf system design and plans and specifications must be certified as meeting all the requirements of this AC and must be submitted to the airport sponsor for review and approval. Installations proposed along runways, runway ends, and high-speed taxiways require approval by the FAA Office of Airport Safety and Standards through the responsible FAA Airports Regional/District Office. The submittal must include all design assumptions and data utilized in its development as well as proposed construction procedures and techniques.

8. INSTALLATION.

a. Base preparation. Base preparation must be conducted in a manner required by the artificial turf manufacturer and meet the specific needs of the airport. FAA specifications for free-draining non-frost susceptible base material or state Department of Transportation specifications for high-quality free-draining non-frost susceptible base material may be used.

b. Post-installation checks. Checks must be conducted in accordance with the artificial turf manufacturer's post-installation checklist.

9. QUALITY ASSURANCE. Suppliers of artificial turf system systems must demonstrate that their firm administers a quality assurance program that includes defined quality assurance procedures and a quality assurance manual. The quality procedures must ensure that materials and installation procedures conform to those used in test site applications. Checks must be in place to assure the systems are installed according to quality procedures, and an internal audit must be conducted. The supplier must present to the airport owner Certificates of Origin that have been issued by the artificial turf manufacturer.

10. MAINTENANCE. Experience to date suggests that periodic brooming and additions to infill material will be required during the useful life of the artificial turf system. The artificial turf system supplier/installer must provide inspection and maintenance program documentation to the airport detailing any necessary procedures, equipment, and protocols for preventative maintenance and repair. The airport staff and/or turf supplier must administer the plan in accordance with a pre-established schedule. The plan must include inspection procedures to ensure the product is performing according to established quality standards.

11. DOCUMENTATION. Airport documents must be annotated to show locations and dimensions of artificial turf installations. These annotations must be made after installation is complete and should be communicated to all appropriate airport personnel.

12. RELATED READING MATERIAL. Publications referenced in this AC are available from the following sources:

a. FAA ACs: www.faa.gov/airports_airtraffic/airports/resources/advisory_circulars

b. DOT/FAA/AR-06/23, *Airside Applications for Artificial Turf*: www.tc.faa.gov/its/worldpac/techrpt/ar06-23.pdf

c. American Society for Testing and Materials (ASTM) International: 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, or www.astm.org

d. German Institute for Normalization (English version): http://www.din.de/cmd?level=tpl-home&contextid=din&languageid=en

13. COMMENTS OR SUGGESTIONS. Send comments or suggestions for improving this AC to—

Manager, Airport Engineering Division
Federal Aviation Administration
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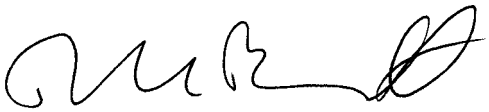

David L. Bennett
Director of Airport Safety and Standards

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