HOUSTON AIRPORT SYSTEM

City of Houston - Department of Aviation - Planning Design and Construction Division

PROJECT MANUAL

RECONSTRUCTION OF TAXIWAY NA
GEORGE BUSH INTERCONTINENTAL AIRPORT

PROJECT NUMBER: 907
CIP NUMBER: A-000570
AIP NUMBER: 3-48-0111-TBD

VOLUME NUMBER 2 OF 3

ISSUED FOR COMPETITIVE SEALED PROPOSAL

July 27, 2018

IEA, Inc.
1225 North Loop West, Suite 320
Houston, Texas 77008
832.494.3800
TBPE Firm Registration No. F-10161

Document 00010

TABLE OF CONTENTS

END OF DOCUMENT

Section 01110

SUMMARY OF WORK

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Project description.

B. Work description.

C. City occupancy.

D. Contractor-salvaged products (Not Used).

E. Separate contracts and work by City (Not Used).

F. Extra copies of Contract Documents.

G. Permits, fees and notices.

1.02 THE PROJECT

A. The Project is located at the George Bush Intercontinental Airport in Houston, Texas.

1.03 GENERAL DESCRIPTION OF THE WORK

A. Construct the Work under a single general construction contract, “Reconstruction of Taxiway NA”, Project Number 907, Capital Improvement Project Number A-000570.

B. Construct the Work in multiple phases following Section 01326 – Construction Sequencing

C. The Work is summarized as the reconstruction and widening of Taxiway NA from the west edge of Taxiway NE to the east edge of Taxiway NP; partial reconstruction and widening of connecting Taxiways NE, NR, NF, NG, NJ, NK, NN, and NP between Taxiway NA and Taxiway NB; reconstruction of connecting Taxiways NE, NR, and NP between Taxiway NA and Runway 8R-26L; and reconstruction of High Speed Exits NF, NH, NK, and NN between Taxiway NA and Runway 8R-26L.

1.04 CITY OCCUPANCY

A. The City will occupy all phase areas of the project not closed for construction for the conduct of normal operations.

1. Cooperate with the City to reduce conflict, and to facilitate the City's operations. Coordinate Contractor's activities with City Operations or Maintenance personnel through City Engineer.

2. Schedule Work to fit these requirements.

1.05 CONTRACTOR-SALVAGED PRODUCTS (Not Used)

1.06 SEPARATE CONTRACTS AND WORK BY CITY (Not Used)

1.07 EXTRA COPIES OF CONTRACT DOCUMENTS

A. Use reproducible documents, furnished by City following Section 00700 – General Conditions, Paragraph 2.2.2, to make extra copies of Contract Documents as required by Contractor for construction operations, and for Contractor's records following Sections 01726 – Base Facility Survey and 01770 – Contract Closeout. Follow Section 00700 – General Conditions, Paragraph 1.3.

1.08 PERMITS, FEES AND NOTICES

A. Refer to Section 00700 – General Conditions, Paragraph 3.14. Reimburse City for City's payment of fines levied against City or its employees because of Contractor's failure to obtain proper permits, pay proper fees, and make proper notifications. Reimbursement will be by Change Order, deducting from the Contract Price the amount of fines imposed.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01145

CONTRACTOR'S USE OF PREMISES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Rights-of-way and access to the Work.

B. Property and Base Facility outside contract limits.

C. General requirements for exterior work.

D. Work in AOA, including electrical lockout/tagout program.

E. Interior Work.

F. Control of access into security areas.

1.02 SUBMITTALS

A. Show start dates and duration of closures and impediments on construction schedule following Section 01325 – Construction Schedules.

B. Prepare written requests and submit requests at least 7 days before access is required, for following:

1. Roadway, street, driveway, curbside and building main entrance/exit closures or impediments. Do not close or impede emergency exits intended to remain.
2. Access to property outside contract limits, required to extend or connect work to utilities or environmental system controls in non-contract areas.

C. For work involving electrical energy or other hazardous energy sources, submit a Lockout/Tagout Program.

1.03 RIGHTS-OF-WAY AND ACCESS TO THE WORK

A. Confine access and operations and storage areas to contract limits and other areas provided by City, following Section 00700 – General Conditions. Do not trespass on non-City-owned property or on airport occupants' spaces.

B. Airport operates "around the clock." In cases of conflicts with construction operations, airport operations take precedence. Airport roads, streets, drives, curbsides and sidewalks, and ticketing, baggage claim, security check points, concessions, restrooms, aircraft gates and similar passenger-related areas are

intended for year-round uninterrupted use and access by the public and airport operations. Maintain uninterrupted traffic movement.

1. Aircraft and emergency vehicles have right-of-way in AOA.
2. Private vehicles, public transportation and emergency vehicles have right-of-way on roads, streets, driveways and curbsides.
3. Passengers have right-of-way in public spaces. Occupants have right-of-way in other occupied areas.

C. Follow instructions of the City Engineer, Airport Manager and of ATCT. Follow FAA procedures.

D. FAA will review Contractor's submittals for compliance with FAA requirements. Attend meetings with FAA to assist the City Engineer in obtaining approvals.

E. Continued violations of or flagrant disregard for policies may be considered default, and individuals disregarding requirements may be determined as objectionable by the City Engineer, following provisions of Section 00700 – General Conditions.

1. Do not close or impede rights-of-way without City Engineer approval.

F. City Engineer may approve temporary storage of products, in addition to areas shown on Drawings, on other on-airport areas if storage piles do not interfere with airport operations.

1. No permission will be granted for this type of storage in Terminal roadway areas.

1.04 PROPERTY AND BASE FACILITY OUTSIDE CONTRACT LIMITS

A. Do not alter condition of property or Base Facility outside contract limits.

B. Means, methods, techniques, sequences, or procedures which may result in damage to property outside of contract limits are not permitted.

C. Repair or replace damage to property outside contract limits to condition existing at start of the Work, or better.

1.05 GENERAL REQUIREMENTS FOR EXTERIOR WORK

A. Obtain permits and City Engineer's approval prior to impeding or closing roadways, streets, driveways, Terminal curbsides and parking areas.

B. Maintain emergency vehicle access to the Work and to fire hydrants, following Section 01505 – Temporary Facilities.

C. Do not obstruct drainage ditches or inlets. When obstruction is unavoidable due to requirements of the Work, provide grading and temporary drainage structures to maintain unimpeded flow.

D. Locate by Section 01726 – Base Facility Survey and protect by Section 01505 – Temporary Facilities underground utilities which may exist. Repair or replace damaged systems to condition existing at start of Work, or better.

E. Public, Temporary, and Construction Roads and Ramps:

1. Construct and maintain temporary detours, ramps, and roads to provide for normal public traffic flow when use of public roads or streets is closed by necessities of the Work.
2. Provide mats or other means to prevent overloading or damage to existing roadways from tracked equipment or exceptionally large or heavy trucks or equipment.
3. Construct and maintain access roads and parking areas following Section 01505 – Temporary Facilities.

F. Excavation in Streets and Driveways:

1. Do not hinder or needlessly impede public travel on roadways, streets or driveways for more than two blocks at any one time, except as approved by City Engineer.
2. Obtain the City Traffic Management and Maintenance Department and City Engineer's approval when the Work requires closing of off-airport roadways, streets or driveways. Do not unnecessarily impede abutting property.
3. Remove surplus materials and debris and open each block for public use as work in that block is complete. Acceptance of any portion of the Work will not be based on return of street to public use.
4. Provide temporary crossings, or complete work in one continuous operation. Minimize duration of obstructions and impediments at drives or entrances.

G. Provide barricades and signs following Sections 01505 – Temporary Facilities and 01507 – Temporary Signs.

H. Traffic Control: Follow Section 01555 – Traffic Control and Regulation.

I. Surface Restoration - Not Used.

1.06 WORK IN AOA

A. If construction requires closing of safety areas of runways, taxiways and aprons and those closings are not already indicated on the Drawings, then submit such

request in writing on a separate document in the Safety Plan. Closings require NOTAMs (Section 01423 – References).

B. Open trenches are generally not permitted in areas of aircraft and GSE movement. Exceptions may be approved by the Airport Manager and by FAA.

1. Barricade, light and mark the edges of permitted open trenches and excavations as directed.

C. Flares are not permitted in the AOA.

D. Do not obliterate runway and taxiway markings, unless required as part of the Work. Repair or replace damaged markings with matching color, material and copy where resulting from work of this contract.

E. Open-flame welding and cutting in the AOA is discouraged. When unavoidable, obtain case-by-case approval. Provide proper fire control equipment, approved by Fire Department / Aviation Section.

F. Hearing protection is recommended for persons in the AOA.

G. Do not store products in safety or object free areas of runways, taxiways or aprons or in runway overruns and clear zones for more than then-active one-day operation. Provide large and long-term storage outside the AOA.

H. Follow lockout/tagout program below.

1. Electrical Lockout/Tagout for HAS Projects:

a. AOA has underground lighting and control cables. Known cables are shown (charted) on Drawings.
b. Survey area within contract limits following Section 01726 – Base Facility Survey, using proper equipment, to confirm location of charted cables and cables discovered during survey. Stake locations.
c. Notify City Engineer and Airport Manager in daily briefings (Section 01312 – Coordination and Meetings) before excavation in the vicinity of charted or discovered cables. Make written request for deactivation and reactivation of circuits.
d. Deactivation and reactivation of circuits is the responsibility of the Airport Manager.
e. Furnish proper personnel, cable locating instruments, tools, splice kits, cable and other products at the time excavation work is underway, for cable repair as required.
f. Excavate, make cable repairs, cover repairs, and backfill excavation at repaired cables and only in presence of City Engineer and Airport Manager.

g. Immediately report discovered or detected outages to City Engineer and Airport Manager.
h. Follow repair details shown on Drawings. If details are not consistent with existing or discovered conditions, or if required repairs cannot be properly made, submit Section 00685 following Section 01255 – Modification Procedures.
i. Record repairs following Section 01770 – Contract Closeout.
j. Test proper operation of circuits, in presence of City Engineer and Airport Manager, before covering repairs. Follow Section 01450 – Contractor's Quality Control. Immediately correct failures.
k. Airport Manager will perform a daily check of circuits in vicinity of construction at 1500 hours to confirm proper operation. Immediately correct failures.

2. Electrical Lockout/Tagout: Follow OSHA 29 CFR 1910.331.

I. Construction near NAVAIDS and ARFF facilities:

1. Do not obstruct line of sight from ATCT or interfere with transmissions from NAVAIDS.
2. Do not obstruct exits or entrances to ARFF facilities.

1.07 GENERAL REQUIREMENTS FOR INTERIOR WORK (Electrical Vault)

A. Obtain City Engineer's approval prior to impeding or closing vault entrances and corridors.

B. Maintain emergency access to the Work and to fire hose and extinguisher cabinets, following Section 01505 – Temporary Facilities.

C. Do not obstruct fire exits. When obstruction is unavoidable due to requirements of the Work, provide fire-retardant enclosures to maintain unimpeded flow, following Section 01505 – Temporary Facilities.

D. Locate by Section 01726 – Base Facility Survey and protect by Section 01505 – Temporary Facilities, utility and communications or data systems which may exist. Repair or replace damaged systems to condition existing at start of Work, or better.

E. Provide temporary facilities and controls following Section 01505 – Temporary Facilities.

F. Provide signs following Section 01507 – Temporary Signs.

1.08 CONTROL OF SECURITY AREA ACCESS

A. Install barricades and enclosures to prevent uncontrolled access into security areas, following Section 01505 – Temporary Facilities. Provide locked access points. Provide duplicate keys to City Engineer.

B. Post one gatekeeper, employed by the Contractor, at each point of access through barricades or enclosures into security areas, during times when access points are not locked. Ensure persons entering are properly badged.

C. Provide signs following Section 01507 – Temporary Signs.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01210

CASH ALLOWANCES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. City's allowances, allocated to the items of work listed or as directed.

B. See Section 00700 – General Conditions, Paragraph 3.11 for costs included and excluded from cash allowance values listed in 1.02 below.

C. Follow Section 01255 – Modification Procedures for processing allowance expenditures. Cash Allowance sums remaining at Final Completion belong to the City, creditable by Change Order.

1.02 SCHEDULE OF CASH ALLOWANCES (TOTAL $350,000.00)

A. Allowance Item 1 – Building Permit.

B. Allowance Item 2 – Electrical Service.

C. Allowance Item 3 –Communications Service.

D. Allowance Item 4 – Gas Service.

E. Allowance Item 5 – Standing Contracts.

F. Allowance Item 6 – Work for replacement of defective City-furnished products.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 01255

MODIFICATION PROCEDURES

PART 1- GENERAL

1.01 SECTION INCLUDES

A. Signatories on behalf of City and Contractor.

B. Contractor's documentation.

C. Change Orders and supplemental agreements for work funded by AIP grant.

D. Requests for Proposal.

E. Work Change Directives.

F. Execution of Modifications.

G. Resolving discrepancies.

H. Requests for Information or Clarification.

I. Correlation of submittals.

1.02 SIGNATORIES

A. Submit at the Preconstruction Conference (Section 01312 - Coordination and Meetings) a letter indicating the name and address of Contractor's personnel authorized to execute Modifications, and with responsibility for informing others in Contractor's employ or Subcontractors of same.

1.03 REFERENCES

A. Blue Book: "Dataquest" Rental Rate Blue Book for Construction Equipment.

B. Rental Rate: The full unadjusted base rental rate for the applicable item of equipment.

1.04 CONTRACTOR'S DOCUMENTATION

A. Maintain detailed records of changes in the Work. Provide full information required for identification and evaluation of proposed changes, and to substantiate costs of changes in the Work.

B. Furnish sufficient data to allow City Engineer's evaluation of Contractor's responses to proposed changes.

C. Include with each proposal the following minimum information (as applicable to form of Contract Price):

1. Quantities of original Bid Schedule unit price work items (with additions, reductions, deletions, and substitutions).

2. When work items are not included in Document 00410 - Bid Tabulation Form, provide unit prices for the new items, with proper supporting information.
3. For Stipulated Price changes, furnish breakdown of labor, products, taxes, insurance, bonds, temporary facilities and controls as applicable, and overhead and profit.
4. Justification for change, if any, in Contract Time.
5. Additional data upon request.

D. Payment for rented equipment will be made to the Contractor by actual invoice cost for the duration of time required to complete additional work. If additional work comprises only a portion of the rental invoice where the equipment would otherwise be on the site, compute the hourly equipment rate by dividing the actual monthly invoice by 176. (One day equals 8 hours and one week equals 40 hours.) Operating costs shall not exceed the estimated operating costs given for the item of equipment in the Blue Book.

E. For changes in the Work performed on a time-and-materials basis using Contractor-owned equipment, compute rates with the Blue Book as follows:

1. Multiply the appropriate Rental Rate (the lowest cost combination of hourly, daily, weekly or monthly rates) by an adjustment factor of 70 percent plus the full rate shown for operating costs. Use 150 percent of the Rental Rate for double shifts (one extra shift per day) and 200 percent of the Rental Rate for more than two shifts per day. No other rate adjustments apply.

2. Standby Rates: 50 percent of the appropriate Rental Rate shown in the Blue Book. Operating costs are allowed.

1.05 CHANGE ORDERS

A. Changes to Contract Price or Time are made only by execution of a Change Order.

B. Stipulated Price Change Order: Stipulated Price Change Orders are based on an accepted Proposal/Contract Modification including the Contractor's lump sum price quotation.

C. Unit Price Change Order:

1. Where Unit Prices for the affected items of Work are included in Document 00410 - Bid Tabulation Form, Unit Price Change Orders are based on unit prices as originally bid, subject to requirements in Articles 7 and 9 of Document 00700 - General Conditions.

2. Where unit prices of Work are not pre-determined in Document 00410 - Bid Tabulation Form, Request for Proposal or Work Change Directive will state the unit prices to use.

D. Time-And-Material Change Order:

1. Provide an itemized account and supporting data after completion of change, within time limits indicated for claims in Document 00700 - General Conditions.

2. City Engineer will determine the change allowable in Contract Price and Contract Time following Document 00700 - General Conditions.

3. For changes in the Work performed on a time-and-material basis, furnish the following in addition to information specified in Paragraph 1.04.C:

a. Quantities and description of products and tools.

b. Taxes, insurance and bonds.

c. Overhead and profit, following Document 00700 - General Conditions Paragraphs 7.3.2.2 or Document 00800 - Supplementary Conditions.

d. Dates and times of work performance, and by whom.

e. Time records and certified copies of applicable payrolls.

f. Invoices and receipts for products, rented tools, and Subcontracts, similarly documented.

E. Major Unit Price Change Order:

1. Definition: Work that would increase or decrease the total amount of the contract, or any major contract item, by more than 25 percent, such increased or decreased work being within the scope of the originally awarded contract; or Work not within the scope of the original contract.

2. Major Unit Price Change Orders will be processed the same as for "Unit Price Change Orders" above.

1.06 REQUEST FOR PROPOSAL

A. City Engineer may issue a Request for Proposal, including a detailed description of proposed changes, supported by revised Drawings and Specifications, if applicable. Prepare and submit Contractor's response to the Request for Proposal within 7 days or as specified in the request.

B. This document does not authorize work to proceed.

C. Follow instructions on back of the Request for Proposal.

1.07 WORK CHANGE DIRECTIVE (WCD)

A. City Engineer may issue a WCD instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

B. City Engineer may issue minor changes in the Work, not involving an adjustment to Contract Price or Time by using a WCD.

C. The document will describe changes in the Work and will designate a method of determining change, if any, in Contract Price or Time. When properly executed, this document authorizes work to proceed. Follow instructions on back of the WCD.

D. Promptly execute changes in the Work following the directions from the Work Change Directive.

1.08 RESOLVING DISCREPANCIES

A. Complete Base Facility survey following Section 01726 - Base Facility Survey prior to preparation of submittal data and commencing main construction operations. Submit survey data of inaccessible concealed conditions as cutting and patching or demolition operations proceed.

B. Prepare and submit a Request for Information for each separate condition with a written statement of substantive discrepancies, including specific scope, location and discrepancy discovered.

C. Based upon the Contractor's knowledge of Base Facility conditions "as-found" and the requirements for the Work, propose graphic or written alternatives to Drawings and Specifications to correct discrepancies. Include as supplementary data to the Request for Information.

D. Modifications due to concealed conditions are allowed only for conditions which are accessible only through cutting or demolition operations.

1. No changes in the Contract Sum or Time are permitted for sight-exposed conditions or conditions visible by entry into access doors or panels and above lay-in or concealed spline acoustical ceilings, or by conditions described in Documents 00320 - Geotechnical Information or 00330 - Existing Conditions.

1.09 REQUEST FOR INFORMATION OR CLARIFICATION

A. The Request for Information or Clarification does not authorize work that changes the Contract Price or Time.

B. Request clarification of Contract Documents or other information by using the Request for Information or Clarification.

1. If additional work is required, then the requirement will be requested by the City Engineer's issuance of a Request for Information or Clarification; Request for Proposal; Work Change Directive.

2. This document does not authorize work to proceed.

C. Changes may be proposed by the Contractor only by submitting a Request for Information following Paragraph 1.08.

D. The City Engineer may issue minor changes in the Work, not involving an adjustment to Contract Price or Time using a Request for Information or Clarification and following Document 00700 - General Conditions.

E. Follow directions on back of the Request for Information or Clarification.

1.10 CORRELATION OF SUBMITTALS

A. For Stipulated Price Contracts, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Price, following Section 01290 - Payment Procedures.

B. For Unit Price Contracts, revise the next monthly estimate of work after acceptance of a Change Order to include new items not previously included and the appropriate unit rates.

C. Promptly revise progress schedules to reflect any change in Contract Time, revise schedules to adjust time for other items of work affected by the change and resubmit for review following Section 01325 - Construction Schedules.

D. Promptly record changes on record documents following Section 01770- Contract Closeout.

PART 2- PRODUCTS (NOT USED)

PART 3- EXECUTION (NOT USED)

END OF SECTION

Section 01270

MEASUREMENT AND PAYMENT

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Procedures for measurement and payment plus conditions for nonconformance assessment and nonpayment for rejected Products.

1.02 AUTHORITY

A. Measurement methods delineated in Specification sections are intended to complement criteria of this Section. In event of conflict, requirements of the Specification section shall govern.

B. Project Manager will take all measurements and compute quantities accordingly.

C. Assist by providing necessary equipment, workers, and survey personnel.

D. Measurement and Payment paragraphs are included only in those Specification sections of Division 01 where direct payment will be made. Include costs in the total bid price for those Specification sections in Division 01 that do not contain Measurement and Payment paragraphs,

1.03 UNIT QUANTITIES SPECIFIED

A. Quantity and measurement estimates stated in the Agreement are for contract purposes only. Quantities and measurements supplied or placed in the Work and verified by Project Manager will determine payment as stated in Article 9 of Document 00700 - General Conditions.

B. When actual work requires greater or lesser quantities than those quantities indicated in Document 00410 – Bid Form, provide required quantities at Unit Prices contracted, except as otherwise stated in Article 9 of Document 00700 - General Conditions.

1.04 MEASUREMENT OF QUANTITIES

A. Measurement by Weight: Reinforcing steel, rolled or formed steel or other metal shapes are measured by CRSI or AISC Manual of Steel Construction weights. Welded assemblies are measured by CRSI or AISC Manual of Steel Construction or scale weights.

B. Measurement by Volume:

1. Stockpiles: Measured by cubic dimension using mean length, width, and height or thickness.

2. Excavation and Embankment Materials: Measured by cubic dimension using average end area method.

C. Measurement by Area: Measured by square dimension using mean length and width or radius.

D. Linear Measurement: Measured by linear dimension, at item centerline or mean chord.

E. Stipulated Price Measurement: By unit designated in the Agreement.

F. Other: Items measured by weight, volume, area, or linear means or combination, as appropriate, as completed item or unit of the Work.

G. Measurement by Each: Measured by each instance or item provided.

H. Measurement by Lump Sum: Measure includes all associated work.

1.05 PAYMENT

A. Payment includes full compensation for all required supervision, labor, Products, tools, equipment, plant, transportation, services, and incidentals; and erection, application or Installation of an item of the Work; and Contractor's overhead and profit.

B. Total compensation for required Unit Price work shall be included in Unit Price bid in Document 00410 – Bid Form. Claims for payment as Unit Price work, but not specifically covered in the list of Unit Prices contained in Document 00410 – Bid Form, will not be accepted.

C. Interim payments for stored materials will be made only for materials to be incorporated under items covered in Unit Prices, unless disallowed in Document 00800 - Supplementary Conditions.

D. Progress payments will be based on Project Manager's observations and evaluations of quantities incorporated in the Work multiplied by Unit Price.

E. Final payment for work governed by Unit Prices will be made on the basis of actual measurements and quantities determined by Project Manager multiplied by the Unit Price for work which is incorporated in or made necessary by the Work.

1.06 NONCONFORMANCE ASSESSMENT

A. Remove and replace work, or portions of the Work, not conforming to the Contract documents.

B. When not practical to remove and replace work, City Engineer will direct one of the following remedies:

1. Nonconforming work will remain as is, but Unit Price will be adjusted lower at discretion of City Engineer.

2. Nonconforming work will be modified as authorized by City Engineer, and the Unit Price will be adjusted lower at the discretion of City Engineer, when modified work is deemed less suitable than specified.

C. Specification sections may modify the above remedies or may identify a specific formula or percentage price reduction.

D. Authority of City Engineer to assess nonconforming work and identify payment adjustment is final.

1.07 NONPAYMENT FOR REJECTED PRODUCTS

A. Payment will not be made for any of the following:

1. Products wasted or disposed of in an unacceptable manner.

2. Products determined as nonconforming before or after placement.

3. Products not completely unloaded from transporting vehicles.

4. Products placed beyond lines and levels of required work.

5. Products remaining on hand after completion of the Work, unless specified otherwise.

6. Loading, hauling, and disposing of rejected Products.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 01290

PAYMENT PROCEDURES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Schedule of Values.

B. Billing forecast.

C. Value / time log.

D. Expenditure of Cash Allowances.

E. Applications for Payment.

F. Payment for mobilization work.

G. Final payment.

1.02 DEFINITIONS

A. *Schedule of Values*: Itemized list, prepared by the Contractor, establishing the value of each part of the Work for a Stipulated Price contract, or for Major Stipulated Price items for a Unit Price contract. The Schedule of Values is the basis for preparing applications for payment. Quantities and unit prices may be included in the schedule when approved or required by City Engineer.

B. *Major Stipulated Price Item*: Item listed in Section 00410 – Bid Form which qualifies as Major Unit Price Work following Section 00700 – General Conditions Paragraph 9.1.5.

1.03 SUBMITTALS

A. The Contractor must utilize Microsoft SharePoint, a web-based system run by the Houston Airport System, to submit Invoices. Before doing so, the Contractor must attend a brief mandatory SharePoint training session, which will be conducted by a member of HAPMT. The Contractor must contact the designated HAPMT trainer prior to the start of construction to schedule a time for training. Access to SharePoint will not be given to the Contractor's team until training is completed. All document collaboration will be done using SharePoint.

B. Submit electronic version in native format of preliminary Schedule of Values at the Preconstruction Conference (Section 01312 – Coordination and Meetings).

Submit electronic copy in native format of final and updated Schedule of Values with each copy of Application for Payment.

C. Submit electronic version in native format of Billing Forecast and Value/Time Log at first Progress Meeting (Section 01312 – Coordination and Meetings). Obtain approval before making first application for payment. Coordinate this submittal with Master Schedule specified in Section 01325 – Construction Schedules.

D. Produce electronic document for Billing Forecast and Value / Time Log on 8-1/2 inch by 11 inch white bond paper.

1.04 SCHEDULE OF VALUES

A. Prepare Schedule of Values as follows:

1. Prior to the submission of the initial Application for Payment, Contractor shall obtain Project Manager approval for the format and content of the schedule of values for all invoices including the grouping of costs along the lines of specific equipment, asset or deliverable produced as a result of the work performed.
2. For Stipulated Price contracts, use the Table of Contents of the Project Manual as the outline for listing the value of work by Sections.
3. For Unit Price contracts, use Section 00410 – Bid Form as the outline. Include a proportional share of Contractor's overhead and profit in each Unit Price item so the sum of all items equals the Contract Price.
4. List mobilization, bonds, insurance, accepted Alternates and Cash Allowances as separate items.

B. Round off values for each item to the nearest $100.00, except for the value of one item of the Contractor's choice, if necessary, to make the total of all items in the Schedule of Values equal the Contract Price.

C. At direction of City Engineer revise the Schedule of Values and resubmit for items affected by Modifications, at least 10 days prior to submitting the next Application for Payment. List each Change Order as a separate item.

1.05 BILLING FORECAST

A. Prepare an electronic graphic or tabular Billing Forecast of estimated monthly applications for payment for the Work.

1. This information is not required in the monthly updates, unless significant changes in work require resubmittal of the schedule. Allocate the units indicated in the bid schedule or the schedule of values to Construction Schedule activities (weighted allocations are acceptable, where appropriate). Spread the dollar value associated with each allocated unit

across the duration of the activity on a monthly basis. Indicate the total for each month and cumulative total.

2. Billing forecast is only for planning purposes of City Engineer. Monthly payments for actual work completed will be made by City Engineer following Section 00700 – General Conditions.

1.06 VALUE/ TIME LOG

A. Prepare an electronic Value / Time Log as a slope chart, showing:

1. Original Contract Time / Modified Contract Time: x coordinate, in weeks.
2. Original Contract Value / Modified Contract Value: y coordinate, in thousands of dollars.

1.07 EXPENDITURE OF CASH ALLOWANCES

A. Verify with City Engineer that work and payment requested is covered by Cash Allowance.

B. Prepare electronic version of Section 00685 – Request for Information following Section 01726 – Base Facility Survey, include following minimum data to support Contractor's request for expenditure of Cash Allowances listed in Section 01210 – Cash Allowances, and process in a timely manner to allow detailed review by City Engineer:

1. Statement of fact indicating reason(s) expenditure is required. Include photographs or video following Section 01321 – Construction Photographs documenting existing conditions.
2. Quantity survey, made from on-site measurements, of quantity and type of work required to properly complete work.
3. Cost of work, including detailed proposals from trade(s) responsible. For work governed by unit prices, applying unit prices following this Section.
4. Trade(s) responsible for corrective work.
5. Change in Contract Time.
6. Administrative data, including contract name and number, and Contractor's name.

C. Do not commence affected work without written authorization.

D. Process approved expenditures following Section 01255 – Modification Procedures and Application for Payment process below.

1.08 APPLICATIONS FOR PAYMENT

A. Submit each Application for Payment following Section 00700 – General Conditions and as directed via SharePoint which utilizes an electronic version

of the American Institute of Architects Document G702 including G703 continuation sheets.

1.09 PAYMENT FOR MOBILIZATION WORK

A. Measurement for mobilization is on a lump sum basis if included as a unit price in Section 00410 – Bid Form.

B. Mobilization payments paid upon application by Contractor subject to:

1. Authorization for payment of 50 percent of the contract price for mobilization will be made upon receipt and approval by City Engineer of the following submittal items, as applicable:

a) Schedule of values.
b) Trench safety program.
c) Construction schedule.
d) Photographs.
e) QC Program.
f) SPCD
g) Contractor Safety Plan
h) NOI / SWPPP

C. Authorization for payment of the remaining 50 percent of the Contract Price for mobilization will be made upon completion of Work amounting to 5 percent of the Contract Price less the mobilization unit price.

D. Mobilization payments are subject to retainage amounts stipulated in the Section 00700 – General Conditions.

1.10 FINAL PAYMENT

A. When Contractor considers the Work is complete, submit written certification that:

1. Work is fully inspected by the Contractor for compliance with Contract Documents.
2. Work follows the Contract Documents, and deficiencies noted on the Punch List are corrected.
3. Products are tested, demonstrated and operational.
4. Work is complete and ready for final inspection.

B. In addition to submittals required by Section 00700 – General Conditions and other Sections:

1. Furnish submittals required by governing authorities, such as Certificate of Occupancy and Certificates of Inspection.

2. Submit a final statement of accounting giving total adjusted Contract Price, previous payments, and sum remaining due (final Application for Payment).

C. When the Work is accepted and final submittals are complete, a final Certificate for Payment will be issued.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01312

COORDINATION AND MEETINGS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. General coordination is required throughout the documents and the Work. Refer to all of the Contract Documents and coordinate as required to maintain communications between Contractor, City and Designer; Subcontractors and Suppliers. Assist City with communications between Contractor and City's separate contractors.

B. Preconstruction conference.

C. Progress meetings.

D. Daily briefings.

1.02 SUBMITTALS

A. In addition to submittals related to meetings and described elsewhere in this Section, see following Sections for submittals prepared under those Sections, but submitted under this Section:

1. Section 01255 – Modification Procedures: Individual authorized to execute Modifications.
2. Section 01506 – Temporary Controls: "Airport Construction Control Plans", containing submittals prepared under Section 01506 – Temporary Controls and other Sections referenced therein.

1.03 RESPONSIBILITIES FOR MEETINGS

A. City Engineer may act directly or through designated representatives identified by name at the Preconstruction Conference, and will schedule, chair, prepare agenda, record and distribute minutes and provide facilities for conferences and meetings.

B. Contractor:

1. Present status information and submittal data for applicable items.
2. Record and distribute Contractor's corrections to meeting minutes.

3. Provide submittal data for attendees. Prepare, reproduce and issue Contractor's documents to support conferences and meetings. Issue typically as part of each session unless more frequent publication is necessary. Issue one copy to each conference attendee, and to others as directed by City Engineer and as required by Contractor.
   a. Transmit documents requiring urgent action by facsimile or messenger.
   b. Provide ~~electrostatic or diazo print copies as applicable to document size and media of originals. Provide foldable sizes to achieve minimum 8-1/2 x 11 inch format~~ electronic and/or hard copies as required to properly document the project or project actions. The Contractor shall coordinate the submittal format with the City Engineer.
4. Initiate and provide facilities for Coordination Meetings as required in 1.04.H.1.
5. Costs for documentation are the Contractor's responsibility.

1.04 CONTRACTOR COORDINATION

A. Coordinate scheduling, submittals, and work of Sections to achieve efficient and orderly sequence of installation of interdependent construction elements.

B. Verify characteristics of products are compatible with existing or planned construction. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing products in service.

C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. Conceal pipes, ducts, wiring and fasteners in finished areas, except as otherwise indicated. Coordinate locations of fixtures and outlets with finish elements. Locate work requiring accessibility to coordinate with existing access panels and doors.

E. Coordinate completion and clean up of work for Substantial Completion and for portions of the Work designated for partial occupancy.

F. Coordinate access to site and within the work area(s) for correction of nonconforming work. Minimize disruption of occupants' activities where work areas are occupied.

G. Do not proceed with affected work until discrepancies in contract requirements are resolved and unsatisfactory substrate and site conditions are corrected.

H. Coordination Drawings: Before materials are fabricated or Work begun, prepare coordination Drawings including plans, elevations, sections, and other details as

required to clearly define relationships between ~~sleeves, piping, ductwork, conduit, ceiling grid, lighting, fire sprinkler, HVAC equipment and other mechanical, plumbing and electrical equipment with other components of the building such as beams, columns, ceilings, and walls~~ the items of work.

1. Hold Coordination Meetings with trades providing the above Work, to coordinate Work of the trades ~~for each floor and mechanical areas~~.
2. Prepare coordination Drawings ~~to 1/4" = 1'-0" scale~~ for general layout, and ~~3/8" = 1'-0" for~~ plans and sections as needed or required to successfully complete the work in congested areas ~~such as equipment spaces~~.
3. Resolve conflicts between trades, prepare composite coordination Drawings and obtain signatures on original composite coordination Drawings.
4. When conflicts cannot be resolved, Contractor shall request clarification prior to proceeding with that portion of the Work affected by such conflicts or discrepancies. Prepare interference Drawings to scale and include plans, elevations, sections, and other details as required to clearly define the conflict between the ~~various systems and other components of the building such as beams, columns, and walls~~ items of work, and to indicate the Contractor's proposed solution.
5. Submit Drawings for approval whenever job measurements and an analysis of the Drawings and Specifications by the Contractor indicate that the ~~various systems~~ items of work cannot be installed without significant deviation from the intent of the Contract. When such an interference is encountered, cease Work in the general areas of the conflict until a solution to the question has been approved by the ~~A/E~~ City Engineer.
6. Submit original composite coordination Drawings as part of record document submittals specified in Section 01770 – Contract Closeout.

1.05 PRECONSTRUCTION CONFERENCE

A. Attendance Required: City Engineer’s representatives, Construction Manager (when so employed), Designer(s), Contractor, Contractor’s Superintendent, and major Subcontractors.

B. Submittals for review and discussion at this conference:

1. Draft Schedule of Values, following Section 01290 – Payment Procedures.
2. Bound draft of Airport Construction Plans, following Sections 01506 – Temporary Controls and 01555 – Traffic Control and Regulation.
3. Draft construction schedule(s), following Section 01325 – Construction Schedules.
4. Draft Submittal Schedule, following Sections 01325 – Construction Schedules and 01340 – Shop Drawings, Product Data and Samples.

C. Agenda:

1. Status of governing agency permits.

2. Procedures and processing of:
   a. Submittals (Section 01340 – Shop Drawings, Product Data and Samples).
   b. Permitted substitutions (Section 01630 – Product Options and Substitutions).
   c. Applications for payment (Section 01290 – Payment Procedures).
   d. Section 00685 – Request for Information.
   e. Modifications Procedures (Section 01255 – Modification Procedures).
   f. Contract closeout (Section 01770 – Contract Closeout).
3. Scheduling of the Work and coordination with other contractors (Sections 01325 – Construction Schedules, 01326 – Construction Sequencing and this Section).
4. Agenda items for Site Mobilization Conference, if any, and Progress Meetings.
5. Procedures for Daily Briefings, when applicable.
6. Procedures for Testing: Sections 01450- Contractor's Quality Control, 01455- City's Acceptance Testing, 01456- Contractor's Value Engineering, and ~~01457- Estimating Percentage of Product Within Specification Limits~~ FAA Section 110 Method of Estimating Percentage of Material Within Specification Limits (PWL).
7. Record documents procedures (Section 01770 – Contract Closeout).
8. Finalization of Contractor's field office and storage locations (Section 01505 – Temporary Facilities).
9. Use of premises by City and Contractor (Section 01145 – Use of Premises).
10. Status of surveys (Sections 01725 – Field Surveying and 01726 – Base Facility Survey).
11. Review of temporary controls and traffic control (Sections 01506 – Temporary Controls and 01555 – Traffic Control and Regulation).
12. Construction controls provided by City.
13. Temporary utilities and environmental systems (Section 01505 – Temporary Facilities).
14. Housekeeping procedures (Section 01505 – Temporary Facilities).

1.06 PROGRESS MEETINGS

A. City Engineer will hold Progress Meetings weekly, or at other frequency determined by progress of the Work, at Department of Aviation office at 16930 JFK Boulevard at George Bush Intercontinental Airport/ Houston), Houston, Texas 77032 (281/233-3000).

B. Attendance Required: Contractor's Superintendent, major Subcontractors' and Suppliers' superintendents, City Engineer representatives, and Designer(s), as appropriate to agenda topics for each meeting.

C. Submittals for review and discussion at this conference:

1. Project schedule (Section 01325 – Construction Schedules).
2. Submittal Log (Section 01340 – Shop Drawings, Product Data and Samples).
3. Log of Section 00685 – Request for Information.

D. Agenda:

1. Review minutes of previous meetings to note corrections and to conclude unfinished topics.
2. Review of: progress schedule; coordination issues if any; corrective measures if any to regain planned progress; planned progress during succeeding work period; off-site fabrication and product delivery schedules.
3. Field observations, problems, and decisions.
4. Identification of problems which impede planned progress and Contractor's proposals for resolution.
5. Review of submittals schedule and status of submittals.
6. Review of RFI status.
7. Review of Request for Proposal, Work Change Directive and Change Order status.
8. Closings and impediments (Section 01145 – Use of Premises).
9. Maintenance of quality and work standards (Sections 01450 – Contractor's Quality Control and 01455 – City's Acceptance Testing).
10. Effect of proposed changes on progress schedule and coordination.
11. Other items affecting completion of the Work within contracted cost and time.

1.07 DAILY BRIEFINGS

A. In addition to Progress Meetings, hold briefings as frequently as required, at place designated by the City Engineer, to coordinate details of construction and airport operations. Discuss specific requirements, procedures and schedule changes, and closures and impediments.

B. When required, hold briefing before start of work each day, to confirm that required activities are properly allocated and unchanged.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01321

CONSTRUCTION PHOTOGRAPHS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Progress photographs to supplement Applications for Payment.

B. Detail photographs and video to supplement Request for Information.

1.02 MEASUREMENT AND PAYMENT

A. Cost of photographs is incidental to the Contract Price. No additional costs will be paid for other than administrative costs of extra copies and photographs resulting from additional station points.

B. Following work will be paid on a Unit Price basis:

1. Extra Prints: Per print.

    a. Extra prints provided direct from the photographer to parties authorized by the City Engineer up to date of Substantial Completion, priced at prevailing local commercial rates. Include photographer's costs and Contractor's administrative costs only.
    b. Extra prints provided direct from the photographer to the City Engineer up to 3 years after the date of Substantial Completion, priced at prevailing local commercial rates. Include photographer's costs but not Contractor's costs for this service.

2. Additional Station Points: Per station point, for photographs made during same trips as Paragraph 2.01.

C. Emergencies: Per trip to site. Take additional photographs or video, as appropriate to conditions, within 24 hours of the City Engineer's request. This applies to professional photography required by conditions stated in Paragraph 8.2.1 in Section 00700 – General Conditions.

D. Following photography will be commissioned by Modification: Publicity photographs; special events at site; photographs taken at fabrication locations off-site.

1.03 SUBMITTALS

A. Station point Plan: One copy of the Site Plan, marked to show plan, altitude and cone-of-view of each station point selected by the City Engineer or Designer. Submit at least 10 days prior to taking Preconstruction Photographs.

B. Preconstruction Photographs: Same as Paragraph C., except one-time only, and marked as such.

C. Progress Photographs: 3 prints of each view. Submit 2 prints with each Application for Payment. Retain 1 print by the Contractor at the work site and available at all times for reference. Retain photographic negatives, at the photographer's office, for 3 years after Substantial Completion.

D. Photographs and Video Supporting RFI: Identify following with RFI number and date of photographs:

1. Submit 1 copy of 3x5 inch prints on white card stock in clear plastic sleeves.
2. Submit videotapes in protector boxes. Include tape number, date of record, approximate location on tape, and brief description of record.

E. Contract Closeout: Follow Section 01770 – Contract Closeout to:

1. Return negatives of RFI photographs in protective envelopes, identified by Project name, Contractor, and date photographs were taken.
2. Return videotapes in protective boxes, each box identified with contents, by RFI number, and each tape numbered sequentially and with "Date From/ To" on each tape.

F. Aerial Progress Photographs: Submit 5 prints and 1 CD ROM of 2 consistent oblique views with each Application for Payment. Retain 1 print by the contractor at the work site and available at all times for reference. The photos shall be large format oblique angles taken from a height and viewpoint to be selected by the City Engineer.

1.04 QUALITY ASSURANCE

A. Timely take and produce photographs from proper station points, and provide proper image quality.

B. Cooperate with the photographer's work. Provide reasonable auxiliary services as requested, including access and use of temporary facilities including temporary lighting.

C. Qualifications of Photographer for General Progress Photographs: A firm or individual of established reputation regularly engaged as a professional building or scene photographer for not less than 3 years.

D. Qualifications of Photographer for RFI Photographs and Video: An employee of the Contractor knowledgeable in photography and videotaping technique, including proper use of video pan-zoom, close-ups, lighting, audio control, clear narrative, smooth transition between subjects, and steady camera support.

E. Qualifications of Aerial Photographer: A firm or individual of established reputation, regularly engaged in aerial photography with prior experience at IAH.

PART 2 – PRODUCTS

2.01 MEDIA

A. Fixed-film: 35mm color print film or color slide film, as determined by City Engineer; ASA 100 minimum, higher when required by lighting conditions.

B. Paper Prints:

1. For Progress Photographs: 8x10 inch matte-finish color, in clear plastic envelop with reinforced 3-ring binding.
2. For RFI Photographs: 3x5 inch minimum size, matte-finish color, contact-mounted on flexible white paper card stock in clear plastic envelop with reinforced 3-ring binding.

C. Video: Standard VHS format, T-120; record at slowest speed or speed capable of freezing a clear image on "Pause"; date and time stamp as part of recording process. Use audio function for slate data below.

1. Provide color playback equipment at Contractor's site office, with minimum 13-inch (diagonal) screen size.

D. Bitmapped Images: MF2HD diskettes, BMP, TGA, or TIF format, maximum 1280x480 and minimum 480x480 pixels, made direct from photograph positives, digitally date and time stamped.

E. Slate for Fixed-film Photographs: Size as required to show Project number, date and time of photographs, location of the photograph station point and photographer's name.

2.02 PRECONSTRUCTION, PROGRESS AND RFI PHOTOGRAPHS

A. Preconstruction Photographs: Prior to beginning on-site construction, take five sets of fixed-film photographs of the project area from approved station points.

Show condition of existing site area, and particular features as directed, within contract limits.

1. At exterior views, surrounding sites, showing streets, curbs, esplanades, landscaping, runway, taxiway, and apron pavements.
2. At interior views, surrounding situs, showing floors, walls, ceilings and architectural signs.
3. Take pan-view photographs as required to encompass existing conditions.

B. Progress Photographs for Applications for Payment: Take 3 fixed-film photographs from each of 2 station-points (same station point each time to show a time-lapse sequence), coinciding with the cutoff date associated with each application for payment, and at Substantial Completion of each stage of the Work.

C. Photographs and Video for Request for Information: Take photographs and video as required to support Section 00685 – Request for Information:

1. Details of existing conditions before construction begins.
2. Details of construction.
3. Details of damage or deficiencies in existing construction and work of separate contractors.
4. Take number of images as required to fully show conditions.

PART 3 – EXECUTION

3.01 GENERAL

A. Do not record over previous video records.

B. Provide clear, sharp, vibration-less video data and clear audio without detrimental background noise.

END OF SECTION

Section 01325

CONSTRUCTION SCHEDULES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Definitions.
B. Responsibility.
C. Submittals.
D. Scheduling personnel.
E. Scheduling software.
F. Master Schedule.
G. Progress Schedule.
H. Rolling Schedules.
I. Submittal Data Schedules.
J. Updating schedules.
K. Narrative reports.
L. Recovery.

1.02 DEFINITIONS

A. CPM: Critical Path Method.

B. PDM: Precedence Diagramming Method.

1.03 RELATED SECTION

A. Section 01312 – Coordination and Meeting.

1.04 RESPONSIBILITY

A. Acceptance of Schedule Requirements by Contractor

1. By bidding this job, the Contractor accepts the responsibility to complete the project on time as called for in the contract. Contractor will provide a schedule showing the necessary resources to complete the project within the time limit allowed by the contract.

B. Schedule

1. The Contractor is responsible for developing his own schedule logic with appropriate durations, resource loading and cost data, however all information must be acceptable and compatible with the City Engineer's Master Schedule, and all target, completion and milestone data generated

must be acceptable to the City Engineer.

2. The City Engineer reserves the right to reject any schedule or report that fails to reflect completion of the Project or any intermediate milestone on their required dates, does not provide a logical sequence of operation for each activity (predecessors and successors), or otherwise indicates unrealistic performance. Failure of the Contractor to deliver satisfactory schedules or reports as required in the Contract Documents may result in actions by the City Engineer as detailed in Paragraph 9.8 of Section 00700 – General Conditions.

1.05 SUBMITTALS

A. The Contractor shall utilize Microsoft SharePoint, a web-based application run by the Houston Airport System, to electronically submit RFIs, Submittals and Invoices. Access to the SharePoint portal and required training will be coordinated through the Project Manager. All submittals will be made at their required time and in the required format. The Contractor will provide the number of copies specified for each document. In addition to the hard copies specified, each submittal shall be accompanied by an electronic copy in its native format.

B. Master Schedule: Submit the preliminary version in its native format at least one (1) week prior to the date of the pre-construction conference ~~at Preconstruction Conference~~ (Section 01325 – Construction Schedules). Submit the final version at first Progress Meeting (Section 01325 – Construction Schedules), and attached to each copy of first Application for Payment (Section 01290 – Payment Procedures).

C. Progress Schedules: Submit 1 copy for each attendee at Progress Meetings and email 1 copy to the project manager (Section 01312 – Coordination and Meetings), and 1 copy attached to each Application for Payment (Section 01290 – Payment Procedures).

D. Submittal Schedule: Submit 1 copy for each attendee at Progress Meetings and email 1 copy to the project manager (Section 01312 – Coordination and Meetings). See Section 01340 – Shop Drawings, Product Data and Samples for statement giving permission to include this schedule as part of the Master Schedule.

1.06 SCHEDULING PERSONNEL

The Contractor shall retain the services of a qualified scheduler to generate the submissions, or provide a qualified designated employee to be the Project Scheduler. In either case, that individual must have had previous scheduling responsibilities on major projects and be experienced with P6. The Contractor

shall submit the resume of the designated scheduler for approval by City Engineer prior to the Notice to Proceed.

1.07 SCHEDULING SOFTWARE

A. The Network Diagramming Method to be utilized shall be the Precedence Diagram Method (PDM).

B. P6 version 7.0 is the required scheduling software for all Contractors & projects governed by these provisions. The Contractor shall make his own arrangements to produce his schedule using the same or approved compatible software.

C. Format Requirements

1. Activities

a. Activities shall include in addition to the construction activities, the submittal, review and approval of samples, manufacturers' data, and shop drawings, the procurement of materials and equipment, installation and testing. Any impact resulting from the operations of other Contractors or from operating restraints imposed by the City shall be identified in the network schedule. The selection and number of activities shall be subject to the City Engineer's approval. ~~The level of detail of each activity shall be such that the durations, in days, will range from one to five days.~~ Schedule logic shall be derived such that activities do not have more than 30 days of total float. No more than 3% of the activities shall exceed these limits. Activity descriptions shall be concise and meaningful. Float belongs to the project, neither the City nor the Contractor will file a claim against the other for use of float. Both parties will be judicious in their use of float.

b. The general contractor is welcome to use the activity ID field to organize the activities within the schedule in addition to establishing a comprehensive and structured WBS in place. However, the activity ID structure is not a requirement in P6.

1.) RESOURCE CODES:

a.) Contractor will identify all resources required to complete the project and will resource load the schedule.

b.) Calendar ID's:

1. Each contractor will be provided with a block of Calendar ID's sufficient to accommodate their varying holiday & other work calendar requirements. These Calendar ID's will be reserved in advance by request to the City Engineer.

2.) COST LOADING

a.) An appropriate monetary value is to be assigned to each work activity or group activity by the Contractor and approved by the City Engineer. These costs will be presented in cost reports at each schedule update and cost loading shall be associated with materials (bid items) rather than labor or equipment so that production rates times the cost factor will equal progress payment amounts. These reports will be the basis for approving the Contractor's application for payment.

3.) RESOURCE LOADING

a.) Each activity shall be resource loaded with manpower (by trade), material, equipment, subcontractor(s) and all other resources required to complete each of the activities. The schedule will be leveled by available resources in order to verify the scheduled activity durations and total project duration. Each resource and the availability thereof shall be defined. The leveling of the schedule shall not be considered to take the place of appropriate schedule logic.

4.) PDM SCHEDULES: activity listings and bar charts with the following information for each activity in the schedule:

a.) Activity ID.
b.) Activity Description.
c.) Estimated (Original) Duration.
d.) Remaining Duration.
e.) Actual Duration.
f.) Early Start Date.
g.) Late Start Date.
h.) Early Finish Date.
i.) Late Finish Date.
j.) Free Float.
k.) Total Float.
l.) Activity Codes (such as Work Type).

1.08 MASTER SCHEDULE

A. Not later than 10 days after notice of contract award, prepare and submit the Preliminary Schedule confirming construction stages following Section 01326 – Construction Sequencing, and showing:

1. Capability of software to produce required schedules in proper form and content.

2. Proposed date of Notice to Proceed (NTP).
3. Single-line bar for each stage including start dates (milestones), duration of work by month, date (milestone) of Substantial Completion.
4. Activities affecting or affected by Separate Contractors.
5. No constraints will be used except for NTP, Project Milestones and external relationships.
6. Major material purchase and delivery of long lead items must be shown on the schedule
7. Duplicate activity descriptions must have an additional identifier (by area/phase etc.) to distinguish between the activities when recording progress.
8. Use “task dependent” activities for all tasks, with the exception of milestones, and let the program summarize the schedule at a WBS level or activity codes level depending on the summarization requirements.
9. Confirm that all WBS levels are fully defined and not blank. CAUTION: missing WBS definitions will lead to confusion and possibly a failure to correctly account for work or costs properly.
10. All construction activities that are part of the capital costs must be completed prior to substantial completion milestone.

B. Designer and City Engineer will review the Proposed Schedule and will note unacceptable deviations noted thereon and return comments to Contractor.

C. Correct Preliminary Schedule and resubmit until approved.

D. Not later than the date of the NTP prepare and submit Master Schedule based on applicable revisions to Preliminary Schedule showing the entire project:

1. Date of NTP.
2. Single-line bar for each activity in each Stage including start dates (milestones), duration of work by week, date (milestone) of completion of each stage, and date (milestone) of Substantial Completion.
3. Single-line bar for acquisition and delivery of major projects.
4. Activities affecting or affected by Separate Contractors.

E. Baseline Data: Information shown on the Master Project Construction Schedule is the baseline against which actual and forecasted progress is tracked.

F. Publish schedules monthly at minimum frequency with Monday-starts. Include calendar-specific dates based on date of NTP and contract duration. Number contract days.

1.09 PROGRESS SCHEDULES

A. For each progress conference (Section 01312 – Coordination and Meetings) and for each application for payment (Section 01290 – Payment Procedures), prepare and submit the Progress Schedule showing for the entire project:

1. Master Schedule data specified in Paragraph 1.06.
2. Immediately below each line of the Master Schedule:

    a. Indicate actual progress (percent complete) not earlier than 2 days prior to each progress conference.
    b. Indicate forecasted progress through completion of each activity.

3. Make and show revisions since previous submissions for changes in scope of work, sequencing and other identifiable changes, based on Modifications approved or then-in-process of approval.
4. The general contractor shall not reduce activity durations in an attempt to reduce negative float. If the general contractor intends to execute activities quicker than the original duration, this shall be mentioned in the float analysis and will be implemented on schedule revisions not schedule updates.

1.10 SUBMITTAL SCHEDULES

A. Prepare a Submittal Schedule showing:

1. Dates (milestones) for Contractor's submittals to Designer.
2. Durations and dates (milestones) for processing by Designer and other parties, at weekly or daily frequency as required. Indicate submittals requiring special processing such as short-duration reviews.
3. Dates (milestones) submittals are required from separate contractors and City (for work by City specified in Section 01110 – Summary of Work) for review by Contractor.

B. Submit a master Submittal Schedule showing all submittals required. If required to adequately show processing requirements, provide schedules for each Stage.

C. List submittals following Section numbers and headings in the Project Manual. If approved, submittal log data specified in Section 01340 – Shop Drawings, Product Data and Samples may be incorporated into this schedule.

D. At the Contractor's option, Submittal Schedules may be prepared as an integral part of construction schedules specified herein.

1.11 UPDATING SCHEDULES

A. Prepare updates to and issue updated Master Schedule and Progress Schedules to reflect changes in the Work or deviations from original schedule.

B. Update to show actual start and finish dates, percent complete, and remaining duration of each activity. Updating to reflect actual progress to date is not a revision to the contract schedule. Revise only with approval and when one or more of the following conditions occur:

1. When a change or delay significantly affects any specified intermediate milestone dates or completion dates or the sequence of activities.
2. When the Contractor proposes to change sequence of activities affecting the critical path or to significantly change the previously approved work plan.
3. When, in the opinion of the City Engineer, the status of the work is such that the schedule and supporting analysis are no longer representative for planning and evaluation of the Work.

C. Provide narrative reports as required to clarify information shown on schedules.

D. Instruct recipients to promptly notify Contractor of problems discovered or anticipated in forecasts shown.

E. Participate with City, occupants, separate contractors, City Engineer and Designer in reviews and resolution of schedule conflicts.

1. 3 WEEK LOOKAHEAD – SORT BY WBS

   a. A bar chart report sorted by WBS showing activities from previous week and upcoming work for the next three (3) weeks.

2. CASH FLOW REPORT

   a. Cash Flow Reports shall be based on agreed completions for each work activity and be formatted to be consistent with the approved schedule of values from the bid documents.
   b. The original cash flow report is to display, either in tabular or graphic format, projections of weekly values of work-in-place. Each schedule of values line item is to be represented within the project. Updated reports are to record the original projection, and actual value of work-in-place, and adjusted projections required to accommodate completion of the project.

3. NARRATIVE REPORT

   a. A narrative description of the Contractor's management philosophy and construction plan will be provided with each submittal. This description will define clearly each activity or group of activities so there is no doubt as to what is encompassed by an activity and what portion of the work is represents.
   b. A written narrative will be supplied with each submittal:

      1.) To describe or explain logic changes.
      2.) To explain out of sequence progress.
      3.) To detail procurement/delivery problems.
      4.) To describe recovery plans whenever negative float is indicated.
      5.) To explain clearly any new activities (the work they represent).

   c. Schedule performance index shall be reported on monthly basis at CSI spec. level.

4. OTHER REPORTS

   a. Other reports may be required by the City Engineer. This will only be required if the Contractor fails to maintain all approved schedules.

1.12 RECOVERY

A. The City Engineer may require the Contractor to add to their plant, equipment, or construction forces, as well as increase the working hours, if operations fall behind schedule by 15 ~~work~~ calendar days or more at any time during the construction period. The cost of the above will be the responsibility of the Contractor.

B. If at any time during the project, any Contractor fails to complete any activity by its latest completion date, he will be required, within fifteen (15) calendar days, to submit to the City Engineer a Recovery Schedule displayed in time scaled PDM format, at no additional cost to the City. The Recovery Schedule shall depict the Contractor's plan for regaining the lost time including but not limited to the following actions:

   1. Adjustment of work sequencing, as depicted on the accepted construction schedule.
   2. Increase resources as necessary.
   3. Increase in the number of working hours per day, shifts per day, working days per week, amount of equipment, or any combination thereof.

C. This work shall not be deemed to be acceleration demanded by the City but shall be recovery time by the Contractor.

D. Recovery Schedule Preparation

1. Within three (3) calendar days after being notified in writing of the late completion of any activity, the Contractor shall prepare and submit a Recovery Schedule incorporating the best available information from subcontractors and others which shall permit return to the approved construction schedule at the earliest possible time, but not exceeding a total duration of seven (7) days from the date of written notification by the City Engineer. The Recovery Schedule shall be prepared to the same level of detail as the Approved Project Target.

E. Schedule Review

1. Within three (3) calendar days after above notifications the Contractor shall participate in a conference with appropriate parties to review and evaluate the Recovery Schedule. The Contractor shall make revisions to his recovery plan as necessitated by this review. The Contractor shall use the accepted Recovery Schedule in his planning and execution of the work for the planned duration of the Recovery Schedule. The Contractor shall also continue to use as reference the Approved Project baseline Target and milestones completion dates (Original Baseline).

F. Schedule Assessment

1. During the planned duration of the Recovery Schedule, the Contractor shall confer with the City Engineer every seven (7) days to assess the effectiveness of the Recovery Schedule. At the end of the recovery period, if the Contractor is:

a) Behind Schedule. If the Contractor is still behind schedule, the Contractor shall prepare another Recovery Schedule.
b) On Schedule. If the Contractor has recovered the delay, the Project shall again be monitored using only the Approved Project Target Schedule.

1.13 MEASUREMENT AND PAYMENT

A. The acquisition of software and the development, updating, revising and submittal of schedules or progress reports will not be measured for payment.

No separate payment will be made for Construction Schedules. The cost of the work described in this item shall be considered incidental to the various other elements included in the project. Failure of the Contractor to provide all information, as specified herein, shall result in the disapproval of the entire construction schedule submission.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

Section 01326

CONSTRUCTION SEQUENCING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Work periods.

B. Mobilization and demobilization.

C. Construction sequence.

1.02 WORK PERIODS

A. ~~No work is permitted at IAH during the following periods:~~ Work schedules are restricted during the periods noted below. No runway closures or removal of any NAVAIDS from service shall be allowed during these periods. No new airfield pavement closures shall occur during these periods, though work shall continue on pavements that have already been closed prior to the periods noted below. No shifts of phasing will be permitted during these periods, though work shall continue on phases that have already commenced prior to the periods noted below. No work that would require support from Airport Operations will be permitted during these periods. The Contractor shall prepare any closed runway pavements to be opened during these periods, including, but not limited to, removal of all barricades and pavement closure devices, replacement of pavement markings, and return to service of any temporarily disabled NAVAIDs. The Contractor shall additionally prepare any other possible airfield pavements to be opened during these periods. The Contractor shall anticipate increased aircraft traffic during these periods that may impact access routes and active pavement crossing points. The Contractor shall coordinate requirements with HAS Airport Operations. No construction will be permitted on JFK Blvd., Will Clayton Parkway, or the Terminal Loop Roads during these periods. This work shall be considered subsidiary to the cost of the project and shall not be measured or paid for separately.

~~1. Beginning at 0600 hours on Tuesday prior to Thanksgiving Day and to 2000 hours the following Monday.~~
~~2. Beginning at 0600 hours one week prior to Christmas Day and to 2359 January 2 following.~~
3. Thanksgiving – Beginning at 6:00 a.m. CST (0600 hours) on the Tuesday before Thanksgiving and ending 11:59 p.m. CST (2359 hours) on the Monday after Thanksgiving.
4. Christmas – Beginning at 6:00 a.m. CST (0600 hours) on December 18 and ending 11:59 p.m. CST (2359 hours) on January 3.

HAS reserves the right to suspend construction operations for short periods of time (i.e. while an aircraft passes), daily, or between construction phases, and / or change the order of construction phasing during the project if it is determined to be in the best interest of Airport Operations or safety. The Contractor may be directed to move personnel, equipment, and materials to a safe location and / or evacuate the site in order to enable aircraft operations. Necessary extensions in contract time will be granted or a stop work order will be issued due to these delays. However, there will be no adjustments in contract price due to these delays, unless otherwise noted in the contract documents.

B. Reference the project phasing sheets of the plan set for details and required work hours, by phase. The contractor is required to complete the work by phase and step within the calendar days noted in the project phasing sheets of the plan set.

C. ~~For purposes of on-site construction operations for interior work, work may be accomplished in one or more of the following daily schedules (shifts) and as specified herein:~~

~~1. "Day (D) Shift": For work fully confined behind dust-resistant enclosures and where airborne or structure-borne noise is abatable by temporarily ceasing operations, work from 0000 hours through 2400 hours each day of the week, meaning a 24 hour shift is available whether or not all hours are used; however, deliver products and remove debris only during "N Shift."~~
~~2. "Night (N) Shift": For work that cannot, due to dust or noise-producing operations, be done during "D Shift", work from 1900 hours through 0600 hours each day of the week (8-hour shift, one-hour lunch break), with the following restrictions on access:~~

~~a. Move products into and remove debris only during "N shift" period.~~
~~b. Complete work of the shift and entirely evacuate the work area by 0600 of the next day, including rubbish removal, leaving enclosures or barricades in place.~~
~~c. Work at the car rental counters at the Baggage Level Public Lobby between 02300 hours to 0500 hours.~~

D. For purposes of on-site construction operations for exterior work within the AOA, work shall conform to the following:
1. The contractor shall not perform lane closures with the Terminal Roadways unless approved in advance and in writing by HAS Airport Operations.
2. Fire station access must be maintained at all times.
3. Maintain access through work zone to terminal buildings and garages at all times unless indicated on the plans. Temporary closures of any access must only be completed between the hours of 10:00 p.m. CST (2200 hours) to 6:00 a.m. CST (0600 hours) on weekend days unless indicated on the plans. Temporary closures of delivery entrances and exits may only occur from 8:00 p.m. CST (2000 hours) to 4:00 a.m. CST (0400 hours) on weekend days unless indicated on the plans.

4. The contractor shall coordinate staging areas for equipment with HAS Airport Operations.
5. See additional traffic control sequencing notes in the plans.

1.03 MOBILIZATION AND DEMOBILIZATION

A. Payment for mobilization is specified in Section 01290 – Payment Procedures and FAA General Provision 105, Mobilization.

B. General mobilization applicable to the Work, regardless of construction sequencing specified herein includes:

1. Construction and Submittal Schedule processing following Sections 01325 – Construction Schedules and 01340 – Shop Drawings, Product Data and Samples.
2. Obtain and pay for permits.
3. Submittal of other documents following Section 01312 – Coordination and Meetings.
4. Survey Base Building following Section 01726 – Base Facility Survey and process related Section 00685 – Request for Information, including accessibility by cutting, following Section 01731 – Cutting and Patching, into concealed areas.
5. Security badging following Section 01506 – Temporary Controls and Section 01 35 13.14 – Safety and Security.
6. Approval of construction schedules following Section 01325 – Construction Schedules.
7. Product acquisition for other tasks; except products with short lead times may be acquired later as required to maintain schedule performance.
8. Acquisition of major construction equipment and set-up of on-site storage and office space.
9. Other activities necessary to maintain schedule performance.
10. Construction and/or use of ~~exterior and interior~~ barricades and enclosures following Section 01505 – Temporary Facilities.

C. Demobilization:

1. Processing of closeout documents, following Section 01770 – Contract Closeout, and activities not otherwise completed at the end of previous tasks.
2. The cost of demobilization shall be considered subsidiary to the cost of mobilization.

1.04 CONSTRUCTION SEQUENCE

A. Sequence of work or tasks indicated in the included in the Drawings is intended only as a guide for Bidding.

B. Prepare and process Contractor's construction schedule following Section 01325 – Construction Schedules.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 CONSTRUCTION SEQUENCE

A. Construct the Work in sequence as shown on Drawings and as provided in the Construction Safety and Phasing Plan (CSPP), included as an attachment to the Project Manual.

END OF SECTION

Section 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Submittal procedures for:

1. Construction Schedules and Cash Flow Curve (billing forecast).
2. Shop Drawings, Product Data and Samples
3. Manufacturer's Certificates
4. Construction Photographs
5. Project Record Documents and monthly certification.
6. Design Mixes

1.02 SUBMITTAL PROCEDURES

A. Scheduling and Handling:

1. The Contractor must utilize Microsoft SharePoint, a web-based system run by the Houston Airport System, to submit RFIs, Submittals and Invoices. Before doing so, the Contractor must attend a brief mandatory SharePoint training session, which will be conducted by a member of HAS. The Contractor must contact the designated HAS trainer prior to the start of construction to schedule a time for training. Access to SharePoint will not be given to the Contractor's team until training is completed. All document collaboration will be done using SharePoint.
2. Submit Shop Drawings, data and Samples for related components as required by Specifications and Project Manager.
3. Schedule submittals well in advance of need for construction Products. Allow time for delivery of Products after submittal approval.
4. Develop submittal schedule that allows sufficient time for initial review, correction, resubmission and final review of all submittals. Allow a minimum of 30 days for initial review. Project Manager will review and return submittals to Contractor as expeditiously as possible but time required for review will vary depending on complexity and quantity of data submitted.
5. Project Manager's review of submittals covers only general conformity to Drawings, Specifications and dimensions that affect layout. Contractor is responsible for quantity determination. No quantities will be verified by Project Manager. Contractor is responsible for errors, omissions or deviations from Contract requirements; review of submittals does not relieve Contractor from the obligation to furnish required items in accordance with Drawings and Specifications.
6. Submit five copies of documents unless otherwise specified.
7. Revise and resubmit submittals as required. Identify all changes made since

previous submittal.

8. Assume risk for fabricated Products delivered prior to approval. Do not incorporate Products into the Work, or include payment for Products in periodic progress payments, until approved by Project Manager.

B. Transmittal Form and Numbering:

1. Transmit each submittal to Project Manager with Transmittal letter which includes:
   a. Date and submittal number
   b. Project title and number
   c. Names of Contractor, Subcontractor, Supplier and manufacturer
   d. Identification of Product being supplied
   e. Location of where Product is to be installed
   f. Applicable Specification section number
2. Identify deviations from Contract documents clouding submittal drawings. Itemize and detail on separate 8-1/2-inch by 11-inch sheets entitled "DEVIATIONS FOR RECONSTRUCTION OF TAXIWAY NA". When no deviations exist, submit a sheet stating no deviations exist.
3. Have design deviations signed and sealed by an appropriate design professional, registered in the State of Texas.
4. Sequentially number transmittal letters beginning with number one. Use original number for resubmittals with an alphabetic suffix (i.e., 2A for the first resubmittal of submittal 2, or 15C for third resubmittal of submittal 15, etc.). Show only one type of work or Product on each submittal. Mixed submittals will not be accepted.

C. Contractor's Stamp:

1. Apply Contractor's Stamp certifying that the items have been reviewed in detail by Contractor and that they comply with Contract requirements, except as noted by requested variances.
2. As a minimum, Contractor's Stamp shall include:
   a. Contractor's name
   b. Job number
   c. Submittal number
   d. Certification statement Contractor has reviewed submittal and it is in compliance with the Contract
   e. Signature line for Contractor

D. Submittals will be returned with one of the following Responses:

1. "REVIEWED AS SUBMITTED" when no response and resubmittal is required.
2. "NO EXCEPTION" when sufficient information has supplied to determine that item described is accepted and that no resubmittal is required.

3. "MAKE CORRECTIONS AS NOTED WHEN EXCEPTIONS DO NOT REQUIRE FUTURE CHANGES" when sufficient information has been supplied to determine that item will be acceptable subject to changes, or exceptions, which will be clearly stated. When exceptions require additional changes, the changes must be submitted for approval. Resubmittal is not required when exceptions require no further changes.
4. "REVISE AND RESUBMIT" when submittal does not contain sufficient information, or when information provided does not meet Contract requirements. Additional data or details requested by Project Manager must be submitted to obtain approval.

1.03 MANUFACTURER'S CERTIFICATES

A. When required by Specification sections, submit manufacturers' certificate of compliance for review by Project Manager.

B. Place Contractor's Stamp on front of certification.

C. Submit supporting reference data, affidavits, and certifications as appropriate.

D. Product certificates may be recent or from previous test results, but must be acceptable to Project Manager

1.04 DESIGN MIXES

A. When required by Specification sections, submit design mixes for review.

B. Place Contractor's Stamp, as specified in this section, on the front of each design mix.

C. Mark each mix to identify proportions, gradations, and additives for each class and type of mix submitted. Include applicable test results from samples for each mix. Perform tests and certifications within 12 months of the date of the submittal.

D. Maintain copies of approved mixes at mixing plant.

1.05 CHANGES TO CONTRACT

A. Changes to Contract may be initiated by completing a Request for Information form. Project Manager will provide a response to Contractor by completing the form and returning it to Contractor.

1. If Contractor agrees that the response will result in no increase in cost or time, a Minor Change in the Work will be issued by City Engineer.
2. If Contractor and Project Manager agree that an increase in time or cost is warranted, Project Manager will forward the Request for Proposal for

negotiation of a Change Order.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01340

SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. General procedural requirements for submittal data:

1. Shop drawings.
2. Product data.
3. Samples, including control samples.
4. Product certifications and compliance statements.
5. Submittal logging.

B. Submittal quantities specified in other Sections supersedes those specified herein.

C. Product interface control documents.

1.02 GENERAL PROCEDURES

A. Review submittal data and indicate results of review on documents submitted to Designer.

1. Obtain review and indicate results of Subcontractors' and applicable Separate Contractors' reviews before submittal to Designer.
2. Include on each shop drawing, sample or product data. Submit the following minimum language, signed (by individuals authorized to make binding agreements on behalf of their respective firms) and dated on behalf of each responsible party:

"The Subcontractor and the Contractor named below hereby certify this submittal has been checked prior to submission to Designer, and conforms to the requirements of the Contract Documents for work represented hereby. This submittal does not deviate from requirements of the Contract Documents. It has been checked for: field conditions; correlation of dimensions and quantities; safety precautions; construction means, methods, techniques, schedules, sequences, procedures and fabrication processes; for errors and omissions in this submittal; and for coordination of the work of the trades.

_____ (Subcontractor Firm)
_____ (Authorized Signature)
_____ (Date)

This submittal has also been checked by the following Subcontractors and Separate Contractors for coordination of substrate/superstrate conditions and applicable product interfaces.

(List company names, place authorized signature and date for each.)

_____ (Contractor)
_____ (Authorized Signature)
_____ (Date)"

B. Transmit submittals as specified in Section 01330 – Submittal Procedures. Number each submittal by specification number, for future reference.

1. Furnish number of copies specified herein or in other Sections, for Designer's and City Engineer's records, plus additional copies as the Contractor requires for construction operations and coordination of the Work.
2. Identify Project, Contractor, Subcontractor, Supplier, and generic name of component or system. Allow space on submittal data to accommodate required stamps by Contractor, applicable Subcontractors, applicable Separate Contractors, Designers, and other reviewers.
3. Indicate applicable Drawing detail and Section number.
4. For submittals using SI (metric) measure as the manufacturer's or fabricator's standard, include corresponding Imperial measure conversions. Follow requirements in Section 01610 – Basic Product Requirements.

C. After Designer's review, revise and resubmit until resubmittal is no longer required; identify and log changes made to previous submittals.

D. Distribute copies of reviewed submittals to concerned parties, including Separate Contractors. Instruct recipients to promptly report inability to comply with requirements indicated therein.

E. Shop Drawings, Product Data and Samples: Follow Contractor's progress schedule for submittals related to work progress. Coordinate submittal of related items. Partial submittals will be returned un-reviewed.

F. Transmit submittals far enough in advance to provide time required for reviews, for securing necessary approvals, for revisions and resubmittals. Allow 14 days after receipt for Designer's review, except where shorter processing time is approved due to extraordinary conditions.

G. Do not submit data where no submittal requirements occur. Unsolicited submittals will be returned un-reviewed.

H. Incomplete, uncoordinated, inaccurate and illegible submittals, and submittals without evidence of review by Contractor, applicable Subcontractors and applicable Separate Contractors will be returned un-reviewed.

I. Responsibility for costs of Designer's additional reviews resulting from improper submittal data remains with the Contractor, deductible from the Contract Sum or Time by Change Order.

1.03 SHOP DRAWINGS

A. Submit electronic copies and hard copies as required. After Designer's review, reproduce and distribute copies required for the Contractor's use. The Designer will reproduce copies for Designer and City Engineer.

B. Sheet Size: 8-1/2 x 11 inches minimum; 22 x 34 inches maximum.

C. If CAD is used, prepare documents readable, writable and printable using PC-compatible hardware and software, based on AutoCAD (13 or later versions) or software translated thereto. Provide AutoCAD data disks following Section 01770 – Contract Closeout.

D. Prepare shop drawings by qualified drafters, accurately and distinctly showing:

1. Field and erection dimensions clearly identified as such.
2. Arrangement and section views.
3. Relation to adjacent materials or structure including complete information for making connections between work under this Contract and work under other contracts.
4. Kinds of materials and finishes.
5. Parts list and descriptions.
6. Assembly drawings of equipment components and accessories showing their respective positions and relationships to the complete equipment package.
7. Where necessary for clarity, identify details by reference to drawing sheet and detail numbers, schedule or room numbers as shown on the Contract Drawings.

E. Drawing to scale, and accurately represent specific products furnished.

1.04 PRODUCT DATA/MANUFACTURERS' LITERATURE

A. Submit electronic copy and 4 original hard copies plus additional copies required for Contractor's use. Designer will retain four copies for distribution to City. Distribute remaining copies.

B. Mark each copy to clearly identify applicable products, models, options, and other data; supplement manufacturers' standard data to provide information unique to the Work.

C. When available, submit "Spec Data" sheets.

D. Include manufacturers' installation instructions.

E. For products specified only by reference standard, give manufacturer's name, product name, model or catalog number, copy of referenced standard, and manufacturer's descriptive technical literature.

1.05 CONTRACTOR-PREPARED SAMPLES

A. Submit 4 original sets of samples plus additional samples as required for Contractor's use. Designer will retain three samples for distribution to City. Distribute remaining samples.

B. Demonstrate functional and visual characteristics of products, complete with integral parts and attachment devices.

C. Submit a reasonable range of manufacturers' standard colors, textures, sheens, and patterns for selection where specific requirements are not specified, where deviations are proposed, and where the nature of the product may vary in color, vein or "grain," texture, sheen and other visible characteristics.

D. Sample characteristics are specified in individual Sections.

E. Size, unless otherwise specified:

1. Paint and Liquid Coated Products: 8-1/2 x 11 inches; tape edges of samples using gypsum board as the base or substrate.
2. Flat or Sheet Products: 8-1/2 x 11 inches.
3. Linear Products: 11 inches long.
4. Bulk Products: Copy of container label, only where label submittal is specified.

F. Full size or on-site samples or mock-ups may be used in the Work if approved.

1.06 CONTROL SAMPLES

A. Certain Base Facility construction establishes performance, product, workmanship, or aesthetic quality requirements for this contract.

B. Required control samples include, but are not limited to, the following:

1. Paint and other applied coatings at sight-exposed surfaces ~~in public spaces~~, regardless of substrate types; for matching compatibility, color, texture, sheen, reflectivity, and other visual and performance characteristics of analogous new work.
2. Reflective Media (Glass Bead), submitted prior to its use, to verify the quality of the materials and to ensure conformance with the applicable specifications. The submitted sample shall include documentation certifying that the material meets the requirements for TT-B-1325D, Type III, as detailed in Specification P-620. 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, as required in Specification P-620.

3. Asphalt binder, submitted prior to and during production, to verify the quality of the materials and ensure conformance with the applicable specifications. The submitted sample shall include certifications showing the appropriate ASTM testes, test results and a statement that the material meets the Specification P-401 requirements.

C. Include control samples with submittal to which they apply.

D. For items transmittable by mail or hand, remove one representative sample, following Section 01312 – Coordination and Meetings, and nondestructively label as "Control Sample." Process following Paragraph 1.06.

E. Obtain control samples following Section 01731 – Cutting and Patching. The control sample will be returned to the Contractor.

F. For items impractical to remove or mail, temporarily and non-destructively tag each item in place and maintain until submittal processing is complete. Request submittal evaluation to occur on-site. Include request with submittal to which it applies.

1. Provide temporary facilities following Section 01505 – Temporary Facilities to provide access to and protection of control samples.
2. Handle, store and protect control samples following Section 01610 – Basic Product Requirements.

G. Maintain control samples until applicable new work is completed or until directed.

1.07 PRODUCT INTERFACE CONTROL DOCUMENTS

A. Following requirements apply where specified in other Sections.

B. Prepare submittal data as required, to indicate proper interface between work of Subcontractors and Separate Contractors, for products of one Section or Contract required to be supported by, or affixed or connected to products of another Section or Contract. Follow Paragraph 1.02 for review and processing requirements.

1. Fully describe mating surfaces between products.
2. Fully describe predecessor and successor staging and sequencing of product fabrications and installations.

C. Field corrections to mating surfaces are not permitted, unless field modification is specified in Sections.

1.08 CERTIFICATIONS AND COMPLIANCE STATEMENTS

A. Submit 4 original copies plus additional copies required for Contractor's use. Designer will retain three copies for distribution to City. Distribute remaining copies. Include original signature and applicable original seal(s) on each copy.

B. Certifications may be in the form of recent test results, research reports, reference data, or affidavits, as applicable to certifications required.

1.9 SUBMITTAL LOG

A. If approved, submittal log may be incorporated into submittal schedules following Section 01325 – Construction Schedules.

B. Coordinate shop drawings, samples, product data and certifications schedule in Section 01325 – Construction Schedules. Log submittals showing proposed submittal number, and expected processing period for each.

C. Denote submittals requiring special attention, such as requested shorter review time due to extraordinary conditions. Indicate reasons for special attention.

D. Update and distribute following Sections 01312 – Coordination and Meetings and 01325 – Construction Schedules.

1.10 DESIGNER'S ACTIONS

A. Comments may be added by Designer to submittal data, to inform the Contractor of detected failure of submittal data to follow contract requirements and the design concept expressed therein.

B. Commencing work governed by submittal requirements without proper processing of required submittals is the risk of the Contractor.

1. Cost increases attributable thereto are the sole responsibility of the Contractor without increase in Contract Sum.
2. Time increases attributable thereto are the sole responsibility of the Contractor under provisions of Article 9.13 (Liquidated Damages) in Section 00700 – General Conditions.

C. Responsibility for Contractor's errors and omissions or construction of defective or deficient work remains with the Contractor and is not relieved by Designer's review.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 CONTROL SAMPLES

A. Reinstall control samples following Section 01731 – Cutting and Patching.

END OF SECTION

Section 01 35 13.14

SAFETY AND SECURITY

DESCRIPTION

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

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

FAA AC 150/5370-2, Operational Safety on Airports During Construction, current edition, latest change

FAA AC 150/5200-18, Airport Safety Self-Inspection, current edition, latest change

FAA AC 150/5210-5, Painting, Marking and Lighting of Vehicles Used on an Airport, current edition, latest change

FAA AC 150/5340-1, Standards for Airport Markings, current edition, latest change

FAA AC 150/5370-13, Offpeak Construction of Airports Using Hot-Mix Asphalt, current edition, latest change

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

CONTRACTOR SAFETY AND SECURITY OFFICER

2.01 Contractor Safety and Security Officer (CSSO). The Contractor shall appoint its onsite construction superintendent or other qualified individual(s) as its duly authorized representative to serve as Contractor Safety and Security Officer (CSSO) for the duration of the project. The CSSO shall thoroughly understand the safety and security requirements of the project, the necessity for them and shall have sufficient authority to implement its provisions without significant deviation. The Contractor shall notify the Engineer in writing of the name of the individual(s) selected for the assignment.

The CSSO shall represent the Contractor on safety and security requirements compliance. The CSSO shall be especially knowledgeable regarding the requirements of *AC 150/5200-18* and *AC 150/5370-2*.

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

a. Develop and submit in writing a detailed work sequence schedule with dates and times specified for all milestone events. This sequence schedule shall conform, as a minimum, to the events specified in Section 3.1, Construction Sequence, and shall be subject to the approval of the Engineer and / or Airport Operations. To assure adequate time for coordination, this document shall be submitted at least one (1) week prior to the date of the pre-construction conference.

b. Develop and submit in writing a Safety Plan Compliance Document (SPCD), See the Contract Documents for requirements and guidelines regarding the SPCD. The SPCD shall, as a minimum, be a detailed outline of the procedures to be followed showing how the Contractor will comply with the CSPP. The SPCD shall detail, but not be limited to, how the Contractor plans to maintain safety and security of both Contractor operations and the integrity of airport landside and airside operations during the prosecution of contract work and the procedures to be followed in the event of an emergency or accident. These procedures shall be subject to the approval of the Engineer and / or Airport Operations and reflect any change as may be deemed necessary. To assure adequate time for coordination, this document shall be submitted at least one (1) week prior to the date of the pre-construction conference. The development of the required SPCD shall be considered incidental to the work of this specification.

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

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

CONSTRUCTION SEQUENCING

3.01 Construction Sequence. The Contractor shall prepare a construction schedule and, in accordance with Section 01330 – Submittal Procedures, submit to the Engineer at least one (1) week prior to the pre-construction meeting.

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

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

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

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

MARKING AND LIGHTING

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

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

TRAFFIC CONTROL

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

a. Display a flashing amber (yellow) dome-type light on top of the vehicle and of such intensity to conform to local codes for maintenance and emergency vehicles. A 3 feet x 3 feet or larger, orange and white checkerboard construction safety flag, each checkerboard color being 1-foot, above the vehicle, may be used to supplement the

flashing light or for transient vehicles or those specifically onsite for the day to complete a specific task during daytime operations only. Any vehicle operating in the AOA during the hours of darkness shall be equipped with a flashing amber (yellow) dome-type light.

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

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

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

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

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

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

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

property.

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

5.03 Material Suppliers. All material suppliers, subcontractors and visitors to the work site are obligated to follow the same safety and security operating procedures as the Contractor. All material suppliers shall make their deliveries using the same access points and routes as the Contractor and shall be advised of the appropriate delivery procedures at the time the materials order is placed. The Contractor shall not use the Airport address for any delivery but shall use the street address appropriate to the location of the entrance to the work site. If it is not practical to conform to the vehicle identification requirements of Section 01 35 13.14-5.01 and the safety and security operations program requirements of Section 01 35 13.14-2.02, the Contractor shall be prepared to escort all suppliers, subcontractors and visitors while they are on the airport.

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

GENERAL SAFETY REQUIREMENTS

6.01 All Contractor vehicles that are authorized to operate on the airport outside of the designated construction area limits or haul routes as defined herein shall be vigilant for conflict with any aircraft and give way to any operating aircraft at all times.

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

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

6.02 In order to protect all aircraft traffic, aviation related businesses, terminal apron areas, etc. from potential damage caused by foreign object debris (FOD) generated by construction activities, the contractor shall provide an adequate number of sweepers and vacuum trucks as specified in Section 01 59 01, temporary construction items. Protecting the aircraft, airport tenants, users, public, etc. against FOD is a critical safety issue.

CONSTRUCTION CONTROL

7.01 A primary and alternate responsible Contractor's representative shall be

designated by the Contractor. The Contractor's representatives shall be available locally on a 24-hour basis. Names of the primary and alternate, including phone number, shall be made available to the Engineer and Airport Operations by the Contractor. The Contractor shall insure that the names and phone numbers are kept current and made available to the Engineer and Airport Operations.

CONSTRUCTION TECHNIQUES

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

METHOD OF MEASUREMENT

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

BASIS OF PAYMENT

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

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

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

However, where major non-conformance with the requirements of this Specification is noted by the Engineer and / or Airport Operations, all contract work may be stopped by direct order of the Owner’s representative regardless of whether corrections are made by the Owner as stated above.

Partial payments will be made in accordance with the following schedule:

Percentage of Original Contract Amount Earned	Percent of the Lump Sum Price for the Item
5	15
15	20
25	25
50	50
75	75
100 (or Contract Completion)	100

Payment shall be made under:

Item 01 35 13.14-10.1 Safety and Security - Per Lump Sum

End of Section 01 35 13.14

This page intentionally left blank.

Section 01410

TPDES REQUIREMENTS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Documentation to be prepared and signed by Contractor before conducting construction operations, in accordance with the Texas Commission on Environmental Quality (TCEQ) Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit Number TXR150000, latest issue (the Construction General Permit).

B. Review of the Storm Water Pollution Prevention Plan (SWPPP) implementation in a meeting with Owner's Representative prior to start of construction.

1.02 UNIT PRICES

A. Contractor will complete and submit a Notice of Intent (NOI), including Certificate of Mailing and Proof of Payment on a lump sum basis. Contractor is responsible for pollution prevention implementation, including maintenance, inspections, and reporting for all pollution prevention measures.

1.03 DEFINITIONS

A. Commencement of Construction Activities: The exposure of soil resulting from activities such as clearing, grading, and excavating.

B. Large Construction Activity: Project that:

1. Disturbs 5 acres or more, or
2. Disturbs less than 5 acres but is part of a larger common plan of development that will disturb 5 acres or more of land.

C. Small Construction Activity: Project that:

1. Disturbs 1 or more acres but less than 5 acres, or
2. Disturbs less than 1 acre but is part of a larger common plan of development that will ultimately disturb 1 or more acres but less than 5 acres.

D. TPDES Operator:

1. The person or persons who have day-to-day operational control of the construction activities which are necessary to ensure compliance with

the SWPPP for the site or other Construction General Permit conditions.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 SITE SPECIFIC STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

A. Prepare a SWPPP following Part III of the Construction General Permit and the Storm Water Management Handbook for Construction Activities issued under City Ordinance Section 47-695(b). If conflicts exist between the Construction General Permit and the handbook, the more stringent requirements will apply.

B. The Storm Water Management Contractor, will be responsible for implementation, maintenance inspection, and termination of storm water pollution prevention control measures including, erosion and sediment controls, and storm water management plans. Waste collection and disposal and off-site vehicle tracking, remain the responsibility of the Contractor.

C. The Storm Water Management Contractor will update or revise the SWPPP as needed during the construction following Part III, Section E of the Construction General Permit.

3.02 NOTICE OF INTENT FOR LARGE CONSTRUCTION ACTIVITY

A. Fill out, sign, and date TCEQ Form 20022, Notice of Intent (NOI), for Storm Water Discharges Associated with Construction Activity under the TPDES Construction General Permit (TXR150000), **ATTACHMENT 1** of this Section 01410:

1. http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwiII9_R9u3JAhVLJiYKHTbNAbwQFggcMAA&url=http%3A%2F%2Fwww.tceq.state.tx.us%2Fassets%2Fpublic%2Fpermitting%2Fwaterquality%2Fforms%2F20022.pdf&usg=AFQjCNFLAdX7XHD5PNYS63cueBHMvjBHjQ&bvm=bv.110151844,d.eWE

B. Submit the Notice of Intent by one of the following methods:

1. Submit online at TCEQ ePermits (www6.tceq.state.tx.us/steers) and pay the application fee. Transmit a copy of the electronic certificate provided by TCEQ to Owner's Representative.
2. Send a ~~$325 check and~~ completed TCEQ Form 20022 and appropriate fees to the Texas Commission on Environmental Quality. Transmit a copy of the check and completed form to Owner's Representative.

C. Owner's Representative will complete a separate Owner's copy of TCEQ Form 20022 for NOI. Owner will submit Notice, along with application fee, to the TCEQ.

D. Submission of the Notice of Intent form by Contractor to TCEQ is required a minimum of seven (7) days before Commencement of Construction Activities.

3.03 CONSTRUCTION SITE NOTICE FOR SMALL CONSTRUCTION ACTIVITY

A. Fill out, sign, and date the Construction Site Notice, Attachment 2 to TPDES General Permit TXR150000, "Construction Site Notice," **ATTACHMENT 2** of this Section 01410.

B. Transmit the signed Construction Site Notice to Owner's Representative at least seven (7) days prior to Commencement of Construction Activity.

3.04 CERTIFICATION REQUIREMENTS

A. Fill out TPDES Operator's Information form, **ATTACHMENT 3** of this Section 01410, including Contractor's name, address, and telephone number and the names of persons or firms responsible for maintenance and inspection of erosion and sediment control measures. Use multiple copies as required to document full information.

B. Contractor and Subcontractors shall sign and date the Contactor's / Subcontractor's Certification for TPDES Permitting, **ATTACHMENT 4** of this Section 01410. Include this certification with other Project certification forms.

C. Submit properly completed certification forms to Owner's Representative for review before beginning construction operations.

D. Conduct inspections in accordance with TCEQ requirements. Ensure persons or firms responsible for maintenance and inspection of erosion and sediment control measures read, fill out, sign, and date the Erosion Control Contractor's Certification for Inspection and Maintenance. Use the EPA NPDES Construction Inspection Form, **ATTACHMENT 5** of this Section 01410; and the City of Houston Storm Water Pollution Prevention Plan Construction Site Inspection Report, **ATTACHMENT 6** of this Section 01410 to record maintenance inspections and repairs.

3.05 RETENTION OF RECORDS

Keep a copy of this document and the SWPPP in a readily accessible location at the construction site from Commencement of Construction Activity until submission of the Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity under TPDES Construction General Permit (TXR150000). Contractors with day-to-day operational control over

SWPPP implementation shall have a copy of the SWPPP available at a central location, on-site, for the use of all operators and those identified as having responsibilities under the SWPPP. Upon submission of the NOT, submit all required forms and a copy of the SWPPP with all revisions to Project Manager.

3.06 REQUIRED NOTICES

Post the following notices from the effective date of the SWPPP until the date of final site stabilization as defined in the Construction General Permit:

1. Post the TPDES permit number for Large Construction Activity, or a signed TCEQ Construction Site Notice for Small Construction Activity. Signed copies of the Contractor's NOI must also be posted.
2. Post notices near the main entrance of the construction site in a prominent place for public viewing. Post name and telephone number of Contractor's local contact person, brief project description and location of the SWPPP.

    a. If posting near a main entrance is not feasible due to safety concerns, coordinate posting of notice with Owner's Representative to conform to requirements of the Construction General Permit.
    b. If Project is a linear construction project (e.g., road, utilities, etc.), post notice in a publicly accessible location near active construction. Move notice as necessary.

3. Post a notice to equipment and vehicles operators, instructing them to stop, check, and clean tires of debris and mud before driving onto traffic lanes. Post at each stabilized construction exit area.
4. Post a notice of waste disposal procedures in a readily visible location on site.

3.07 ON-SITE WASTE MATERIAL STORAGE

A. On-site waste material storage shall be self-contained and shall satisfy appropriate local, state, and federal rules and regulations.

B. Prepare list of waste material to be stored on-site. Update list as necessary to include up-to-date information. Keep a copy of updated list with the SWPPP.

C. Prepare description of controls to reduce pollutants generate from on-site storage. Include storage practices necessary to minimize exposure of materials to storm water, and spill prevention and response measures consistent with best management practices. Keep a copy of the description with the SWPPP.

3.08 NOTICE OF TERMINATION

A. Submit a NOT, **ATTACHMENT 7** of this Section 01410, to Project Manager within 30 days after:

1. Final stabilization has been achieved on all portions of the site that are the responsibility of the Contractor; or
2. Another operator has assumed control over all areas of the site that have not been stabilized; and
3. All silt fences and other temporary erosion controls have either been removed scheduled to be removed as defined in the SWPPP, or transferred to a new operator, if the new operator has sought permit coverage.
4. http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwj87fnU-e3JAhXG2B4KHZwxDu0QFggcMAA&url=http%3A%2F%2Fwww.tceq.state.tx.us%2Fassets%2Fpublic%2Fpermitting%2Fwaterquality%2Fforms%2F20023.pdf&usg=AFQjCNEw3swKhMy7DdMzmz5SolDlU7UI9Q&bvm=bv.110151844,d.dmo

B. Contractor is responsible for Contractor's notices to the TCEQ and MS4 entities.

C. Project Manager will complete City's NOT and submit Contractor and City's notices to the TCEQ and MS4 entities.

3.09 MEASUREMENT AND PAYMENT

A. Payment for TPDES Requirements shall be made at the contract lump sum price. This price shall include all labor, material, equipment, permitting, and incidentals necessary to complete this item. A prorated portion of the lump sum shall be paid on a monthly basis determined by the total lump sum amount divided by the number of months of actual contract duration.

ATTACHMENT 1

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwiIl9_R9u3JAhVLJiYKHTbNAbwQFggcMAA&url=http%3A%2F%2Fwww.tceq.state.tx.us%2Fassets%2Fpublic%2Fpermitting%2Fwaterquality%2Fforms%2F20022.pdf&usg=AFQjCNFLAdX7XHD5PNYS63cueBHMvjBHjQ&bvm=bv.110151844,d.eWE

ATTACHMENT 2

CONSTRUCTION SITE NOTICE
FOR THE
Texas Commission on Environmental Quality (TCEQ)
Storm Water Program
TPDES GENERAL PERMIT TXR150000

The following information is posted in compliance with **Part II.D.2** of the TCEQ General Permit Number TXR150000 for discharges of storm water runoff from construction sites. Additional information regarding the TCEQ storm water permit program may be found on the internet at:

http://www.tceq.state.tx.us/permitting/water_quality/stormwater/TXR15_AIR.html

Contact Name and Phone Number:	
Project Description: (Physical address or description of the site's location, estimated start date and projected end date, or date that disturbed soils will be stabilized)	
Location of Storm Water Pollution Prevention Plan :	

For Construction Sites Authorized Under Part II.D.2. (Obtaining Authorization to Discharge) the following certification must be completed:

I _____ (Typed or Printed Name Person Completing This Certification) certify under penalty of law that I have read and understand the eligibility requirements for claiming an authorization under Part II.D.2. of TPDES General Permit TXR150000 and agree to comply with the terms of this permit. A storm water pollution prevention plan has been developed and implemented according to permit requirements. A copy of this signed notice is supplied to the operator of the MS4 if discharges enter an MS4 system. I am aware there are significant penalties for providing false information or for conducting unauthorized discharges, including the possibility of fine and imprisonment for knowing violations.

_____ _____
Signature and Title Date

ATTACHMENT 3

TPDES OPERATOR'S INFORMATION

Owner's Name and Address :

_____

Telephone: _____

Contractor's Names and Addresses:

General Contractor: _____

Telephone: _____

Site Superintendent: _____

Telephone: _____

Erosion Control and Maintenance Inspection: _____

Telephone: _____

Subcontractor's Names and Addresses:

_____ _____

Phone: _____ Phone: _____

Note: Insert name, address, and telephone number of persons or firms.

ATTACHMENT 4

CONTRACTOR'S / SUBCONTRACTOR'S

CERTIFICATION FOR TPDES PERMITTING

I certify under penalty of law that I understand the terms and conditions of TPDES General Permit No. TXR150000 and the Storm Water Pollution Prevention Plan for the construction site identified as part of this certification.

Signature: _____

Name: (printed or typed) _____

Title: _____

Company: _____

Address: _____

Date: _____

Signature: _____

Name: (printed or typed) _____

Title: _____

Company: _____

Address: _____

Date: _____

Signature: _____

Name: (printed or typed) _____

Title: _____

Company: _____

Address: _____

Date: _____

ATTACHMENT 5

Revision 4, March 1, 2000

EPA NPDES Construction Inspection Form

The following inspection is being performed in compliance with Part IV.D.4. of the NPDES Region 6 Storm Water Construction General Permit [63 Fed. Reg. 36502] and being retained in accordance with Part V of the Permit. Qualified personnel (provided by the permittee or cooperatively by multiple permittees) shall inspect disturbed areas of the construction site that have not been finally stabilized, areas used for storage of materials that are exposed to precipitation, placement and effectiveness of structural control measures, and locations where vehicles enter or exit the site. Inspections shall be performed at least once every 14 days and within 24 hours of the end of a storm event of 0.5 inches or greater. Where sites have been temporarily stabilized, runoff is unlikely due to winter conditions, or during seasonal arid periods in arid areas (0-10 inches of rainfall annually) and semi-arid areas (10-20 inches annually) such inspections shall be conducted at least once every month. This form is primarily intended for use with construction projects in Texas and New Mexico. Permittees on Indian Country lands in Oklahoma, Louisiana and Arkansas and some oil and gas facilities in Oklahoma may use this form if they are eligible for this permit. Other facilities need to check with their NPDES authority before using this form.

If you do not know your NPDES Permit Number, contact the NOI Processing Center at (301)495-4145. This form was prepared as an example and it is not a required form for use with the permit. Alternative forms may be used if they contain all of the required information as set forth in the permit. This form and additional information regarding the NPDES Region 6 storm water program may be found on the Internet at http://www.epa.gov/region6/sw/. Any person with a complaint about the operation of this facility in regards to this permit should contact EPA Region 6 at (214)665-7112.

Permit Number(s) covered by this inspection (e.g. owners, developers, general contractor, builders)	
Signature and Certification in accordance with Part VI.G of the permit:	I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. Signature_____ Date_____
Date of Inspection	
Inspector Name	
Is there a copy of the permit language with the SWPPP?	❒ YES ❒ NO
Is the inspector qualified and are the qualifications documented in the SWPPP?	❒ YES ❒ NO
Is an NPDES storm water construction sign posted at the entrance for all permittees?	❒ YES ❒ NO

You may want to use EPA Region 6 construction checklist to assure components of the SWPPP are complete. This form, the construction sign, and the checklist are available on the Region 6 NPDES Storm Water Forms and Documents web page which may be found on the internet at http://www.epa.gov/earth1r6/6en/w/formsw.htm In addition to the checklist, you should provide a narrative (see next page) on the existing Best Management Practices and Structural Controls found during each inspection. Any problems identified in an inspection should be corrected within 7 days. The inspection should cover all components of the SWPPP and all potential pollutants. While eroded soil is the primary pollutant of concern, do not forget to inspect for other pollutant sources such as fuel tanks, paints, solvents, stabilization materials, concrete hardner, batch plants, and construction debris. The inspector will need to update the SWPPP to reflect findings of the inspection. The site map should be updated after an inspection to show controls that have been added or removed, to ensure the site map is kept current in accordance with Part IV.C. of the permit.

ATTACHMENT 5

Narrative Findings of the inspection:

Observations should include any findings of Best Management Practices or controls that are not in accordance with the SWPPP. If a control is not in place or failed, observe the reason why. A control removed temporarily for work is not necessarily a violation if properly recorded in the SWPPP. If it has been removed, record why it was removed and, if applicable, when it will be reinstalled. If the control has failed, observe the conditions so a conclusion may be made as to wether the control failed for improper maintenance or improper design. The qualified inspector will know when a failed control is inadequate and should be replaced by an improved control mechanism. Qualified inspectors are to have authority to make changes to the SWPPP to assure compliance. Controls that have not been installed should be given a reason why they are not installed and/or a scheduled date for installation if they are designed for a later phase of construction. After the inspection, the SWPPP and its site map should be updated to reflect current conditions of controls and Best Management Practices at the time of the inspection. This includes removing uninstalled controls from the site map or otherwise denoting on the site map if they are no longer installed if the controls have been removed because they are no longer necessary (e.g. stabilization has been achieved in that area).

Revision 4, March 1 , 2000

ATTACHMENT 6

City of Houston

Storm Water Pollution Prevention Plan
Construction Site Inspection Report

TPDES/EPA Permit Number _____
COH Storm Water Quality Permit Number _____
DATE _____

☐ No exceptions noted.

The following must be corrected prior to continuing work:

☐ Public Notice improperly posted
☐ Initial Construction Site Inspection Report information requires updating
☐ Copy of NOI not on site
☐ Storm water pollution prevention plan not on site
☐ Erosion and sediment controls improperly installed
☐ Erosion and sediment control devices improperly maintained
☐ Fueling or washout areas not properly protected
☐ Portocan or other sanitary facilities not properly protected
☐ Self-inspection and maintenance records incomplete
☐ Sediment from site outside area of construction
☐ Other (see description below)

_____

_____

Please contact the Storm Water Quality Engineer at
611 Walker, RA-257, Houston TX 77002
713-837-7116 fax 713-837-0570

Once the above items have been corrected, call to arrange for reinspection. No further inspections for any construction related activity shall be made until the above items have been corrected.

Inspector's Signature	Contractor's Signature
Inspector's Name	Contractor's Name
	☐ not present

Distribution Stormwater Quality Engineer, Code Enforcement, Inspector, Operator
(Operator is Contractor)

Form _____ (10-01-01)

ATTACHMENT 7

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwj87fnU-e3JAhXG2B4KHZwxDu0QFggcMAA&url=http%3A%2F%2Fwww.tceq.state.tx.us%2Fassets%2Fpublic%2Fpermitting%2Fwaterquality%2Fforms%2F20023.pdf&usg=AFQjCNEw3swKhMy7DdMzmz5SolDlU7UI9Q&bvm=bv.110151844,d.dmo

Intentionally Left Blank

Section 01423

REFERENCES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. General quality assurance related to Reference Standards.

B. List of references.

C. List of definitions.

D. List of phrases.

1.02 QUALITY ASSURANCE

A. For work specified by association, trade, or Federal Standards, follow requirements of the standard, except when more rigid requirements are specified or are required by applicable codes or by Contract Documents.

B. Follow reference standard effective on the date stated in Section 00700 – General Conditions.

C. Submit Section 00685 – Request for Information before proceeding if specified reference standards conflict with Contract Documents, or if no standards apply.

1.03 PARTIAL LIST OF REFERENCES

AA Aluminum Association
900 19th St. N.W.
Washington, DC 20006
Ph: 202-862-5100

AASHTO Amer. Assoc. of State Hwy. Officials
444 North Capitol Street, N.W. #249
Washington, DC 20001
Ph: 202-624-5800

ACI American Concrete Institute
P.O. Box 9094
Farmington Hills, MI 48333-9094
Ph: 248-848-3700

AGC Associated General Contractors of America
333 John Carlyle St., #200
Alexandria, VA 22314
Ph: 703-548-3118

AI Asphalt Institute
Research Park Dr.
P.O. Box 14052
Lexington, KY 40512-4052
Ph: 859-288-4960

AITC American Institute of Timber Construction
7012 S. Revere Pkwy, #140
Englewood, CO 80112
Ph: 303-792-9559

AISC American Institute of Steel Construction
1 E. Wacher Dr., #3100
Chicago, IL 60601-2001
Ph: 312-670-2400

AISI American Iron & Steel Institute
1101 17th Street, N.W., #1300
Washington, DC 20036
Ph: 202-452-7100

REFERENCES

ASME American Soc. of Mech. Engrs.
Three Park Ave.
New York, NY 10016-5902
Ph: 212-591-7733

ANSI American Natl. Stds. Institute
25 W. 43rd St., 4 Floor
New York, NY 10036
Ph: 212-642-4900

APA The Engineered Wood Assoc.
7011 So. 19th,
Tacoma, WA 98466
Ph: 253-565-6600

API American Petroleum Institute
1220 L Street, N.W.
Washington, DC 20005-4070
Ph: 202-682-8000

AREA Amer. Railway Engrg. Assoc.
8201 Corporate Dr., #1125
Landover, MD 20785
Ph: 301-459-3200

ASTM American Soc. for Testing & Materials
100 Barr Harbor Dr.,
PO Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9585

AWPA American Wood-Preservers' Association
PO Box 388
Selma, AL 36702-0388
Ph: 334-874-9800

AWS American Welding Society
550 N.W. LeJeune Rd.
Miami, FL 33126
Ph: 800-443-9353

AWWA Amer. Water Works Assoc.
6666 West Quincy Avenue
Denver, CO 80235
Ph: 303-794-7711

BICSI Bldg. Industry Consulting Svc. Intl.
8610 Hidden River Pkwy.
Tampa, FL 33637-1000
Ph: 800-242-7405

COH City of Houston
900 Bagby Street (Box 1562)
Houston, TX 77251-1562
Ph: 713-837-0311

CLFMI Chain Link Fence Mfgrs Inst.
10015 Old Columbia Rd., #B-215
Columbia, MD 21046
Ph: 301-596-2583

CRSI Conc. Reinf. Steel Institute
933 N. Plum Grove Road
Schaumburg, IL 60173-4758
Ph: 847-517-1200

EJMA Expansion Joint Mfgrs. Assoc.
25 N. Broadway
Tarrytown, NY 10591
Ph: 914-332-0040

FS Federal Standardization Documents
Gen. Svcs. Admin. Specifictns. Unit (WFSIS)
7th and D Streets, S.W. #6039
Washington, DC 20407
Ph: 202-472-2205

HAS (City of) Houston Airport System
P.O. Box 60106 (16930 JFK Blvd., 77032)
Houston, TX 77205-0106
Ph: 281-233-3000

HOU William P. Hobby Airport (Airport Manager)
7800 Airport Blvd.
Houston, Texas 77061
Ph: 713-640-3000

IAH George Bush Intercontinental Airport Houston
(Airport Manager)
2800 N. Terminal Road
Houston, TX 77032
Ph: 281-230-3100

ICEA Insulated Cable Engineer Association
P.O. Box 1568
Carrollton, GA 30112

IEEE Institute of Electrical and Electronics Engineers
445 Hoes Lane, or P.O. Box 1331
Piscataway, NJ 08854-1331
Ph: 732-981-0060

MIL Military Specifications (see "FS" for address)

NACE National Association of Corrosion Engineers
440 1st St. N.W.
Washington, DC 20001
Ph: 202-393-6226

NARTE National Association of Radio and Telecommunications Engineers, Inc.
167 Village Street
P.O. Box 678
Medway, MA 02053
Ph: 508-533-8333, 800-896-2783

NEMA National Electrical Manufacturers' Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209
Ph: 703-841-3200

NFPA National Fire Protection Association
1 Batterymarch Park, P.O. Box 9101

Quincy, MA 02169-7471
Ph: 617-770-3000

OSHA Occupational Safety Health Administration
200 Constitution Avenue, NW
Washington, DC 20210
Ph: 866-487-2365

PCA Portland Cement Association
5420 Old Orchard Road
Skokie, IL 60077-1083
Ph: 847-966-6200

PCI Prestressed Concrete Institute
201 North Wacker Drive
Chicago, IL 60606
Ph: 312-786-0300

SDI Steel Deck Institute
P.O. Box 25
Fox River Grove, IL 60021
Ph: 847-458-4647

SSPC The Society for Protective Coatings
40 24th Street, 6th Floor
Pittsburgh, PA 15222-4656
Ph: 412-281-2331

TAC Texas Admin. Code,
Texas Water Development Board
Box 13231, Capitol Station
Austin, TX 78711-3231
Ph: 512-463-7926

UL Underwriters' Laboratories, Inc.
333 Pfingston Road
Northbrook, IL 60062-2096
Ph: 877- 854-3577, 800-285-4476

UNI-BELL UNI-BELL Pipe Association
2655 Villa Creek Dr., Suite 155
Dallas, TX 75234
Ph: 972-243-3902

1.04 PARTIAL LIST OF DEFINITIONS

Airport: Area of land or water used or intended to be used for landing and takeoff of aircraft, and includes buildings and facilities. Airports under control of City are certificated by FAA under FAR Part 139, and operate under specific safety requirements applicable to maintenance and construction activities.

Airport Manager: Individual delegated by Director of Department of Aviation, with absolute responsibility and authority for overall airport operation and compliance with FAR Part 139. Airport Manager shall communicate with Contractor through City Engineer except in case of emergency when City Engineer is not present. The Airport Manager may delegate responsibilities to other persons, such as airport electricians to coordinate lockouts/tagouts.

Air Operations Area (AOA): Any area of Airport used or intended to be used for landing, takeoff, or surface maneuvering of aircraft, including paved or unpaved areas used or intended to be used for unobstructed movement of aircraft in addition to associated runway, taxiway, or apron. The AOA includes any adjacent areas (such as general aviation areas) that are not separated by adequate security systems, measures, or procedures.

Airport Security Officers: 1) Uniformed City of Houston Police (HPD) officers enforcing airport regulations and apprehension of unauthorized personnel in security areas; 2) Non-uniformed federal or local government personnel authorized to test for compliance with existing regulations.

Air Traffic Control Tower (ATCT): Person responsible for positive control of aircraft and vehicle traffic, including Contractor's, on and around runways, taxiways, and aprons.

Base Facility: Existing structure upon and within which the Work is constructed. "Existing construction" and "existing" mean the same as Base Facility.

1. By way of general description, Base Facility includes sidewalks and pavement; foundations; superstructure columns, beams and floors; exterior and interior walls, partitions and doors; mechanical and electrical systems; conveying systems; interior finish materials.

    a. Underground structures include: sewer, water, gas, fuel and other piping, and manholes, chambers, electrical and signal conduits, ducts, tunnels, manholes and other means of access, foundations and below-ground extensions of surface structures and other existing subsurface Work located within or adjacent to the limits of the Work.
    b. Surface structures include: existing buildings, tanks, masts and poles, navigational aids, walls, bridges, roads, dams, channels, open drainage, piping, wires, posts, signs, markers, curbs, walks, pavements and surfaces for wheeled vehicles (including aircraft), guard cables, fencing, lighting and similar constructs above the ground surface or visible without excavation, demolition or cutting.

DOT: Acronym for U.S. Department of Transportation.

Emergency Medical Service: Operational division of Houston Fire Department.
Emergency Vehicles: ARFF, HPD and EMS vehicles operating in emergency mode

Federal Aviation Administration (FAA): Agency of U.S. Department of Transportation. FAA also means FAA's Administrator or Administrator's duly authorized representative.

Ground Support Equipment (GSE): Mobile and stationary vehicles and equipment for servicing aircraft.

Navigation Aids (NAVAIDS): Equipment used to locate aircraft and direct movement while airborne.

Public areas: Areas where no accessibility restrictions are imposed, generally including roadways, streets, parking lots and structures, and building interiors up to but not including baggage and passenger checkpoints at concourses.

Secured Area: Any portion of the airport where aircraft operators (and foreign air carriers that have a security program under part 1544 or 1546) enplane and deplane passengers, sort and load baggage, and any adjacent areas not separated by adequate security measures.

Security Areas, Security Identification Areas (SIDAs): 1.) AOA; 2) Secured Areas: Exterior or interior areas the access to which is controlled by authorized

security personnel or by keyed or electronic locks, and which may have posted notice of restricted access.

Traffic Activity: In-the-air or on-the-ground aircraft and emergency vehicle activity that, determined by ATCT, Airport Manager or City Engineer because of safety reasons, prohibits the start, continuation or completion of construction operations.

Transportation Security Administration (TSA): Agency of U.S. Department of Transportation charged with implementing and enforcing federal airport security rules and regulations. TSA also means TSA's Undersecretary or the Undersecretary 's duly authorized representative(s).

TSR: an acronym for Transportation Security Regulation.

1.05 PARTIAL LIST OF PHRASES

A. Read "includes" and "including" as having the phrase "but not necessarily limited to" immediately following the words, if not otherwise written out.

B. "Required" means products, labor and services provided by the Contractor to properly complete the Work following the Contract Documents and the design concept expressed therein, such required work being determined and governed by field or shop conditions.

1.06 PARTIAL LIST OF ABBREVIATIONS AND ACRONYMS

A. Following abbreviations and acronyms may appear on Drawings and in other Sections:

1. *CFP:* City-furnished product(s).
2. *CSP:* Contractor-salvaged product(s).
3. *NIC or N.I.C.:* Not in contract.
4. *NOTAM: Notice to Airman.*
5. *PDC:* Department of Aviation Planning Design Construction Group.
6. *RFI:* Request for Information/Clarification.
7. *RFP:* Request for Proposal.
8. *WCD:* Work Change Directive.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01450

CONTRACTOR'S QUALITY CONTROL

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. General requirements for Contractor's quality control services.

B. Contractor's responsibilities related to City's testing are specified in Section 01455 – City's Acceptance Testing.

1.02 GENERAL

A. Maintain source and on-site quality control over suppliers, manufacturers, products, services, site conditions, quality assurance programs, and workmanship, to provide work of required quality at no additional cost to the City.

B. Follow manufacturers' installation instructions, including each step in sequence.

C. Request clarification from City Engineer before proceeding should manufacturers' instructions conflict with Contract Documents.

D. Follow specified standards as minimum requirements for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform work by persons qualified to produce the specified level of workmanship.

F. Observe, inspect, collect samples and test samples of the Work as it progresses and as required for compliance with Section 00700 – General Conditions, Paragraph 3.2.

1. At Contractor's discretion, retain a testing laboratory to supplement manufacturers' own product testing programs, except do not retain the same testing laboratory retained by City under Section 01455 – City's Acceptance Testing.
2. Additional responsibilities of Contractor related to testing are specified in Section 01455 – City's Acceptance Testing.

1.03 CONTRACTOR'S QUALITY ASSURANCE PROGRAM (QAP)

A. Implement and maintain a QAP of inspection, sampling, testing, and observation and test results reporting for the Work, applicable to product source, fabrication, mixing, and through final installation, to provide proper work.

B. Submit required submittals and requests for information (RFIs) into the HAS's web-based application, Microsoft SharePoint. Access to the SharePoint portal and required training will be coordinated through the Project Manager. Submit Contractor's Quality Assurance Program (QAP), following Section 01340 – Shop Drawings, Product Data and Samples, with following minimum information:

1. Organization chart indicating Contractor's QAP personnel.
2. Inspection, Sampling and Testing Matrix / Schedule: Overlaid with requirements of Section 01325 – Construction Schedules and Section 01455 – City's Acceptance Testing.
3. Sample QAP reporting forms.
4. Procedures for action to correct defective work.
5. Procedures to implement and manage the QAP.
6. Submit one copy of Contractor's written QAP Inspection , Test, and Daily Reports to City and one copy to ITL, on a daily basis, indicating:
   a. Project Name, Number, CIP Number.
   b. Date/time of inspection/sampling/test, and quantity of product involved.
   c. Product or installation batch, mill number, or production run number, and method used to assure statistically based random sampling following ASTM D3665.
   d. Environmental conditions where applicable to results.
   e. Name and signature of observer or tester, certifying as follows:
      "The above work was inspected/sampled and tested in the manner described, and the result(s) are hereby certified by the undersigned as complete and accurate."
   f. Product or installation inspected, by Section number, and location of inspection (such as product source, fabrication shop, or on site), and quantity of product tested.
   g. Location in the Work, by Drawing/detail number, floor number, range/station number, or other specific identifier traceable to the Drawings.
   h. Type of inspection or test (such as visual; non-destructive X-ray), and type of test by referenced standard test number.
   i. Type of inspection, sample or test products used.
   j. Performance standard required.
   k. Factual evidence and results of inspections, measurements or tests stated as "pass" or "fail."
   l. Factual evidence and record of observations and tests. Include nature and type of failure, and comments as applicable.

C. Contractor's QAP Personnel for Sitework:

1. Quality Control Manager: Sole responsibility for management, implementation and control of the QAP; an employee of Contractor and specialist in type of applicable construction. If not an officer of firm, this person shall report to an officer.

a. Duties and Responsibilities: Plan, organize, staff, direct and control the QC Program; supervise QCTs (below); collate and review detail reports of QC activities for accuracy and completeness before publication, and prepare factual summary reports. The QCM may work projects other than this project, except QCM shall be present at times of sampling, testing or observation, within 2 hours of notice.

b. Demonstrated experience in paving construction and quality assurance compliance equivalent in scope and complexity to work of this contract, plus one of the following minimums:
   1) Registered civil engineer, with 1 year above experience.
   2) Engineer-in-Training, with 2 years above experience.
   3) Graduate Bachelor of Science degree in Civil Engineering, Civil Engineering Technology or Construction, with 3 years above experience.
   4) National Institute for Certification in Engineering Technologies (NICET), Level III, certified Construction Materials Technician, Highway Materials Technician, or Highway Construction Technician, with 4 years above experience.
   5) NICET-certified Civil Engineering Technician, with 5 years above experience, and approved by the City Engineer.

2. Quality Control Technicians (QCT): Responsibility for processing this QC Program; report to the QCM.

   a. Duties and Responsibilities: Inspect work, collect samples, take measurements, test work, collate test and measurement data, and prepare factual, accurate and complete reports. Use as many QCTs as required. QCTs may be Contractor's employees or personnel of a qualified ITL subcontracted to the Contractor, except do not use City's ITL to fulfill Contractor's testing requirements.
   b. Demonstrated experience in same construction as QCM, and quality assurance compliance equivalent in scope and complexity to work of this contract, plus one of the following minimums:
      1) Engineer or Engineering Technician, with 1 year above experience.
      2) NICET Level II or higher certification as Construction Materials Technician, Highway Materials Technician, or Highway Construction Technician, with 2 years above experience.
3. Equivalent certifications by authorities other than NICET may be substituted following Section 01630 – Product Options and Substitutions.

D. Contractor's QAP Personnel for Buildings:

1. Quality Control Manager: Sole responsibility for management, implementation and control of the QAP; an employee of the Contractor and

specialist in type of applicable construction. If not an officer of firm, this person shall report to an officer.

a. Duties and Responsibilities: Plan, organize, staff, direct and control the QC Program; supervise QCT staff (below); collate and review detail reports of QC activities for accuracy and completeness before publication, and prepare factual summary reports. The QCM may work projects other than this project, except QCM shall be present at times of sampling, testing or observation, within 2 hours of notice.

b. Demonstrated experience in building Structural construction and quality assurance compliance equivalent in scope and complexity to work of this contract, plus one of the following minimums:
   1) Registered structural engineer, with 1 year above experience.
   2) Engineer-in-Training, with 2 years above experience.
   3) Graduate Bachelor of Science degree in structural engineering, with 3 years above experience.

2. Quality Control Technicians (QCT): Responsibility for processing QAP; report to the QCM.

   a. Duties and Responsibilities: Inspect work, collect samples, take measurements, test work, collate test and measurement data, and prepare factual, accurate and complete reports. Use as many QCTs as required. QCTs may be Contractor's employees or personnel of a qualified ITL subcontracted to the Contractor, except do not use City's ITL to fulfill Contractor's testing requirements.

   b. Engineer or Engineering Technician, with minimum 1 year demonstrated experience in same construction as QCM, and quality assurance compliance equivalent in scope and complexity to work of this contract.

E. Contractor's QAP shall also meet the requirements of Section 00701 – FAA AC 150 5370-10G General Provisions. In the case of conflict, this Section 01450 shall govern.

1.04 REFERENCES

A. Obtain copies of referenced standards and maintain at site when required by other Sections.

1.04 MANUFACTURER'S FIELD SERVICES

A. When specified in other Sections or when conditions are required to maintain schedule, cost or quality control, provide services of properly qualified manufacturer's or supplier's technical representative(s) to observe field conditions, conditions of substrates and installation, quality of workmanship, startup, testing, adjusting, balancing, demonstration and City-personnel training as required.

B. Within 14 days of observation, submit a written report to City Engineer, prepared by manufacturer's representative, documenting their observations, supplementary instructions and instructions at variance with manufacturer's written instructions, and, where applicable, recommendations for corrective action. Costs and time for corrective action is Contractor's responsibility, without increase in Contract Sum or Time.

1.05 SUBCONTRACTS

A. Coordinate work of subcontractors. Inform subcontractors of relation of their work to that of other subcontractors and Separate Contractors and direct scheduling of work to prevent conflicts or interferences.

B. Employ subcontractors with documented proof of proper completion of two projects during the past 3 years of work similar in scope, type and quality as that required for this contract.

1.06 EXAMINATION AND PREPARATORY WORK

A. Carefully examine substrates whether Base Facility or provided as part of the Work before commencing work applied to or accommodated by substrates. Proceed after unsatisfactory conditions are corrected, and after substrate work is properly prepared and complete.

B. Take field dimension and establish and maintain lines, dimensions, and benchmarks as required to control proper fabrication and installation of work.

C. Do not proceed with affected work until unsatisfactory site conditions and substrates are correct.

1. Make written notification of scope and type of corrections required of separate contracts.

D. Repair remaining substrates following Section 01731 – Cutting and Patching.

1.07 CONTRACTOR'S TESTING

A. Follow Section 00700 – General Conditions, Paragraph 3.9.2, and this Section 01450.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 INSPECTIONS BY BUILDING OFFICIALS AND OTHER AGENCIES

A. Immediately notify City Engineer of the date of inspections by governing authorities, in order for City Engineer to attend.

END OF SECTION

Section 01455

CITY'S ACCEPTANCE TESTING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. City will retain an Independent Testing Laboratory (ITL) for following services:

1. Collect product samples at source, site of fabrication, or project site as required by referenced test procedure, as specified herein or in other Sections.
2. Test product samples at source, site of fabrication, project site or in ITL's laboratory as required by referenced test procedure, as specified herein or in other Sections.
3. Inspect execution of work at source, site of fabrication, or project site, as applicable, as specified herein or in other Sections.
4. Record and distribute observations of work during inspections, indicating "pass" or "fail."
5. Record and distribute results of tests, indicating "pass" or "fail."
6. ITL does not have authority to:
   a. Release, revoke, alter, or enlarge requirements of Contract Documents.
   b. Approve or accept work.
   c. Assume duties of Contractor.
   d. Stop the Work or a part thereof.

B. Where requirements for acceptance testing appear in other Sections, without reference to this Section 01455, inspect and test that work following requirements in those Sections and this Section 01455.

1.02 CONTRACTOR'S RESPONSIBILITIES

A. Notify City Engineer, ITL and Designer minimum 24 hours prior to expected time for inspections or sample collections. Schedule ITL's, City Engineer's, and Designer's presence for timely inspections, observations, and sample collection without delay to the Work.

B. Provide access to the Work and cooperate with ITL for inspection and sample collection.

C. Furnish samples of manufactured products to ITL for inspection and testing.

D. Provide incidental labor, products, services and facilities for sample collection and for transportation and handling of samples to ITL's vehicle or to ITL's on-site test facility.

E. Reimburse City by Modification (Section 01255 – Modification Procedures) for costs of retesting previously "failed" work, including time expended by City's personnel related thereto.

F. Time delays and costs resulting from ill-timed QC work are the Contractor's responsibility, without increase in Contract Time or Price.

G. Follow Section 00700 – General Conditions, Paragraph 3.2, and Section 01450 – Contractor's Quality Control.

H. Perform work following requirements of Contract Documents.

I. Read reports of failed tests or measurements. Implement corrective actions to prevent defective work from proceeding farther.

J. Stop affected work when corrective action fails to bring work to required standards.

K. Remove defective work following Section 01731 – Cutting and Patching and replace with proper work.

L. Inspect, sample and test Base Facility (Section 01726 – Base Facility Survey) as required to determine and confirm acceptability of existing construction as substrate for new construction.

M. If Contractor employs a testing laboratory, follow ASTM D3740 and ASTM E329, plus other test standards specified in other Sections.

N. Provide QAP following Section 01450 – Contractor's Quality Control.

O. Not Used.

P. Contractor shall not:
   1. Employ for Contractor's quality assurance testing the same ITL employed by the City for this Project.
   2. Retain possession of ITL's samples.

1.03 SUBMITTALS BY ITL

A. Submit 3 copies of following to City:

   1. Written certification of compliance with following:
      a. ASTM D3740 – Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
      b. ASTM E329 – Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in

Construction.

2. Copy of latest inspection report by Materials Reference Laboratory/ National Bureau of Standards (NBS) or inspection traceable thereto, with statement of remedies of deficiencies.
3. Invoice for retesting previously "failed" work.

B. Submit 5 copies of following, 3 to City, 2 to Contractor. Immediately transmit "fail" reports by facsimile directly to City and to Contractor.

1. Project Name, Number, CIP Number, AIP Number.
2. Identify ITL, Contractor, Subcontractor or Supplier, Section number and name, generic and manufacturer's name of product, numerical sequence when more than one inspection, sample or test of the same product is made, date and time of each inspection, sample collection or test, and applicable Drawing detail number.
3. Date/time of inspection/sampling/test, and quantity of product involved.
4. Product or installation batch, mill number, or production run number, and method used to assure statistically based random sampling following ASTM D3665.
5. Environmental conditions where applicable to results.
6. Name and signature of observer or tester, certifying as follows:

   "The above work was inspected/sampled and tested in the manner described, and the result(s) are hereby certified by the undersigned as complete and accurate."

7. Product or installation inspected, by Section number, and location of inspection (such as product source, fabrication shop, or on site), and quantity of product tested.
8. Location in the Work, by Drawing/detail number, floor number, range/station number, or other specific identifier traceable to the Drawings.
9. Type of inspection or test (such as visual; non-destructive X-ray), and type of test by ASTM or other reference standard test number.
10. Type of inspection, sample or test equipment used.
11. Performance standard required
12. Factual evidence and results of inspections, measurements or tests stated as "pass" or "fail."
13. Factual evidence and record of observations and tests. Include nature and type of failure, and comments as applicable. Furnish graphic or narrative data, or both, indicating nominal requirements and actual test values. Indicate type and numerical value of deviations from specified requirements.
14. For submittals using SI (metric) measure as the ITL's standard, include corresponding Imperial measure conversions. Follow Section 01610 – Basic Product Requirements.

C. Print and distribute copies of records.

D. Transmit reports within 7 days of observations, inspections or test completion, except where shorter processing time is required due to possibility of Contractor continuing installation of "failing" work.

E. For data in the form of drawings:

1. Submit electronic and hard copies, as required, to City Engineer. Submit electronic and hard copies, as required, to Contractor.
2. Sheet Size: 8-1/2 x 11 inches minimum; 22x 34 inches maximum.
3. If CAD is used, prepare documents readable, writable and printable using PC-compatible hardware and software, based on AutoCAD (13 or later versions) or software translated thereto. Provide copy of AutoCAD data disks to City Engineer
4. Prepare drawings by qualified drafters.
5. Draw to scale, and accurately represent products.

F. For statistical records in the form of spreadsheets or graphs:

1. Submit electronic files and hard copies, as required.
2. Sheet Size: 8-1/2 x 11 inches minimum; 11 x 17 inches maximum.
3. Provide copy of data disks to City Engineer at completion of the Work.

PART 2 – PRODUCTS

2.01 SAMPLING AND TEST EQUIPMENT

A. Provide and maintain in proper function sampling and test equipment of type and quantity required, with calibration and accuracy traceable to NBS.

PART 3 – EXECUTION

3.01 GENERAL PROCEDURES

A. Follow requirements of individual Sections.

B. Not Used.

C. Coordinate inspections, sampling and testing with construction progress and Contractor's schedule specified in Section 01325 – Construction Schedules.

D. At least once per shift inspect mixing, fabrication and installation of soil, cementitious and petroleum-based products for proper operation or tolerances. Confirm installers and tool operators are qualified, and tools are properly

functioning.

E. Sample at frequencies following requirements of applicable Sections or as specified herein, and test each sample.

F. Take quantity, linear, volume and bulk measurements as frequently as necessary to control mixing, fabrication and installation.

G. Properly calibrate test equipment and measuring tools before use.

H. Immediately report failed tests or measurements.

I. Test work for proper function and performance as specified herein and in other Sections.

3.02 INSPECTION AND OBSERVATION

A. Inspect work by properly experienced personnel. Observe mixing, fabrication and installation procedures. Record observations.

B. Inspect at frequency indicated, using visual observation and measuring tools appropriate to the work. If not otherwise required in other Sections, inspect product source at the site of origin.

3.03 SAMPLING

A. Unless otherwise indicated in Sections or otherwise required by test standard, randomly collect 3 samples and maintain possession until observation and testing is complete and results documented.

B. Collect and handle samples following test standard.

C. Coordinate operations with Contractor.

3.04 TESTING

A. Test products *in situ* as approved by City Engineer or in laboratory where destructive tests are required, test to product failure. Note factual observations, test results, and measuring equipment setup, typed or legibly handwritten. For graph illustrations, use computerized database or spreadsheets.

B. Store and cure samples following test standards or as required to maintain samples in pristine condition until tested.

C. Test samples for conformance with requirements.

D. Follow test standards specified herein and in other Sections.

E. Not Used.

3.05 SCHEDULE OF INSPECTIONS, SAMPLES AND TESTS

A. Observe mixing, fabrication and installation, and inspect, collect samples and test, as indicated in applicable Sections.

END OF SECTION

Section 01505

TEMPORARY FACILITIES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. General temporary facilities:

1. Utilities and environmental systems.
2. Sanitary facilities.
3. Field office.
4. Storage sheds, buildings and lay-down areas.
5. General-purpose radios.
6. ATCT radios for monitoring ATCT communications.
7. Fire protection.
8. Protection of the Work and property.
9. Interim cleaning.
10. Disposal of trash and debris.
11. All other associated appurtenances and incidentals necessary for completion of the project Work.
12. Also reference Section 01 59 01 – Temporary Construction Items.

B. Temporary facilities for exterior work:

1. Barricades.
2. Hazard lighting.
3. Access roads and parking.
4. Environmental controls.
5. Disposal of excavated material.
6. Control of erosion and water runoff.

~~C. Temporary facilities for interior work:~~

~~1. Barricades and enclosures, including those for accessways and exitways.~~
~~2. Hazard lighting.~~
~~3. Environmental controls.~~
4. Existing electrical power, water, and HVAC are available at interior construction projects for Contractor's use at no charge by City Engineer.

D. Provide temporary product handling facilities and construction aids, such as scaffolds, staging, ladders and stairs, protective railings, hoists, chutes and other facilities, as required for construction operations and to protect persons, property and products. Follow governing agency requirements for scope, type and location if not otherwise specified.

E. Follow Section 01326 – Construction Sequencing and FAA General Provision 105, Mobilization, for mobilization and demobilization requirements.

F. Temporary facilities specified herein are minimum standards. Provide additional facilities as required for proper execution of the Work and to meet responsibilities for protection of persons and property.

G. Properly install temporary facilities.

H. Maintain in proper operating condition until use is no longer required or as otherwise approved.

I. Modify and extend temporary facilities as required by Work progress.

J. Restore existing facilities used temporarily, to specified or original condition following Section 01731 – Cutting and Patching.

K. Provide weather protection and environmental controls as required to prevent damage to remaining Base Facility, the Work, and to other property.

~~L. Follow Section 01___ for other temporary facilities for asbestos abatement and lead-based paint removal. Requirements of [that Section] [those Sections] govern in case of conflicts with requirements of this Section.~~

M. Follow regulatory agency requirements for required temporary facilities not specified herein.

N. Where disposal of spoil and waste products, whether or not they are contaminated, is required under this or other Sections, make legal dispositions off site following governing authorities' requirements, unless on-site disposition is allowed under this or other Sections.

1.02 SUBMITTALS

A. Follow Section 01340 – Shop Drawings, Product Data and Samples. The Contractor shall be required to submit a Safety Plan Compliance Document (SPCD) to the airport describing how the Contractor will comply with the requirements set forth in the Construction Safety and Phasing Plan (CSPP). Reference Section 01506 – Airport Temporary Controls and the associated project CSPP for additional details and requirements.

B. Submit shop drawings and descriptive data showing:

1. Enclosure and barricade construction.
2. Enclosure and barricade layout if different from that shown on Drawings, including for each stage if applicable.

C. Submit preliminary version of ATCT and general-purpose radio procedures with list of ATCT and general-purpose radio operators, general-purpose radio call signs and frequency following Section 01340 – Shop Drawings, Product Data, and Samples. Submit final version following Section 01312 – Coordination and Meetings.

1.03 GENERAL REQUIREMENTS FOR UTILITIES AND ENVIRONMENTAL SYSTEMS

A. Make arrangements with utility service companies for temporary services.

B. Follow rules and regulations of utility service companies or authorities having jurisdiction.

C. Maintain utility service until Substantial Completion, including fuel, power, light, heat, and other utility services necessary for execution, completion, testing, and initial operation of the Work.

D. Follow Section 01312 – Coordination and Meetings for advance notifications and approvals of shutdowns of existing services and systems.

E. Water: Provide water for construction, at Contractor's sole cost and expense except as otherwise required below. Coordinate location and type of temporary water service with and obtain approval from City Engineer.

1. For water obtained direct from water mains or fire hydrants, obtain permit or license from proper authorities, and install temporary meter if applicable.
2. For water obtained downstream from Department of Aviation meter, City will provide water without cost for construction operations. Obtain approval of tap types, locations, and pipe routing. Provide valves and pipe as required.
3. For drinking water for personnel, provide potable water in proper dispensing containers~~, except public drinking fountains close to interior construction projects are available as long as use by Contractor does not impede airport operations or increase airport maintenance~~.

F. Electrical Power: Provide power for lighting, operation of Contractor’s plant or tools, or other uses by Contractor, at Contractor’s sole cost and expense, except as otherwise required below. Coordinate location and type of temporary power service with and obtain approval from City Engineer.

1. For power obtained direct from electric mains, obtain permit or license from proper authorities, and install temporary meter if applicable.
2. For power obtained downstream from Department of Aviation meter, City will provide power, without cost for construction operations, however,

this shall be solely at the discretion of the City Engineer. Tap existing electrical panels and circuits at locations and ampacities approved by City Engineer. Obtain approval of tap types, locations, and conduit/wire routing. Provide switches as required.

3. Provide temporary power service or generators to power construction operations and to power existing facilities during main service shutdowns, and at locations where proper commercial power is not available.

G. Lighting: Provide lighting in construction areas, or other areas used by Contractor, at Contractor's sole cost and expense, except as otherwise required below. Coordinate location and type of temporary light fixtures with and obtain approval from City Engineer.

1. Provide explosion-resistant fixtures in areas where fuel is stored, handled or dispensed.
2. Minimum Lighting Level: 5 foot-candles for open areas; 10-foot-candles for exitways. Provide minimum of one 300W lamp per 20 square feet of work area.

H. Heat and Ventilation: Provide temporary heat and ventilation as required for protection or completion of the Work and to control dust, odors and other environmental contaminants. Provide safe working conditions. Maintain enclosed work areas, including interior work areas, at minimum of 50 degrees F.

1.04 SANITARY FACILITIES

A. Provide one portable self-contained chemical toilet/urinal for each 25 workers for exterior construction projects or construction areas not close to existing public restrooms. Place at reasonably secluded locations outside object free areas conveniently accessible to workers. The Contractor shall provide portable sanitary facilities within the work area for each work period with anticipated or possible "in the box" operations. The Contractor's employees shall not be allowed to cross active pavements during "in the box" operations to access sanitary facilities. Follow regulations of State and local departments of health.

~~1. Public restrooms close to interior construction projects are available as long as use by Contractor does not impede airport operations or increase airport maintenance.~~

B. Enforce use of sanitary facilities.

C. Supply and service temporary sanitary units at least twice per week. Legally dispose of waste off-site.

1.05 CONTRACTOR'S FIELD OFFICE

A. Furnish and maintain portable building(s) for Contractor's field office, located on-site at the Contractor's staging and storage area, as shown on Drawings, or in a place approved by City Engineer. Include furnishings and equipment as required by Contractor for proper construction operations and with following minimums when used by City Engineer or Designer:

1. Structurally sound foundation and superstructure.
2. Completely weathertight with insulated roof and walls.
3. Exterior finish acceptable to City Engineer.
4. Slip-resistant entry ramp sloped 1:12 maximum, with handrail platform (5x5 feet) with mud scraper at door. Supplemental and railings and slip-resistant stairs as required. Follow requirements of Americans with Disabilities Act.
5. Interior finishes acceptable to City Engineer.
6. Screened windows sufficient for light, view, and ventilation.
7. Minimum Parking: 2 all weather hard surfaced parking spaces, all-weather paving, for use by City Engineer and Designer, connected to office by walkway.

B. ~~For projects where interior space becomes available as a result of construction operations, Contractor may, if approved by City Engineer, install field office facilities inside the building, following Paragraphs C, D, E and F below, and then decommission and remove portable-type building(s).~~

C. ~~Field Office Using Existing Interior Facilities:~~

~~1. For interior projects where open unfinished space is available within the contract limits, install non-combustible gypsum drywall and metal or noncombustible (noncom) wood stud partitions with noncom wood doors in metal or noncom wood frames. Provide services, furnishings and office equipment following Paragraphs C, D and E below.~~

~~1. For interior projects where existing built-out office space is available, use such spaces without modification. Provide services, furnishings and office equipment following Paragraphs C, D and E below.~~

D. Minimum Services for Contractor's Field Office:

1. Interior lighting of 50 foot-candles at desktop height.
2. Exterior light at entrance.
3. Automatic HVAC to maintain 65 degrees F in winter, 70 degrees F in summer.
4. Electric power service.
5. Two telephone lines:

a. One for voice, with telephone instrument.
b. One for facsimile, with facsimile instrument.
c. For use by Contractor's personnel and others performing work or services. Pay for cost of local calls. Directly bill applicable parties for cost of long distance, without cost to the contract.

6. Minimum one cellular telephone, in possession of Superintendent at all times.
7. One digital pager per shift supervisor.
8. Base station for general-purpose radios, if radios are used.
9. Chilled drinking water.

a. Existing drinking fountains within the contract limits may be used.

10. Unisex restroom with plumbing facilities and sewers as required, one water closet, one urinal, one lavatory, one mirror. Protect from freezing.

a. Existing toilet facilities within the contract limits may be used for personal hygiene only.

11. Conference table and chairs to accommodate 16 persons.

E. Maintenance for Field Office:

1. Continuous maintenance of office, accessways, and services; clean not less than once per week;
2. Provide soap, paper towels, cleansers, janitorial service and appurtenances;
3. Immediately repair damage, leaks or defective service.

1.05a ENGINEER'S FIELD OFFICE

A. Reference and FAA General Provision 60, Control of Materials, Section 60-05, Engineer's Field Office, for requirements.

1.06 STORAGE SHED, BUILDINGS AND LAY-DOWN AREAS

A. Store products neatly and orderly onsite, arranged to allow inspection, identification and inventory, at locations approved by City Engineer.

B. When lack of or ill-timed environmental control systems could damage products, store in bonded off-site facilities approved by manufacturer, supplier or fabricator.

C. Provide suitable and substantial storage sheds, rooms, covers, or other facilities, for storage of material subject to contamination or damage from other construction operations. Provide environmental control to maintain

products within manufacturers' required limits, when required. Storage of materials not susceptible to weather damage may be on blocks off the ground.

D. Do not overload Base Facility structure. Provide temporary shoring or bracing as required to prevent damage to structures.

1.07. ~~GENERAL-PURPOSE~~ RADIOS

A. Furnish type and number of radios as required by Contractor, for the dedicated purpose of monitoring ATCT communications.

1. The ATCT has sole positive authority over radio transmissions on aircraft control frequencies. The Contractor shall under no circumstances communicate directly with the ATCT.
2. The Contractor shall keep ATCT radios turned on and with radio operators and maintain attention to ground control radio traffic while in the AOA. The Contractor shall keep radios in charging bases when not in use.
3. Obtain ATCT communications protocol and transmission training before preparation of submittal data.

    a. ATCT communication with aircraft takes precedence over other Contractor communications.
    b. Train radio operators in proper procedures, frequently monitor radio communication and counsel his personnel on correct procedures.

4. If communication is lost with ATCT, hold in place, or move to a safe area without crossing active runways, taxiways and aprons and reestablish contact.

B. Furnish type and number of radios as required by Contractor, for the limited purpose of Contractor's internal communications, on FCC-approved frequencies provided those frequencies do not interfere with ATCT communications.

C. Provide proper FCC licenses for operators.

1.08 FIRE PROTECTION

A. Follow fire protection and prevention requirements specified herein and those established by Federal, State, or local governmental agencies.

B. Follow applicable provisions of NFPA Standard No. 241, Safeguarding Building Construction and Demolition Operations.

C. Provide portable fire extinguishers, rated not less than 2A or 5B following NFPA Standard No. 10, Portable Fire Extinguishers, for field office and for every 3000 square feet of floor area of facilities under construction, located within 50 feet maximum from any point in the protection area.

D. Prohibit smoking in hazardous areas. Post suitable warning signs in areas which are continuously or intermittently hazardous.

E. Use metal safety containers for storage and handling of flammable and combustible liquids.

F. Do not store flammable or combustible products inside occupied buildings or near stairways or exits.

G. Maintain clear exits from all points in the Work.

1.09 PROTECTION OF THE WORK AND PROPERTY

A. Take precautions, provide programs, and take actions necessary to protect the Work and public and private property from damage.

B. Prevent damage to existing public and private utilities and systems during construction. Utilities are shown on Drawings at approximate locations, but this information is not warranted as complete or accurate. Give City Engineer at least 48 hours notice before commencing work in the area, for locating the utilities during construction, and for making adjustments or relocation of the utilities when they conflict the Work.

1. Utilize the Utility Coordinating Committee One Call System, telephone number, (713) 223-4567, called 48 hours in advance. The toll free telephone number is 1-800-245-4545, Texas One Call System.
2. Follow Section 01726 – Base Facility Survey, to determine existing utilities and systems.
3. Follow Section 01761 – Protection of Existing Services, to make coordination efforts for each existing Service that requires protection.

C. Provide safe barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, access ways, and hazardous areas. Reference Section 01506 – Airport Temporary Controls and the project Construction Safety and Phasing Plan (CSPP) for additional details and requirements.

D. Obtain written consent from proper parties, before entering or occupying with workers, tools, or products on privately-owned land, except on easements required by the Contract Documents.

E. Assume full responsibility for preservation of public and private property on or adjacent to the site. If direct or indirect damage is done by or on account of any act, omission, neglect, or misconduct in execution of the Work by Contractor, restore by Contractor, at no cost or time increase, to a condition equivalent to or better than that existing before the damage was done.

F. Where work is performed on or adjacent to roadways, rights-of-way, or public places, provide barricades, fences, lights, warning signs, and danger signals sufficient to prevent vehicles from being driven on or into Work under construction.

1. Paint barricades to be visible from sunset to sunrise
2. Install at least one flashing hazard light at each barricade section.
3. Furnish watchmen in sufficient numbers to protect the Work.
4. Other measures for protection of persons or property and protection of the Work.

G. Protect existing trees, shrubs, and plants on or adjacent to the site against unnecessary cutting, breaking or skinning of branches, bark, or roots.

1. Do not store products or park vehicles within drip lines.
2. Install temporary fences or barricades in areas subject to damage from traffic.
3. Water trees and plants to maintain their health during construction operations.
4. Cover exposed roots with burlap and keep continuously wet. Cover exposed roots with earth as soon as possible. Protect root systems from physical damage and damage by erosion, flooding, run-off, or noxious materials contamination.
5. Repair branches or trunks if damaged, prune branches immediately and protect the cut or damaged areas with emulsified asphalt compounded specifically for horticultural use in a manner approved by City Engineer.
6. Remove and replace damaged trees and plants that die or suffer permanent injury. Replace with product of equivalent size and in good health.
7. Coordinate this work with Division 2 requirements for clearing and landscaping.

H. Protection of Existing Structures:

1. Fully sustain and support in place and protect from direct or indirect injury underground and surface structures located within or adjacent to the limits of the Work.

a. Before proceeding with sustaining and supporting work on property of others, satisfy City Engineer that the owner of the property approves the methods and procedures proposed.

2. Do not move or in any way change the property of public utilities or private service corporations without prior written consent of a responsible official of that service or public utility. Representatives of these utilities reserve the right to enter within the limits of the Work for the purpose of maintaining their properties, or of making changes or repairs to their property considered necessary by performance of the Work.

a. Notify the owners and/or operators of utilities and pipelines of the nature of construction operations proposed and the date or dates on which those operations will be performed. When construction operations are required in the immediate vicinity of existing structures, pipelines, or utilities, give minimum 5 working days advance notice. Probe and securely flag locations of underground utilities prior to beginning excavation.

3. Assume all risks attending presence or proximity of existing construction within or adjacent to the limits to the Work including but not limited to damage and expense for direct or indirect injury caused by the Work to existing construction. Immediately repair damage caused, following Section 01731 – Cutting and Patching.

I. Protect installed products to prevent damage from subsequent operations. Remove protection facilities when no longer needed.

1. Control traffic to prevent damage to products and surfaces.
2. Provide coverings to protect products from damage. Cover projections, wall corners, jambs, sills, and off-site of openings in areas used for traffic and for passage of product in subsequent work.

1.10 ACCESS ROADS AND PARKING

A. Follow Section 01575 – Stabilized Construction Exit for construction exits.

B. Provide temporary stable construction roads, walks, and parking areas of a load bearing capacity required during construction connecting to public thoroughfares and for use of emergency vehicles. Design and maintain temporary roads and parking areas for full use in all weather conditions.

1. Locate temporary roads and parking areas as approved by City Engineer.

2. Prevent interference with traffic, City and airport operations on existing roads. Indemnify and save harmless the City from expense caused by Contractor's operations over these roads.
3. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking. If not shown on the Drawings, locate as directed by City Engineer.
4. Minimize use of construction traffic on existing on-site streets and driveways. For tracked vehicles, use street plugs. Do not load paving beyond design capacity.
5. Do not allow heavy vehicles or construction equipment in existing parking areas.
6. Construction personnel may use designated areas of existing parking facilities.
7. Remove temporary roads, walks and parking areas prior to final acceptance. Return to its original condition, unless otherwise required by the Contract Documents.

C. Public, Temporary, and Construction Roads and Ramps:

1. Public Roads: Follow laws and regulations of governing authorities when using public roads. If Contractor's work requires public roads be temporarily impeded or closed, obtain approvals from governing authorities and pay for permits before starting work. Coordinate activities with City Engineer following Section 01312 – Coordination and Meetings.
2. On-Site Roads: Prepare temporary roads, construction roads, ramps, and areas on the site to be accessible for trucking and equipment.
3. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage. Extend and relocate as approved by City Engineer as Work progress requires, provide detours as necessary for unimpeded traffic flow. Maintain 12-foot width access road with turning space between and around combustible materials. Provide and maintain access for fire trucks to fire hydrants free of obstructions.

   a. Do not use limestone for paving.

4. Obtain approval of special requirements covering handling exceptionally large or heavy trucks, cranes, or other heavy equipment. Provide mats or other means, so roadways are not overloaded or otherwise damaged.

D. Submit access road and parking locations to City Engineer for approval.

PART 2 – PRODUCTS

2.01 GENERAL

A. Provide products for temporary construction using equivalent type as required for permanent construction, except "construction grade" quality may be used (such as for wood framing, enclosures and barricades, and construction locks).

B. Where materials for use in this Section are not specified or detailed, propose products in writing and obtain approval from City Engineer before commencing work.

2.02 TEMPORARY EXTERIOR ENCLOSURES AND BARRICADES

A. Provide temporary fencing as required to enclose exterior storage/staging and demolition areas, during on-site operations, chain link fence at remote areas (away from Terminal buildings), and chain link fence with plywood overlay at on-site areas (adjacent to or near Terminal buildings and AOA).

1. Chain Link: Minimum 6 foot high commercial quality galvanized fabric, galvanized steel or minimum 4 x 4 treated wood posts at 8 feet on center maximum, gate frames as required, with barbed wire at top if required by Contractor. For natural earth areas, provided minimum 8-inch diameter by 3-foot deep hole for posts. Fill annular space with pea gravel or crushed stone. For paved areas, provide welded base plate on each post and attach to paving with drill-in or powder actuated fasteners of size and quantity required to resist imposed loads. Provide corner bracing and struts as required to maintain erect fencing and taut fabric. Provide gate locks of Contractor's choice. Provide one set of keys to City Engineer.
2. Plywood Overlay: Exterior grade, minimum 3/4 inch thick, 8 feet high. Tie plywood with wire to public side of chain link fence and gates. Paint exterior (public) face with flat latex-based paint to match "Nevamar Pepperdust" plastic laminate.

B. Barricades In Safety Areas of Taxiways and Aprons at AOA: ~~Preservative-treated wood construction, maximum 3 feet high sawhorse legs at both ends of one 8 inch high top rail, with 45 degree-angled white and orange hashmarks, on 4 by 4 inch wood posts and struts bolted to 12 by 12 inch continuous timber base. Install hazard lights at maximum 6 feet centers and at each end and corners of the barricade. Sandbag wood frame to prevent overturning by jet blast or prop wash.~~ Reference Section 01506 – Temporary Facilities, the project Safety and Phasing Plan (CSPP), Section 01 35 13.14 – Safety and Security and the project plans for details on barricades, barricade use, and requirements for use within the AOA.

~~C. Barricades at Roadways and Outside Safety Areas: Standard 13 foot 6 inch long traffic guard rail type or precast concrete "Jersey" barriers, with 1 hazard light for each section.~~

2.03 TEMPORARY INTERIOR ENCLOSURES AND BARRICADES

A. Provide temporary partitions and ceilings or reuse existing partitions as required to separate work areas during on-site finishing operations, to prevent penetration of dust, odors, gases and moisture into occupied areas and to prevent damage to remaining Base Facility and to Contractor's work. Remove new and existing barricades upon completion of work or as directed by City.

B. Rigid Barricades and Enclosures: Provide wood or metal framing and gypsum board or plywood sheet materials with closed joints; flame spread rating of 25 or less following ASTM E84.

1. Paint faces exposed to public areas to match "Nevamar Pepperdust" plastic laminate, as required by City Engineer.
2. Sandbag or foam-tape floor track to existing terrazzo or tile flooring. Do not fasten to existing finished walls or ceiling tiles.

C. Membrane Enclosures: Provide same framing as above. Cover with minimum 12 mil black plastic sheet, with taped joints and edges. Seal punctures as they occur.

D. Perimeter Tape: Manufactured plastic tape, with printed "Construction Area" or equivalent message. Fasten to saw horses, "trees" or equivalent moveable posts. Repair breaks as they occur. Install around areas where quick changeability of barrier limits is required.

2.04 HAZARD LIGHTS

A. ~~Provide battery-powered flashing yellow lights on barricades and enclosures around perimeter of exterior areas adjacent to AOA, roadways, and parking aisles or spaces. Install on posts set in striped barrels and anchored with sand, or attach to fencing, as applicable and as ground space permits where barricades or enclosures do not occur.~~ Reference Section 01506 – Temporary Facilities, the project Safety and Phasing Plan (CSPP), Section 01 35 13.14 – Safety and Security and the project plans for details on barricades, barricade use, and requirements for use within the AOA.

2.05 TEMPORARY UTILITY AND ENVIRONMENTAL SYSTEMS WORK

A. Furnish temporary HVAC, plumbing and electrical products as required to provide continued Base Facility operation, including systems by-pass

dampers, ductwork, valves, pipe and fittings, conduit, wiring, junction boxes, and other items.

B. Coordinate these products with products of Sections 01731 – Cutting and Patching and ~~Divisions 2, 15 and 16~~ the project Technical Specifications.

PART 3 – EXECUTION

3.01 CONTRACTOR'S AND ENGINEER'S FIELD OFFICES

A. Install field offices ready for occupancy, 10 days after date fixed in Notice to Proceed, if required.

3.02 ENCLOSURE AND BARRICADE, SIGN, AND HAZARD LIGHT INSTALLATION

A. Fill and grade site for temporary structures to provide drainage away from buildings. Follow Section 01506 – Temporary Controls and ~~01572 – Erosion and Sedimentation Control~~ FAA Specification P-156, Temporary Air and Water Pollution, Soil Erosion, And Siltation Control, for erosion and sedimentation control.

B. Follow Section 01507 – Temporary Signs.

C. Install and maintain enclosures and barricades, passageways, signs and lights at locations shown on Drawings, or as directed by City Engineer, or as required to safely divert unauthorized parties away from or around construction operations.

1. Maintain minimum 3 foot candles of illumination at exitways, including those remaining adjacent to permanent barricades.
2. Reinforce barricades at AOA as required to withstand jet blast loads.

3.03 TEMPORARY UTILITY AND ENVIRONMENTAL SYSTEMS

A. Install temporary HVAC, plumbing and electrical products as required to maintain adequate environmental conditions to facilitate progress of Work, to meet specified minimum conditions for installation of materials, to protect materials and finishes from damage due to temperature or humidity beyond specified or otherwise required ranges, and to maintain proper Base Facility systems operation outside contract limits.

B. Provide ventilation of enclosed areas for proper curing of installed products, to disperse or control humidity, and to prevent hazardous accumulations of dust, fumes, vapors or gases inside or outside of enclosures.

3.04 CONSTRUCTION EQUIPMENT

A. See Section 00646 – Affidavit for FAA Form 7460-1 for filing of information related to height of construction equipment. When not in use, store equipment in designated location outside safety areas.

3.05 BRIDGING OF TRENCHES AND EXCAVATIONS AT ROADS

A. Install steel plates of thickness required to support TMUTCD H-20 loading, truck or lane, which produces maximum stress. Install with camber in direction proper to reduce tire impact noise.

B. Extend plates minimum 12 inches beyond all edges of trenches and excavations. Install pre-mix pavement patch widely feathered out from edge of plate onto road surface.

C. Properly barricade around trenches or excavations and remove bridging plates for access to trenches or excavations during construction operations. Properly install bridging and remove barricades during non-working periods. Maintain feathered pavement.

D. See also Section 01555 – Traffic Control and Regulation.

3.06 REMOVAL OF TEMPORARY FACILITIES

A. Maintain temporary facilities until Substantial Completion inspection, or when use is no longer required, or as directed by City Engineer.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Restore existing facilities used during construction to specified or original condition following Section 01731 – Cutting and Patching.

3.07 DISPOSAL OF DEBRIS, EXCESS PRODUCTS AND EXCAVATED MATERIAL

A. Legally dispose of waste and excess products off site. Do not burn or bury on site.

1. Prepare and file with Texas Department of Health (TDH) “TDH Demolition/ Renovation Notification” related to compliance with National Emissions Standards for Hazardous Air Pollutants. Obtain form from TDH, 10500 Forum Place Drive, Suite 300, Houston, TX 77036-8599, (713) 414-6125, or (800) 572-5548.

B. Dispose of all excess excavated material off site. Do not make disposition within the City in an area designated as being within the 100-Year Flood Hazard Area unless a “Special Development Permit” as defined by City Ordinance No. 81-914 and Number 85-1705 has been issued. Verify the floodplain status of proposed disposal site.

1. For floodplain information, contact the City of Houston Storm Sewer Engineering Section at (713) 837-0989.
2. Immediately remove and properly dispose of excavated material placed in the 100-Year Flood Hazard Area without a ‘Special Development Permit” at no cost or time increase to the contract.

C. Do not dispose of debris in sewers. Repair sewer lines to proper function within contract limits as a result of permitted use.

D. Remove and legally dispose of excess and other products not designated for salvage.

3.08 INTERIM CLEANING

A. Temporarily store debris in areas concealed from public, occupants’ and AOA view. Prevent migration of debris and dust following Section 01506 – Temporary Controls.

B. Clean-up dirt and debris in vicinity of construction entrances each day. Clean up debris, scrap materials, and other disposable items before completion of each day's work. Keep streets, driveways, and sidewalks clean of dirt, debris and scrap materials.

1. Failure on the Contractor’s part to maintain a clean site is the basis for City Engineer take action following Section 2.5 in Section 00700 – General Conditions.

C. Remove debris daily.

D. Prevent hazardous conditions due to product or debris storage in work areas and storage areas.

E. Keep streets used for entering or leaving the job area free of excavated material, debris, and foreign material, including carryout dust and mud, resulting from construction operations. Follow Section 01575 – Stabilized Construction Exit for vehicle wash areas. Follow City of Houston Ordinance No. 5705, Construction or Demolishing Privileges.

F. As frequently as necessary, sweep and damp mop floors of spaces in public spaces adjoining access points through barricades or enclosures.

~~3.09 ACCESS THROUGH JETWAYS OR EXTERIOR WALL~~

~~A. Obtain City Engineer's approval to use City-owned jetways for bringing material into and out of flight station areas. Do not use privately owned or leased jetways.~~

~~B. Where approved by City Engineer, remove and salvage curtainwall glazing at one light, provide temporary enclosure and building protection, and reinstall salvaged products upon completion of required accessibility.~~

3.10 MEASUREMENT AND PAYMENT

A. Payment shall be as specified in Section 01 59 01 – Temporary Construction Items.

END OF SECTION

Intentionally Left Blank

Section 01506

AIRPORT TEMPORARY CONTROLS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Dust control.

B. Noise control.

C. Pest and rodent control.

D. Pollution and environmental control.

E. Security controls, security plan and procedures. Work in AOA or the airport's secured area is not intended as part of this Contract; however, TSA may be involved in reviews of Contractor's construction plans to verify no TSA requirements or restrictions apply.

F. Safety requirements and ~~safety plan~~ Safety Plan Compliance Document (SPCD).

G. Emergency procedures.

H. Construction Safety and Phasing Plan (CSPP).

1.02 REFERENCES

A. U.S. Department of Transportation Federal Aviation Administration Advisory Circular AC 150/5370-2~~C~~, current edition, latest change.

1.03 SUBMITTALS

A. Make following submittals in 3-ring "D" binders, with clear spine and cover pockets and label "~~Airport Construction Control Plans~~ Construction Safety and Phasing Plan (CSPP) / Safety Plan Compliance Document (SPCD)" on white card-stock inserts. Prepare submittals as work of this and other Sections, but submit following Section 01312 – Coordination and Meetings.

B. Preliminary "~~Airport Construction Control Plans~~ Safety Plan Compliance Document (SPCD)": Submit, under provisions of Section 01325 – Construction Schedules, 3 copies in draft form ~~of the following~~ meeting the requirements of the SPCD as required in the CSPP which has been provided as a part of the Project Manual within this section 01506. The

SPCD shall include, with section dividers labeled as and containing, at a minimum the following items:

1. Construction Traffic Control Plan, prepared under Section 01555 – Traffic Control and Regulation.
2. Emergency Response Plan listing Safety Officers (Paragraph 1.09) with names, positions, office and home telephone numbers, and pager and portable telephone numbers.
3. ~~Safety Plan, including~~ Trench Safety Plan prepared under Section 01561 – Trench Safety System.
4. Security Plan.
5. Dust Control Plan.
6. Ground Water and Surface Water Control Plan prepared under Section 01578 – Control of Ground and Surface Water.
7. Revise as required and submit 5 final copies, in same form as preliminary copies under Section 01312 – Coordination and Meetings.

C. Pesticides and Poisons: Submit following Section 01340 – Shop Drawings, Product Data and Samples. Include Material Safety Data Sheets and manufacturers' recommendations for use and application. Include copy of applicator's certification from manufacturer.

1.04 DUST CONTROL

A. Prevent uncontrolled dust creation and movement. Prevent airborne particulates from reaching receiving streams or storm water conveyance systems, building interiors and AOA.

B. Use spray-on adhesives or plastic covers on exposed soil piles.

C. Follow Section 01505 – Temporary Facilities for interior enclosures.

D. Implement dust control methods immediately whenever dust migration is observed.

1.05 NOISE CONTROL

A. Provide vehicles and tools with noise suppressors and use methods and products that minimize noise to the greatest degree practicable. Follow OSHA standards and City Ordinances regarding noise. Do not create noise levels which interfere with the Work, with work by City, with airport operations, or which create a nuisance in surrounding areas.

B. Do not use impact-type or powder-actuated-type tools adjacent to occupied office-type areas.

1.06 PEST AND RODENT CONTROL

A. Provide pest and rodent control as required to prevent infestation of construction or storage areas using legal chemicals applied by a licensed applicator.

B. Provide methods and products with no adverse effect on the Work or adjoining properties.

C. Use and store chemicals following manufacturers' recommendations and with local, state, and federal regulations. Avoid overuse of pesticides that produce contaminated runoff. Prevent spillage. Do not wash pesticide containers in or near flowing streams or storm water conveyance systems, or inside buildings.

1.07 POLLUTION AND ENVIRONMENTAL CONTROL

A. Prevent contamination of soil, water or atmosphere by discharge of noxious substances from construction operations.

B. Contain spillage, and remove contaminated soils or liquids. Excavate and dispose of contaminated earth off-site, and replace with suitable compacted fill and topsoil.

C. Prevent harmful substances from entering public waters. Prevent disposal of wastes, effluents, chemicals, or other such substances adjacent to streams, or in sanitary or storm sewers.

D. Provide systems for control of atmospheric pollutants. Prevent toxic concentrations of chemicals. Prevent harmful dispersal of pollutants into the atmosphere.

E. Use equipment during construction following Federal, State, and local laws and regulations.

F. Follow statutes, regulations, and ordinances governing prevention of environmental pollution and preservation of natural resources, including but not limited to the National Environmental Policy Act of 1969, PL 91-190, Executive Order 11514.

G. Undeveloped areas on the airport site have considerable natural value. Do not cause unnecessary excavation or filling of terrain, unauthorized destruction of vegetation, air or stream pollution, nor harassment or destruction of wildlife.

H. Follow environmental requirements. Limit disturbed areas to boundaries established by the Contract Documents. Do not pollute on-site streams, sewers, wells, or other water sources.

1.08 SECURITY CONTROLS, PLAN AND PROCEDURES

A. Reference the CSPP provided for project specific safety, security and phasing requirements. Additionally, the following general requirements shall apply and are required to be addressed in the Contractor's submitted SPCD.

B. Protect products and property from loss, theft, damage, and vandalism. Protect City property and other private property from injury or loss in connection with the Work.

C. Employ watchmen as needed to provide required security and prevent unauthorized entry.

D. Repair damage or replace property vandalized.

E. If existing fencing or barriers are breached or removed for purposes of construction, provide an appropriate (as determined by the airport manager or designee) number of guards and/or maintain temporary security fencing equivalent to existing and approved by City Engineer.

F. Maintain security program through construction until City's acceptance and occupancy precludes need for Contractor's security program. The Contractor's Security program shall follow the guidelines listed herein and those contained in the CSPP and will be implemented as a part of the SPCD. The security program implemented by the Contractor is a subsidiary obligation of Contractor compensated through Section 01 35 13.14 – Safety and Security.

G. Provide chain link fence Terminal area staging areas, following Section 01505 – Temporary Facilities.

H. Airport Security Requirements:

1. Airport Manager and TSA monitor effectiveness of airport security by attempting to gain unauthorized entry into security areas. When TSA gains unchallenged access to security areas, City and/or the responsible individual may be fined. When unauthorized entry into security areas is made through contract limits or other areas under the Contractor's control:

a. Reimburse the City, without increase in contract price, the amount of imposed fines levied against the City,

accomplished by Change Order following Section 01255 – Modification Procedures.

b. Cease work in breached areas until proper security measures are in place, without change in contract price or time.

2. Immediately notify HPD of discovered presence of unbadged or unknown persons, vehicles or animals in security areas. Dial (IAH) 281-231-3100.
3. Obtain permitted AOA gate and other security area access locations from Airport Manager. Assign personnel to control passage through entry points not staffed by airport personnel.
4. Badges:

   a. After contract award and before preparation of the ~~Safety Plan~~ SPCD (Paragraph 1.09E) and construction schedule (Section 01325 – Construction Schedules), obtain permitted security badges.
   b. Security identification badges are required for access into AOA/Secured areas. Badges are valid for one year or for the period of the contract, whichever is shorter.
   c. TSA TSR Part 1542.209 applies to personnel engaged in work of this contract occurring within the AOA or secured area, and reads in part as follows:
   "…each airport operator must ensure that no individual is granted unescorted access authority unless the individual has undergone a fingerprint-based criminal history records check (CHRC) that does not disclose that he or she has a disqualifying criminal offense."
   d. Obtain from City Engineer and fill out one security badge application package (application form and all associated paperwork) per person (including subcontractors' personnel) needing unescorted access in security areas.
   e. Contact the airport ID badging office to arrange for collection and submittal of fingerprints. Prepare and maintain a file for each applicant, including a copy of the completed application. Keep in Contractor's main office until expiration of the warranty period.

      (1) Short-term or temporary personnel are permitted in security areas but only under constant escort by a properly badged escort, who shall have no duty other than to escort short-term or temporary personnel.
      (2) Badged and escorted personnel are limited to access to and from work areas and shall remain in the work area.

(3) Personnel under constant escort shall be continuously observed by and in the immediate company of badged personnel.
(4) City Engineer may limit the number of badged personnel and personnel under constant escort.

f. Submit completed applications to City Engineer for further review.
g. Attend required security training sessions.
h. Pick up completed badges and pay badging fees (as of December 2000, $55.00 per badge for a 1-year period--verify fee and duration with Airport Manager).

5. Do not leave fence breaks unattended. Restore fence or erect equivalent secure temporary fencing before departing the work area.
6. Provide proper identification on Contractor's vehicles permitted in AOA.
7. Submit draft SPCD at the Preconstruction Conference, following Section 01312 – Coordination and Meetings.

1.09 SAFETY REQUIREMENTS

A. Reference the CSPP provided for project specific safety, security and phasing requirements. Additionally, the following general requirements shall apply and are required to be addressed as a part of the Contractor's submitted SPCD.

B. Contractor and not City, City Engineer or Designer is solely and without qualification responsible for observation and compliance with safety regulations without reliance or superintendence of or direction by City, City Engineer or Designer.

C. Safety measures, including but not limited to safety of personnel, provision of first-aid equipment, installation, operation and removal of temporary ventilation and safety equipment, in the Contract Documents are a subsidiary obligation of Contractor compensated through various payment items.

D. Follow Section 00700 – General Conditions, Paragraph 10.1, and this Section for safety plan and procedures.

E. Prepare a written detailed ~~Safety Plan~~ SPCD for the Work describing:

1. Specific methods used to maintain airport safety procedures, based on requirements of the Contract Documents, airport procedures,

FAA/TSA requirements and Contractor's own safety and security program.

2. Contractor's emergency procedures in event of following minimum set of circumstances: airport's, tenants', or Contractor's on-site property damage; accidents; fire emergency; medical emergency; Airport Manager's intervention in construction operations; detainment or arrest of unauthorized Contractor's employees and subcontractors in Security areas; discovery of hazardous materials.
3. Provisions for temporary removal of security fencing (including culvert and drainway grates). Include proposed actions to prevent entry of people or animals into security areas when security fence is breached. Do not breach fencing without approval.
4. Requirements for closing safety areas.
5. Submit draft ~~Safety Plan~~ SPCD at the Preconstruction Conference, following Section 01312 – Coordination and Meetings.

F. City Engineer will review the ~~safety program~~ SPCD with FAA and ATCT, as applicable, for compliance with applicable regulations. If the plan fails to demonstrate compliance, modify it until approval is obtained.

G. Contractor's Safety Officers: Refer to Section 01550 – Public Safety & Contractor Safety Staffing, Paragraph 1.05, Contractor's Safety Staffing Requirements.

H. Submit final ~~Safety Plan~~ SPCD at the first Progress Meeting following Section 01312 – Coordination and Meetings.

1. Include in the ~~safety plan~~ SPCD Contractor's response to trench safety requirements following Section 01561 – Trench Safety System.

I. Follow applicable Federal, State and local safety codes and statutes and with proper construction practice. Establish and maintain procedures for safety of work, personnel and products involved in the Work.

J. Follow Texas Occupational Safety Act (Art. 5182a, V.C.S.) and promulgations of Secretary of Labor under Section 107 of Contract Work Hours and Standards Act, published in 29 CFR Part 1926 and adopted by Secretary of Labor as occupational safety and health standards under the Williams-Steiger Occupational Safety and Health Act of 1970. Follow other legislation enacted for safety and health of Contractor employees. These safety and health standards apply to Contractor, Subcontractors and Suppliers and their respective employees.

K. Immediately notify City Engineer of investigation or inspection by Federal Safety and Health inspectors of the Work or place of work on the job site,

and after such investigation or inspection inform City Engineer of results. Submit one (1) copy of accident reports to City Engineer within 10 days of date of inspection.

L. Protect areas occupied by workmen by the best available devices for detection of lethal and combustible gases. Frequently test devices to assure their functional capability. Monitor liquids and gases infiltrating into work areas for visual or odor evidences of contamination. Take immediate appropriate steps to seal off entry of contaminants into to the Work.

M. Maintain coordination with City's Police and Fire Departments during the Work.

1.10 EMERGENCY PROCEDURES

A. If an emergency situation occurs, including involvement in or witness to aircraft or motor vehicle emergencies and emergencies involving other parties or property regardless of fault, or a violation of requirements of this Section, or a violation of FAA/TSA regulations, take one or more of the following minimum actions as appropriate to the situation.

B. Immediately report to City Engineer accident or damage to pavement, buildings, utilities, and vehicles involving or caused by Contractor, Subcontractors, Suppliers, personnel, equipment or others.

C. In general:

1. Immediately notify HFD or HPD (public areas) as appropriate and applicable to location of emergency.
2. Notify City Engineer by telephone or in person.
3. Stop work in the area. Secure site as required to prevent further damage to property and persons.
4. Evacuate non-essential personnel from the scene. Keep involved personnel and witnesses on-site until otherwise directed by City Engineer or security officers.
5. Impound involved vehicles in "as-is condition" until otherwise directed.
6. Do not resume work in the area until released by City Engineer.

D. For discovery of actual or suspected hazardous material contamination, proceed with Paragraph B above while simultaneously initiating Contractor's own hazardous material response program.

E. Follow City Engineer's instructions for emergencies affecting the Work but occurring outside the Contract Limits. Certain situations may require the

Work or work to be temporarily stopped under provisions of Section 00700 – General Conditions.

1. Maintain a log documenting cost and time impact of the stop-work order.
2. Submit data to the City Engineer in form as instructed at that time.

1.11 CONSTRUCTION SAFETY AND PHASING PLAN (CSPP)

The Construction Safety and Phasing Plan (CSPP) sets forth guidelines and requirements for the project to help ensure the highest levels of safety, security and efficiency at the airport at the time of construction. Guidelines and requirements for the CSPP are developed from FAA Advisory Circular (AC) 150/5370-2F, Operational Safety on Airports During Construction, except as modified herein by those requirements listed above.

The CSPP is a single document to be used by all personnel involved in the project. The CSPP covers the actions of not only the construction personnel and equipment, but also the action of inspection personnel and airport staff.

Additionally, The Contractor shall develop and submit, for review and approval, a draft Safety Plan Compliance Document (SPCD), at the pre-construction meeting and the final SPCD at the first progress meeting following Section 01312 – Coordination and Meetings.

The SPCD shall comply with the provisions and requirements required by the Airport, those requirements outlined in the CSPP and with those requirements outlined in FAA AC 150/5370-2F. The SPCD must also include a certified statement by the Contractor that indicates its understanding of those operational, safety and security requirements. The certified statement must also assert that the Contractor will not deviate from the approved CSPP and SPCD unless written approval is granted by the Airport.

Implementation of the CSPP and SPCD will minimize interruptions to airport operations, reduce construction costs, and maximize the performance and safety of construction activity. Strict adherence to the provisions of the CSPP and SPCD by all personnel assigned to or visiting the construction site is mandatory. In the event Contractor activities are found in non-compliance with the provisions of the CSPP and/or the SPCD, the Airport or its duly authorized representative will direct the Contractor, in writing, to immediately cease operations in violation. In addition a safety meeting will be conducted for the purpose of reviewing those provisions in the CSPP and/or SPCD which were violated. The Contractor will not be allowed to resume any construction operations until the safety meeting has been conducted and the issue has been addressed and corrected or resolved.

The CSPP is specifically made a part of this contract and has been included as an appendix to this document.

1.12 MEASUREMENT AND PAYMENT

A. Payment shall be as specified in Section 01 59 01 – Temporary Construction Items.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

Section 01507

TEMPORARY SIGNS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Temporary signs at construction access points.

B. Maintenance.

C. Removal.

D. Project and Contractor identity signs are not permitted.

1.02 QUALITY ASSURANCE

A. Design signs and supporting sign structure to remain in place and withstand 50 miles-per-hour wind velocity.

B. Sign Manufacturer/Maker/Painter: Experienced professional sign company.

C. Finishes, Painting: Withstand weathering, fading, and chipping for duration of construction.

D. Appearance: Fresh, new-looking, legible and neat look during the entire period during which required.

1.03 SUBMITTALS

A. Follow Section 01340 – Shop Drawings, Product Data and Samples.

B. Submit shop drawings including:

1. Signboards and Copy: Show to-scale size, dimensions, content, layout, font style and size, and colors.
2. Location of each sign during each ~~stage~~ phase (Reference Section 01326 – Construction Sequencing, Construction Safety and Phasing Plan, and project plan sheets).

1.04 MEASUREMENT AND PAYMENT

A. Payment shall be as specified in Section 01 59 01 – Temporary Construction Items.

PART 2 – PRODUCTS

2.01 TEMPORARY SIGNS FOR ACCESS POINTS

A. Posts for Exterior Signs: New 4x4 inch moisture-resistant-treated wood or 2-1/2 inch diameter by 12-foot long galvanized steel.

1. ~~[[Paint [black] [white] [_____] [as scheduled or shown on Drawings.]] *****OR***** [Unpainted.]~~
2. Fabricate to length required for 3-foot direct-bury plus aboveground length required for proper height of signboard mounting.
3. Furnish number of posts as required for proper support of signboard

B. Signboards:

1. For Exterior Signs: 3/4 inch thick exterior grade medium density overlay (MDO) plywood, or 3/16 inch sheet aluminum. Paint background ~~[black]~~ [white] ~~[_____] [as shown on Drawings]~~.

a. Contractor's Option: Use colored vinyl film in lieu of paint for aluminum.

~~2. For Interior Signs: 3/4 inch thick fire-retardant treated medium density overlay plywood, or colored plastic laminate cladding both faces and with painted edges, or 1/8 inch sheet aluminum. Paint background black.~~

~~a. Contractor's Option: Use colored vinyl film in lieu of paint for aluminum.~~

C. Color Coating for Signboards and Hashmarks: Flat ultraviolet inhibited acrylic polyurethane or matte vinyl, all visible surfaces.

D. Copy and Borders: Flat color (color as scheduled) vinyl die-cut, Helvetica Medium typeface, size as shown or scheduled.

E. Rough Hardware: For wood, galvanized steel or brass for fasteners and other hardware. For aluminum, cadmium-plated steel or stainless steel.

F. Skid-mounted Signs: Allowed only when approved by the City Engineer. Approval does not release Contractor from responsibility of maintaining temporary signs on site and does not make City responsible for security of temporary signs.

2.03 SIGN FABRICATION

A. Fabricate signboards and install copy in the shop.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install temporary signs at construction area access points, including within security areas and AOA, at following location:

1. As scheduled below.
2. Where shown on Drawings.
3. Where required by City Engineer.
4. To denote Haul Routes. The Contractor shall use colored cones or reflective tape, easily visible from 150 feet, to denote the limits of the haul route. The color shall match that of the project specific color assigned to the project, as described in the plans.

B. Install signs fully visible, legible, level and plumb.

3.02 MAINTENANCE

A. Maintain signs and supports and markings clean. Repair deterioration and damage.
B. Relocate signs as work progresses ~~[at each site] [at each stage] [at both]~~ as required at no additional cost to the City.

3.03 REMOVAL

A. Remove temporary sign work when control is no longer needed or as directed by City Engineer.

3.04 MESSAGE SCHEDULE

A. Construction Entrance Warning Sign: 3-foot by 2-foot signboard, white copy and border on black background. Surface-mount on access gates through fences and on doors through barricades or enclosures; at 50 feet on center unless otherwise required by governing agencies:

NO ENTRANCE (4 inch)
CONSTRUCTION AREA (4 inch)
(45-degree hash marks, full width) (2 inch)
Hard Hat Required (2 inch)
Security Badge Required (2 inch)

B. Emergency Egress Sign: One foot square signboard, white copy and border, with directional arrow, on black background. Surface-mount on fences, barricades or enclosures, or freestanding, spaced 50 feet on center along path of egress, unless otherwise required by governing agencies.

EXIT (4 inch)
(Arrow direction as appropriate to egress path) (6 inch)

~~C. No Entrance to Closed Parking Area: 8 by 4 foot signboard, white copy and border on black background, free-standing; at each ramp access to floor on which work occurs:~~

~~**NO ENTRANCE** (6 inch)~~
~~**CONSTRUCTION AREA** (6 inch)~~
~~(45-degree hash marks, full width) (4 inch)~~
~~This Parking Area Closed (4 inch)~~
~~Until _____, 199_ (4 inch)~~

~~D. Notice of Intent to Close Parking Area: 8 by 4 foot signboard, white copy and border on black background, free-standing; at each ramp access to floor on which work occurs:~~

~~**WARNING (6 inch)**~~
~~THIS PARKING LEVEL (6 inch)~~
~~WILL BE CLOSED (6 inch)~~
~~(45-degree hash marks, full width) (4 inch)~~
~~Do Not Park on This Level (4 inch)~~
~~From _____, 199_ (4 inch)~~
~~Until _____, 199_ (4 inch)~~

END OF SECTION

Section 01550

PUBLIC SAFETY AND CONTRACTOR'S SAFETY STAFFING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Public Safety and Convenience.

B. General Requirements.

C. Street Markers and Traffic Control Signs.

D. Contractor's Safety Staffing Requirements.

1.02 RELATED SECTIONS

A. Section 00700 – General Conditions.

B. Section 01506 – Airport Temporary Controls.

C. Section 01555 – Traffic Control and Regulations.

D. Section 01561 – Trench Safety System.

E. Section 01 35 13.14 – Safety and Security.

F. Construction Safety and Phasing Plan (CSPP).

1.03 PUBLIC SAFETY AND CONVENIENCE

A. The Work in this Project is to be performed ~~[edit wording for scope of work and coord. w/other const. Projects going on in the immediate area].~~ within the Aircraft Operations Area (AOA) of the airport. Construction operations associated with this project have been broken into multiple phases of work. Due to the importance of maintaining airfield operations, safety, and security during construction, it is the Contractor's responsibility to be apprised of and fully implement the guidelines established for each phase of construction as detailed in Section 01506 – Airport Temporary Controls, Section 01 35 13.14 – Safety and Security, the Construction Safety and Phasing Plan (CSPP), and the project plan set. The Contractor shall furnish and maintain appropriate barricades, ~~and~~ signage, and any other necessary equipment as well implementing all operational procedures required to maintain a safe work environment for the HAS employees, the public and construction staff working at the project site.

B. Contractor shall plan and execute his operations in a manner that will cause a minimum interference with other construction projects. This plan shall be detailed in the Contractor's submitted Safety Plan Compliance Document (SPCD).

C. Signs, barricades and warning devices informing public of construction features will be placed and maintained by Contractor, who shall be solely responsible for their maintenance.

D. Contractor shall perform the necessary cleanup and finishing immediately after all or a portion of the Work is completed.

E. All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

1.04 GENERAL REQUIREMENTS

A. The Contractor shall observe the rules and regulations of the State of Texas and agencies of the U.S. Government which prohibit the pollution of any lake, stream, river, or wetland by dumping of any refuse, rubbish, dredge material, or debris therein.

B. The Contractor is specifically cautioned that disposal of materials into any water of the State must conform to the requirements of the Texas Natural Resource Conservation Commission (TNRCC), and any applicable permit from the US Army Corps of Engineers.

C. Waste material must be disposed of at sites approved by the Owner's Representative and permitted by the City.

1.05 CONTRACTOR'S SAFETY STAFFING REQUIREMENTS

A. Refer to Section 00700 – General Conditions, Article 10 – Safety Precautions.

B. Refer to Section 01506 – Airport Temporary Controls.

C. Refer to Specification – Section 01 35 13.14 Safety and Security.

D. Refer to Construction Safety and Phasing Plan (CSPP).

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

Section 01555

TRAFFIC CONTROL AND REGULATION

PART 1- GENERAL

1.01 SECTION INCLUDES

A. Signs, signals, lights and control devices.

B. Flagmen.

C. Construction parking control.

D. Designated haul routes.

E. Construction Traffic Control Plan.

F. See also Section 01145 – Use of Premises.

G. See also Section 01506 – Airport Temporary Controls.

I. See also Section 01 35 13.14 – Safety and Security.

H. See also Construction Safety and Phasing Plan (CSPP).

1.02 DEFINITIONS

A. See Section 01312 – Coordination and Meetings for definition of terms related to Aircraft Operations Area (AOA).

B. Flagman: A person who has successfully fulfilled all airport required flagman training and the "Certified Flagman" requirements set forth by the Texas Department of Transportation. Flagman certification may be achieved either through the Texas Department of Transportation, Texas Engineering Extension Services (TEEX), the City of Houston's E.B Cape Training Center, or by a trained and certified flagman instructor, employed by the Contractor. The certified flagman must carry proof of certification while performing flagman duties. The certified flagman will be required to wear a distinctive, bright colored vest and be equipped with appropriate flagging and communication devices. He/she must be fluent in English (speaking, reading, and writing), with Spanish an advantageous, but not required, primary or secondary language. Flagmen must be badged and must have successfully completed the airport flagman training instructed by Airport Operations, in addition to the regular badge and movement training, prior to performing in that capacity on airport property. Gate guards and escorts shall be

considered under the Flagmen classification and shall be subject to the same requirements as Flagmen.

C. Peace Officer: A licensed police officer actively employed in a full time capacity as a peace officer, working on average, minimum 32 paid hours per week, at a rate not less than the prevailing minimum rate following the Federal Wage and Hour Act, and entitled to full benefits as a peace officer, and who receives compensation for private employment as an individual employee or independent contractor. Private employment may be either in employee-employer relationship or on an individual contractual basis. He/she must be fluent in English (speaking, reading, and writing) with Spanish an advantageous, but not required, primary or secondary language. The use of Peace Officers is not prohibited, but is not specifically required, for this project. The use of Peace Officers shall be at the Contractor's discretion at no additional cost to the Owner.

D. Uniformed Flagman: A peace officer trained in traffic control and familiar with George Bush Intercontinental Airport roadway traffic patterns and airport operation procedures. A uniformed flagman may not be a reserve peace officer. The use of Uniformed Flagmen is not prohibited, but is not specifically required, for this project. The use of Uniformed Flagmen shall be at the Contractor's discretion at no additional cost to the Owner.

1.03 SUBMITTALS

A. For Contractor-proposed changes to Traffic Control and Regulation shown on Drawings, permitted only in order to reduce construction time and cost through re-sequencing the Work, prepare plan drawings and supplement with product literature, narrative description, and construction schedule.

1.04 MEASUREMENT AND PAYMENT

A. Traffic Control and Regulation, excluding Flagmen: Measurement is on a lump sum basis, including submittal of Contractor-proposed changes. Payment will be made based on schedule of values and percent of work complete under Section 01 35 13.14 – Safety and Security.

B. Flagmen: Measurement is on a lump sum basis as required for the Work. Payment will be made based on schedule of values and percent of work complete. For the purposes of payment, there shall be no separate distinction for Flagmen, Gate Guards, Escorts, Peace Officers, Uniformed Flagmen, or similar. Payment for all of these titles shall be made under the umbrella term "flagmen". Payment for flagmen shall be as specified under Section 01 59 01 – Temporary Construction Items.

C. Follow Section 01290 – Payment Procedures.

1.05 CONSTRUCTION TRAFFIC CONTROL PLAN AND PROCEDURES

A. Develop a written and graphic detailed Construction Traffic Control plan. The Construction Traffic Control plan shall be considered incidental to the pay items described under Section 01 35 13.14 – Safety and Security. The plan shall at a minimum address and describe the following ~~describing~~:

1. Rerouting of public roadway and AOA roadway traffic (outside safety areas) showing route, duration, and methods for change over from one route to the other and return to normal.
2. Product Deliveries: Location, space required and duration for temporary off-loading along public roadways or curbsides and along AOA roadways and around buildings adjacent to aprons, and route through occupied building interiors.
3. Barricade locations and duration of installation. Submit barricade construction details following Section 01505 – Temporary Facilities.
4. Maintain, update and obtain approval for changes.

PART 2 – PRODUCTS

2.01 SIGNS, SIGNALS, AND DEVICES

A. Furnish traffic cones, drums, barricades and traffic intersection lights, including control devices in AOA, following TMUTCD.

2.02 FLAGMEN AND OTHER PERSONNEL

A. Provide certified flagmen in number, at assigned, locations, and for durations as required to regulate even flow of vehicular and pedestrian traffic affected by construction activities.

B. Employ other personnel, i.e. uniformed peace officers, to take the additional steps required to protect the Work and public, or when specifically requested by Airport Operations personnel through the City Engineer to assist flagmen in the regulating of airport roadway traffic. The uniformed peace officer will coordinate with City Engineer, contractor, and/or Airport Operations personnel, as appropriate, prior to beginning shift.

C. Use of flagmen or peace officers does not reduce responsibility for damage for which the contractor would otherwise be liable.

PART 3 – EXECUTION

3.01 GENERAL

A. Install traffic control devices, including flagmen, at approaches to site and on site, at crossroads, detours, parking areas, at AOA, at construction entrances, and elsewhere as required in the project plan set to direct construction and affected public traffic, aircraft and GSE, or where directed by City Engineer and/or Airport operations personnel.

B. As directed by appropriate authority, e.g. City Engineer, employ additional uniformed peace officers to supplement the flagmen when performing a total terminal area road closure, detour, or overnight activity that affects existing traffic patterns. The uniformed peace officer will coordinate with City Engineer, contractor, and / or Airport Operations personnel, as appropriate, prior to beginning shift.

C. Install and operate traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control, and areas affected by Contractor's operations.

D. Install warning lights on traffic control devices for use during hours of low visibility to delineate traffic lanes and to guide traffic. Do not use flares or flame pots.

E. Relocate traffic controls as Work progresses, to maintain effective traffic control.

3.02 HAUL ROUTES

A. Confine construction traffic to designated haul routes.

B. Regulate construction traffic along haul routes. Minimize interference with public traffic.

C. Follow Texas State Highway and Public Transportation load limits of roadways.

D. The Contractor shall use colored cones or reflective tape, easily visible from 150 feet, to denote the limits of the haul route. The color shall match that of the project specific color assigned to the project, as described in the plans.

3.03 PUBLIC ROADS AND TERMINAL AREA ROADS

A. Abide by laws and regulations of governing authorities when using roads.

B. Maintain road lane use as follows, unless otherwise shown in the plans or permitted by Airport Manager or Airport Operations personnel, as coordinated through City Engineer.

1. All Terminal area road lanes available from 5:00 a.m. CST (0500 hours) to 10:00 p.m. CST (2200 hours); minimum two lanes in each direction at all times.
2. All on-airport road lanes (outside Terminal area) available from 5:00 a.m. CST (0500 hours) to 9:00 a.m. CST (0900 hours), and from 4:00 p.m. CST (1600 hours) to 7:00 p.m. CST (1900 hours); minimum two lanes in each direction at all times.

C. Maintain access at driveways. Do not block any vehicle or pedestrian traffic area without obtaining prior approval from the Houston Airport. Any unusual or otherwise unforeseen activity will require forty-eight (48) hours of notification to the City Engineer as well as Airport Operations personnel. Traffic control meetings are held weekly, on Thursdays, at 2:00 p.m. CST (1400 hours) at a location to be identified during the pre-construction conference. Contractor shall attend these meetings to coordinate all roadway traffic impacts. Contractor must present detailed traffic control / coordination plan, including drawings, written narrative, etc., with dates, times, and durations of proposed activities. This plan must be presented a minimum of three (3) weeks prior to intended activity.

D. Maintain roads on airport property clean at all times. Broom or wash as required. At Terminal area roads, follow behind haul vehicles and immediately clean up roads and debris and foreign material resulting from construction operations is deposited.

E. Follow City of Houston Ordinance 5705, Construction or Demolishing Privileges.

3.04 CONSTRUCTION PARKING CONTROL

A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and airport operations.

B. Prevent construction personnel's vehicles in revenue-producing facilities. Maintain vehicular access to and through construction parking areas.

C. Do not park on or adjacent to roadways or curbsides.

D. Comply with all security directives with regard to parking in the Terminal area.

3.05 REMAINING EXISTING CONTROL AND REGULATION DEVICES

A. Leave existing control and regulation devices in place and properly operating and visible during construction, unless indicated for removal or otherwise permitted.

B. Repair damage resulting from construction operations.

3.06 REMOVAL OF EXISTING CONTROL AND REGULATION DEVICES

A. Contact City of Houston Signal Shop Dispatcher at 713-803-3004 before removing or deactivating existing control and regulation devices.

B. Remove designated or permitted existing control and regulation devices following Section 01731 – Cutting and Patching.

C. Unless otherwise indicated or directed, remove existing lane striping and reflective buttons in conflict with temporary control and regulation devices. Install matching temporary lane striping and reflective buttons, maintain during construction, remove after construction is complete, and install permanent matching lane striping and reflective buttons.

3.07 BRIDGING TRENCHES AND EXCAVATIONS IN ROADS

A. Follow Section 01505 – Temporary Facilities.

3.08 REMOVAL OF TEMPORARY CONTROL AND REGULATION

A. Remove controls and regulation when no longer required. Repair damage caused by installation.

B. Remove post settings to a depth of two (2) feet.

END OF SECTION

Section 01561

TRENCH SAFETY SYSTEM

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Trench safety system for construction of trench excavations.

B. Trench safety system for excavations governed by State and Federal trench safety laws.

1.02 MEASUREMENT AND PAYMENT

A. For Unit-Price-based Contact:

1. Measurement for trench safety systems used on trench excavations is on a linear foot basis measured along the trench centerline, including manholes and other line structures.
2. Measurement for Special Shoring – Not Used.
3. Payment for trench safety system is on a line-item basis.

1.03 DEFINITIONS

A. *Trench:* A narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet.

B. Trench safety system requirements will apply to larger open excavations if erection of structures or other installations limits space between the excavation slope and the installation to dimensions equivalent of a trench, as defined.

C. Trench safety systems include both Protective Systems and Shoring Systems but are not limited to sloping, sheeting, trench boxes or trench shields, side rail systems, sheet piling, cribbing, bracing, dewatering or diversion of water to provide adequate drainage.

1. *Protective System*: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of an adjacent structure.
2. *Shoring System*: A structure that supports the sides of an excavation and which is designed to prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.
3. *Special Shoring*: A shoring system meeting Special Shoring requirements for locations shown on Drawings.

1.04 SUBMITTALS

A. Submit a safety program specifically for construction of trench excavation. Design the trench safety program following OSHA 29CFR standards governing presence and activities of individuals working in and around trench excavations, and following Special Shoring requirements shown on Drawings.

B. Have construction and shop drawings for trench safety systems sealed as required by OSHA by a licensed professional engineer retained and paid by Contractor.

C. Review of the safety program by City Engineer will only be in regard to compliance with this Section and will not constitute approval by City Engineer nor relieve Contractor of obligations under State and Federal trench safety laws.

1.05 REGULATORY REQUIREMENTS

A. Install and maintain trench safety systems following Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989, including Sections 1926-650 through 1926-652, all of which is hereby incorporated, by reference, into this Section.

B. A reproduction of the OSHA standards included in "Subpart P - Excavations" from the Federal Register Vol. 54, No. 209 is available upon request of Bidders and Contractor. City assumes no responsibility for accuracy of the reproduction. Contractor is responsible for obtaining a copy of the referenced section of the Federal Register.

C. Legislation enacted by Texas Legislature regarding Trench Safety Systems, is hereby incorporated, by reference, into this Section. Refer to Texas Health and Safety Code Ann., 756.021 (Vernon 1991).

D. Reference materials, if developed for the Work, issued with Bid Documents, include:

1. Section 00830 – Trench Safety Geotechnical Information: Geotechnical information obtained for use in design of the trench safety system.
2. Section 00831 – Special Shoring Requirements: Not Used.

1.06 Indemnification

A. Indemnify and hold harmless City, its employees, and agents from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgements or claims by anyone for injury or death of

persons resulting from collapse or failure of trenches constructed under this Contract.

B. Contractor acknowledges and agrees this indemnity provision provides indemnity for City in case City is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failure to issue stop work orders, and the hiring of Contractor.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install and maintain trench safety systems following provisions of OSHA 29CFR.

B. Install specially designed trench safety systems following Contractor's trench excavation safety program for locations and conditions identified in the program. Install Special Shoring at locations shown on Drawings.

C. Obtain verification from a competent person, as identified in Contractor's trench excavation safety program, trench boxes and other pre-manufactured systems are certified for actual installation conditions.

3.02 INSPECTION

A. Conduct daily inspections by Contractor or Contractor's independently retained consultant, of trench safety systems to ensure installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.

B. If evidence of possible cave-ins or slides is apparent, immediately stop work in the trench and move personnel to safe locations until necessary precautions are taken by Contractor to safeguard personnel.

C. Maintain permanent record of daily inspections.

3.03 FIELD QUALITY CONTROL

A. Verify specific applicability of selected or specially designed trench safety systems to field conditions encountered at each trench.

END OF SECTION

Section 01575

STABILIZED CONSTRUCTION EXIT

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Stabilized construction exits for erosion and sedimentation control.

1.02 SUBMITTALS

A. Manufacturer's catalog sheets and other product data on geotextile fabric.

B. Sieve analysis of aggregates conforming to requirements of this Specification.

1.03 MEASUREMENT AND PAYMENT

A. ~~Stabilized construction exit is incidental to the Work. Include costs for stabilized construction exit in the cost of work for which it is required.~~ The quantity of Stabilized 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.

1.04 REFERENCES

A. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

1.05 PERMITTED METHODS

A. Use only the following methods:

1. Cement-Stabilized Soil – Compacted cement-stabilized soil or other fill material of minimum 8 inches thick.
2. Wood Mats/Mud Mats – Nominal 6-inch thick oak or other hardwood timbers placed edge-to-edge across minimum 12 inch square wood beams placed on existing soil.
3. Steel Mats – Perforated mats placed across perpendicular support members.

PART 2 – PRODUCTS

2.01 GEOTEXTILE FABRIC

A. Woven or Nonwoven Geotextile Fabric: Either polypropylene, polyethylene, ethylene, or polyamide material.

B. Minimum Grab Strength: 270 psi in any principal direction (ASTM D-4632), and the equivalent opening size between 50 and 140.

C. Furnish geotextile and threads resistant to chemical attack, mildew, and rot and shall contain ultraviolet ray inhibitors and stabilizers to provide minimum of 6 months of expected usable life at a temperature range of 0 degrees F to 120 degrees F.

D. Representative Manufacturers: Mirafi, Inc., or equivalent; substitutions following Section 01630 – Product Options and Substitutions.

2.02 COARSE AGGREGATES

A. Coarse Aggregate: Clean, hard, durable crushed stone, gravel, crushed blast furnace slag, or a combination of these materials, free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.

B. Gradation:

Sieve Size (Square Mesh)	Percent Retained (By Weight)
2-1/2 inches	0
2 inches	0 - 20
1-1/2 inches	15 - 50
3/4 inches	60 - 80
No. 4	95 - 100

PART 3 – EXECUTION

3.01 PREPARATION

A. Follow ~~Section 01572 – Erosion and Sedimentation Control~~ FAA Specification P-156, Temporary Air and Water Pollution, Soil Erosion, And Siltation Control.

B. Install stabilized construction roads and exits at construction, staging, parking, storage, and disposal areas, as required to keep the street clean of mud carried by construction vehicles and equipment.

C. Remove stabilized construction roads and exits promptly when directed by the City Engineer.

3.02 INSTALLATION

A. Provide stabilized access roads and parking areas, and other on-site vehicle transportation routes where shown on Drawings.

B. Provide stabilized construction exits, and truck washing areas when approved by City Engineer, of the sizes and locations where shown on Drawings or as specified in this Section.

C. Clean tires of vehicles leaving construction areas to remove sediment prior to entrance onto public right-of-way. Follow ~~Section 01572 – Erosion and Sedimentation Control~~ FAA Specification P-156, Temporary Air and Water Pollution, Soil Erosion, And Siltation Control, for requirements for washing area.

D. Construct stabilized construction exit, and other areas requiring temporary stabilization, following the Drawings.

1. Roadway Width: 14 feet minimum for one-way traffic; 20 feet minimum for two-way traffic, full width at ingress and egress.
2. Length: As shown on Drawings.
3. Stabilization Thickness: Minimum 8 inches.

E. Install geotextile fabric as a permeable separator to prevent mixing of coarse aggregate with underlying soil. Expose geotextile fabric to the elements between laydown and cover a maximum of 14 days to minimize damage potential.

F. Grade roads and parking areas to provide sufficient drainage away from stabilized areas. Use sandbags, gravel, boards, or similar methods to prevent sediment from entering public right-of-way, receiving stream or storm water conveyance system.

G. Inspect and maintain stabilized areas daily. Provide periodic top dressing with additional coarse aggregates too maintain the required depth. Repair and clean out damaged control measures used to trap sediment. Immediately remove sediment spilled, dropped, washed, or tracked onto public right-of-way.

H. Stabilized area may be widened or lengthened to accommodate truck-washing area when authorized by City Engineer.

END OF SECTION

Intentionally Left Blank

Section 01576

WASTE MATERIAL DISPOSAL

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Disposal of waste material and salvageable material.

B. Following Section 01505 – Temporary Facilities: for Disposal of Trash and Debris, Excess Products, and Excavated Material.

1.02 SUBMITTALS

A. Conform to requirements of Section 01325 – Construction Schedules.

B. Submit copy of approved "Development Permit", as defined in Chapter 19 of Flood Plain Ordinance (City Ordinance Number 81-914 and Number 85-1705), prior to disposal of excess material in areas designated as being in "100-year Flood Hazard Area" within the City. Contact the City of Houston Flood Plain Manager, 3300 Main Street, at (713) 525-7605 for flood plain information.

C. Obtain and submit disposal permits for proposed disposal sites, if required by local ordinances.

D. Submit copy of written permission from property owner, with description of property, prior to disposal of excess material adjacent to Project. Submit written and signed release from property owner upon completion of disposal work.

E. Describe waste materials expected to be stored on-site and a description of controls to reduce Pollutants from these materials, including storage practices to minimize exposure of materials to storm water; and spill prevention and response measures in the Project's Storm Water Pollution Prevention Plan (SWPPP). Refer to Section 01410 – TPDES Requirements.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 ~~SALVAGEABLE MATERIAL~~

~~A. Excavated Material: When indicated on Drawings, load, haul, and deposit~~

~~excavated material at location or locations shown on Drawings outside limits of Project.~~

~~B. Base, Surface, and Bedding Material: Load shell, gravel, bituminous, or other base and surfacing material designated for salvage into City trucks.~~

~~C. Pipe Culvert: Load culverts designated for salvage into City trucks.~~

~~D. Other Salvageable Materials: Conform to requirements of individual Specification Sections.~~

~~E. Coordinate loading of salvageable material on City trucks with Project Manager.~~

3.02 EXCESS MATERIAL

A. Remove and legally dispose of vegetation, rubble, broken concrete, debris, asphaltic concrete pavement, excess soil, and other materials not designated for salvage from job site. Do not burn or bury on site. Do not dispose of debris in sewers. Repair sewer lines to proper function within contract limits as a result of permitted use.

1. Prepare and file with Texas Department of Health (TDH) “TDH Demolition/ Renovation Notification” related to compliance with National Emissions Standards for Hazardous Air Pollutants. Obtain form from TDH, 10500 Forum Place Drive, Suite 300, Houston, TX 77036-8599, (713) 414-6125, or (800) 572-5548.

~~B. Excess soil may be deposited on private property adjacent to Project when written permission is obtained from property owner. See Paragraph 1.02 D above.~~ Dispose of all excess excavated material off site.

C. Verify flood plain status of any proposed disposal site. Do not dispose of excavated materials in area designated as within 100-year Flood Hazard Area unless “Development Permit” has been obtained. Remove excess material placed in "100-year Flood Hazard Area" within the City, without “Development Permit", at no additional cost to the City.

D. Remove waste materials from site daily, in order to maintain site in neat and orderly condition.

END OF SECTION

Section 01578

CONTROL OF GROUND AND SURFACE WATER

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Dewatering, depressurizing, draining, and maintaining trenches, shaft excavations, structural excavations and foundation beds in stable condition, and controlling ground water conditions for tunnel excavations.

B. Protecting work against surface runoff and rising floodwaters.

C. Trapping suspended sediment in the discharge form the surface and ground water control systems.

1.02 MEASUREMENT AND PAYMENT

A. UNIT PRICES

1. When noted, dewatering of trench or excavation during course of project shall be measured per linear foot and paid for at contract unit prices for dewatering, when directed to perform such work by Project Manager. Dewatering must be fully detailed in submittal and submittal must be approved prior to performing dewatering work before payment will be made for dewatering. No payment will be made for work unless directed to perform work by Project Manager.

2. Presence of a pump on project does not constitute dewatering for payment under bid item "Ground Water Control for Open Cut Construction."

3. Dewatering required during course of project to lower water table for other utility installation less than 24 inches in diameter, construction of structures, removal of standing water, surface drainage seepage, or to protect against rising waters or floods shall be considered incidental to Work unless otherwise noted.

4. No separate payment will be made for groundwater control associated with augering, tunnels or casing. Include cost in unit price for augering.

5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum) Contract. If the Contract is a Stipulated Price Contract, include payment for work under this section in the total Stipulated

Price.

1.03 REFERENCES

A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soils Using Standard Effort (12,400 ft-lbf/ft3 (600kN-m/m3)

B. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA)

C. Storm Water Management Handbook for Construction Activities prepared by City of Houston, Harris County and Harris County Flood Control District.

1.04 DEFINITIONS

A. Ground water control system: system used to dewater and depressurize water-bearing soil layers.

1. Dewatering: lowering the water table and intercepting seepage that would otherwise emerge from slopes or bottoms of excavations, or into tunnels and shafts; and disposing of removed water. Intent of dewatering is to increase stability of tunnel excavations and excavated slopes, prevent dislocation of material from slopes or bottoms of excavations, reduce lateral loads on sheeting and bracing, improve excavating and hauling characteristics of excavated material, prevent failure or heaving of bottom of excavations, and to provide suitable conditions for placement of backfill materials and construction of structures and other installations.

2. Depressurization: includes reduction in piezometric pressure within strata not controlled by dewatering alone, necessary to prevent failure or heaving of excavation bottom or instability of tunnel excavations.

B. Excavation drainage: includes keeping excavations free of surface and seepage water.

C. Surface drainage: includes use of temporary drainage ditches and dikes and installation of temporary culverts and sump pumps with discharge lines necessary to protect Work from any source of surface water.

D. Monitoring facilities for ground water control system: includes piezometers, monitoring wells and flow meters for observing and recording flow rates.

1.05 PERFORMANCE REQUIREMENTS

A. Conduct subsurface investigations to identify groundwater conditions and to

provide parameters for design, installation, and operation of groundwater control systems. Submit proposed method and spacing of readings for review prior to obtaining water level readings.

B. Design ground water control system, compatible with requirements of Federal Regulations 29 CFR Part 1926 and Section 02260 - Trench Safety Systems, to produce following results:

1. Effectively reduce hydrostatic pressure affecting:

   a. Excavations

   b. Tunnel excavation, face stability or seepage into tunnels

2. Develop substantially dry and stable subgrade for subsequent construction operations

3. Preclude damage to adjacent properties, buildings, structures, utilities, installed facilities and other work

4. Prevent loss of fines, seepage, boils, quick condition, or softening of foundation strata

5. Maintain stability of sides and bottom of excavations

C. Provide ground water control systems that include single-stage or multiple-stage well point systems, eductor and ejector-type systems, deep wells, or combinations of these equipment types.

D. Provide drainage of seepage water and surface water, as well as water from other sources entering excavation. Excavation drainage may include placement of drainage materials, crushed stone and filter fabric, together with sump pumping.

E. Provide ditches, berms, pumps and other methods necessary to divert and drain surface water from excavation and other work areas.

F. Locate ground water control and drainage systems so as not to interfere with utilities, construction operations, adjacent properties, or adjacent water wells.

G. Assume sole responsibility for ground water control systems and for any loss or damage resulting from partial or complete failure of protective measures and settlement or resultant damage caused by ground water control operations. Modify ground water control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, adjacent water wells, or potentially contaminated areas. Repair damage caused by ground water control systems or resulting from

failure of system to protect property as required.

H. Install an adequate number of piezometers installed at proper locations and depths, necessary to provide meaningful observations of conditions affecting excavation, adjacent structures and water wells.

I. Install environmental monitoring wells at proper locations and depths necessary to provide adequate observations of hydrostatic conditions and possible contaminant transport from contamination sources into work area or ground water control system.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittals Procedures.

B. Submit Ground Water and Surface Water Control Plan for review by Project Manager prior to start of excavation work. Include the following:

1. Results of subsurface investigations and description of extent and characteristics of water bearing layers subject to ground water control

2. Names of equipment Suppliers and installation Subcontractors

3. Description of proposed ground water control systems indicating arrangement, location, depth and capacities of system components, installation details and criteria and operation and maintenance procedures

4. Description of proposed monitoring facilities indicating depths and locations of piezometers and monitoring wells, monitoring installation details and criteria, type of equipment and instrumentation with pertinent data and characteristics

5. Description of proposed filters including types, sizes, capacities and manufacturer's application recommendations

6. Design calculations demonstrating adequacy of proposed systems for intended applications. Define potential area of influence of ground water control operation near contaminated areas.

7. Operating requirements, including piezometric control elevations for dewatering and depressurization

8. Excavation drainage methods including typical drainage layers, sump pump application and other means

9. Surface water control and drainage installations

10. Proposed methods and locations for disposing of removed water

C. Submit following records upon completion of initial installation:

1. Installation and development reports for well points, eductors, and deep wells

2. Installation reports and baseline readings for piezometers and monitoring wells

3. Baseline analytical test data of water from monitoring wells

4. Initial flow rates

D. Submit the following records weekly during control of ground and surface water operations:

1. Records of flow rates and piezometric elevations obtained during monitoring of dewatering and depressurization. Refer to Paragraph 3.02, Requirements for Eductor, Well Points, or Deep Wells.

2. Maintenance records for ground water control installations, piezometers and monitoring wells

1.07 ENVIRONMENTAL REQUIREMENTS

A. Comply with requirements of agencies having jurisdiction.

B. Comply with Texas Commission on Environmental Quality regulations and Texas Water Well Drillers Association for development, drilling, and abandonment of wells used in dewatering system.

C. Obtain necessary permits from agencies with jurisdiction over use of groundwater and matters affecting well installation, water discharge, and use of existing storm drains and natural water sources. Since review and permitting process may be lengthy, take early action to obtain required approvals.

D. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites.

PART 2 P R O D U C T S

2.01 EQUIPMENT AND MATERIALS

A. Select equipment and materials necessary to achieve desired results for dewatering. Selected equipment and materials are subject to review by Project Manager through submittals required in Paragraph 1.06, Submittals.

B. Use experienced contractors, regularly engaged in ground water control system design, installation, and operation, to furnish and install and operate educators, well points, or deep wells, when needed

C. Maintain equipment in good repair and operating condition.

D. Keep sufficient standby equipment and materials available to ensure continuous operation, where required.

E. Portable Sediment Tank System: Standard 55-gallon steel or plastic drums, free of hazardous material contamination.

1. Shop or field fabricate tanks in series with main inlet pipe, inter-tank pipes and discharge pipes, using quantities sufficient to collect sediments from discharge water.

PART 3 E X E C U T I O N

3.01 GROUND WATER CONTROL

A. Perform necessary subsurface investigation to identify water bearing layers, piezometric pressures and soil parameters for design and installation of ground water control systems. Perform pump tests, if necessary to determine draw down characteristics. Present results in the Ground Water and Surface Water Control Plan. submittal

B. Provide labor, material, equipment, techniques and methods to lower, control and handle ground water in manner compatible with construction methods and site conditions. Monitor effectiveness of installed system and its effect on adjacent property.

C. Install, operate, and maintain ground water control systems in accordance with the Ground Water and Surface Water Control Plan. Notify Project Manager in writing of changes made to accommodate field conditions and changes to Work. Provide revised drawings and calculations with notification.

D. Provide continuous system operation, including nights, weekends, and holidays. Arrange appropriate backup if electrical power is primary energy source for dewatering system.

E. Monitor operations to verify systems lower ground water piezometric levels at rate required to maintain dry excavation resulting in stable subgrade for

subsequent construction operations.

F. Depressurize zones where hydrostatic pressures in confined water bearing layers exist below excavations to eliminate risk of uplift or other instability of excavation or installed works. Define allowable piezometric elevations in the Ground Water and Surface Water Control Plan.

G. Removal of ground water control installations.

1. Remove pumping system components and piping when ground water control is no longer required.

2. Remove piezometers, including piezometers installed during design phase investigations and left for Contractor's use, upon completion of testing, as required in accordance with Part 3 of applicable specification.

3. Remove monitoring wells when directed by Project Manager.

4. Grout abandoned well and piezometer holes. Fill piping that is not removed with cement-bentonite grout or cement-sand grout.

H. During backfilling, maintain water level a minimum of 5 feet below prevailing level of backfill. Do not allow the water level to cause uplift pressures in excess of 80 percent of downward pressure produced by weight of structure or backfill in place. Do not allow water levels to rise into cement-stabilized sand until at least 48 hour after placement.

I. Provide uniform pipe diameter for each pipe drain run constructed for dewatering. Remove pipe drains when no longer required. If pipe removal is impractical, grout connections at 50-foot intervals and fill pipe with cement-bentonite grout or cement-sand grout after removal from service.

J. The extent of ground water control for structures with permanent perforated underground drainage systems may be reduced, for units designed to withstand hydrostatic uplift pressure. Provide a means to drain affected portions of underground systems, including standby equipment. Maintain drainage systems during construction operations.

K. Remove systems upon completion of construction or when dewatering and control of surface or ground water is no longer required.

L. Compact backfill to not less than 95 percent of maximum dry density in accordance with ASTM D 698.

M. Foundation Slab: Maintain saturation line at least 3 feet below lowest elevations where concrete is to be placed. Drain foundations in areas where

concrete is to be placed before placing reinforcing steel. Keep free from water for 3 days after concrete is placed.

3.02 REQUIREMENTS FOR EDUCTOR, WELL POINTS, OR DEEP WELLS

A. For aboveground piping in ground water control system, include a 12-inch minimum length of clear, transparent piping between each eductor well or well point and discharge header to allow visual monitoring of discharge from each installation.

B. Install sufficient piezometers or monitoring wells to show that trench or shaft excavations in water bearing materials are pre-drained prior to excavation. Provide separate piezometers for monitoring of dewatering and for monitoring of depressurization. Install piezometers and monitoring wells for tunneling as appropriate for selected method of work.

C. Install piezometers or monitoring wells at least one week in advance of the start of associated excavation.

D. Dewatering may be omitted for portions of under drains or other excavations, where auger borings and piezometers or monitoring wells show that soil is pre-drained by existing systems and that ground water control plan criteria are satisfied.

E. Replace installations that produce noticeable amounts of sediments after development.

F. Provide additional ground water control installations, or change method of control if, ground water control plan does not provide satisfactory results based on performance criteria defined by plan and by specifications. Submit revised plan according to Paragraph 1.06B.

3.03 SEDIMENT TRAPS

A. Install sediment tank as shown on approved plan.

B. Inspect daily and clean out tank when one-third of sediment tank is filled with sediment.

3.04 SEDIMENT SUMP PIT

A. Install sediment sump pits as shown on approved plan.

B. Construct standpipe by perforating 12 inch to 24-inch diameter corrugated metal or PVC pipe.

C. Extend standpipe 12 inches to 18 inches above lip of pit.

D. Convey discharge of water pumped from standpipe to sediment trapping device.

E. Fill sites of sump pits, compact to density of surrounding soil and stabilize surface when construction is complete.

3.05 EXCAVATION DRAINAGE

A. Use excavation drainage methods if well-drained conditions can be achieved. Excavation drainage may consist of layers of crushed stone and filter fabric, and sump pumping, in combination with sufficient ground water control wells to maintain stable excavation and backfill conditions.

3.06 MAINTENANCE AND OBSERVATION

A. Conduct daily maintenance and observation of piezometers or monitoring wells while ground water control installations or excavation drainage is operating at the site, or water is seeping into tunnels, and maintain systems in good operating condition.

B. Replace damaged and destroyed piezometers or monitoring wells with new piezometers or wells as necessary to meet observation schedules.

C. Cut off piezometers or monitoring wells in excavation areas where piping is exposed, only as necessary to perform observation as excavation proceeds. Continue to maintain and make specified observations

D. Remove and grout piezometers inside or outside of excavation area when ground water control operations are complete. Remove and grout monitoring wells when directed by Project Manager.

3.07 MONITORING AND RECORDING

A. Monitor and record average flow rate of operation for each deep well, or for each wellpoint or eductor header used in dewatering system. Also, monitor and record water level and ground water recovery. Record observations daily until steady conditions are achieved and twice weekly thereafter.

B. Observe and record elevation of water level daily as long as ground water control system is in operation, and weekly thereafter until Work is completed or piezometers or wells are removed, except when Project Manager determines more frequent monitoring and recording are required. Comply with Project Manager's direction for increased monitoring and recording and

take measures necessary to ensure effective dewatering for intended purpose.

3.08 SURFACE WATER CONTROL

A. Intercept surface water and divert it away from excavations through use of dikes, ditches, curb walls, pipes, sumps or other approved means. Requirement includes temporary works required to protect adjoining properties from surface drainage caused by construction operations.

B. Divert surface water and seepage water into sumps and pump it into drainage channels or storm drains, when approved by agencies having jurisdiction. Provide settling basins when required by agencies.

END OF SECTION

Section 01579

TEMPORARY VEHICLE AND EQUIPMENT FUELING AREA

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Installation of erosion and sediment control for a temporary vehicle and equipment fueling area for aboveground fuel storage tank, which will be on site for more than 48 hours.

1.02 SUBMITTALS

A. Follow Section 01340 – Shop Drawings, Product Data and Samples.

B. Submit manufacturer's catalog sheets and other product data on dispensing equipment, pump, and aboveground fuel storage tanks, indicating the capacity and dimensions of the tank.

C. Submit drawings to show the location of tank protection area and driveway. Indicate the nearest inlet or channelized flow area. Clearly dimension all distances and measurements.

D. Submit a copy of Contractor's spill response and containment procedures to City Engineer. In lieu of the above, the Contractor shall submit a written statement declaring that the Spill Containment Procedures contained in the Airport's pollution prevention plan will be used in the event of a spill, and that a copy of the spill procedures will be located on-site.

E. Submit a list of significant materials to be used or stored at the airport construction site. Submit statement that all significant materials and associated waste containers that are to be used or stored overnight at the airport construction site will be properly labeled.

F. Submit a list of spill containment equipment, and quantities thereof, located at the fueling area.

G. Submit manufacturer's catalog sheets and other product data on geotextile fabric.

H. Submit inspection reports after the fueling site has been returned to its original condition or constructed in accordance with the Drawings.

1.03 MEASUREMENT AND PAYMENT

A. Unless indicated in Section ~~00405~~ 00410 – Bid Form, the Temporary Vehicle and Equipment Fueling Area is incidental to the Work. Include costs for Temporary Vehicle and Equipment Fueling Area in the cost of work for which it is required.

B. ~~When indicated in Section 00405~~ 00410 ~~– Bid Form, measurement and payment for Temporary Vehicle and Equipment Fueling Area will be on a lump sum basis. The Temporary Vehicle and Equipment Area measured as stated, will be paid for at the unit price bid for "Temporary Vehicle and Equipment Fueling Area, Complete in Place."~~

~~1. Payment for Temporary Vehicle and Equipment Fueling area will include and be full compensation for all labor, equipment, materials, supervision, and all incidental expenses for construction of these items, complete in place, including, but not limited to, embankment and excavation, concrete foundation and curbs, protection barrier, driveway, maintenance requirements, repair and replacement of damaged sections, removal of sediment deposits, redressing of aggregates and stones, and removal of erosion and sedimentation control systems at the end of construction.~~

1.04 QUALITY ASSURANCE

A. Person conducting visual examination for pollutant shall be fully knowledgeable about the ~~NPDES~~ TPDES Construction General Permit, detecting sources of storm water contaminants, inspection of aboveground storage tank and appurtenances for leakage, and the day to day operations that may cause unexpected pollutant releases.

PART 2 – PRODUCTS

2.01 ABOVEGROUND STORAGE TANK

A. Tank Assembly: Must be listed with UL 1709 and UL 2085.

B. Inner Steel Storage Tank: Follow UL 142, with minimum thickness of 1/8-inch all welded construction.

C. Tank Encasement: Either concrete or steel to provide a minimum of 110 percent containment of the inner tank capacity. Provide 5-gallon overspill containment pan for tank refueling.

D. Dispenser Pump: For submersible pump, UL listed emergency shut-off valve to be installed at each dispenser. For suction pump, UL listed vacuum-activated shut-off valve, with a shear section, is to be installed at each dispenser. Fuel may

not be dispensed from a tank by gravity flow or by pressurization of the tank. Means must be provided to prevent release of fuel by siphon flow.

E. Representative Manufacturers: Convault, Fireguard, Ecovault, SuperVault, or equal.

2.02 CONCRETE

A. Follow ~~Section 03310 – Structural Concrete~~ FAA Specification P-610 – Structural Concrete ~~with a minimum concrete strength of 4,000 psi at 28 days~~.

2.03 AGGREGATES

A. Coarse aggregate shall consist of crushed stone, gravel, crushed blast furnace slag, or a combination of these materials. Aggregate shall be composed of clean, hard, durable materials, free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic and injurious matter.

B. Coarse aggregate shall conform to the following gradation requirements.

Sieve Size (Square Mesh)	Percent Retained (By Weight)
2-1/2"	0
2"	0-20
1-1/2"	15-50
3/4"	60-80
No. 4	95-100

2.04 GEOTEXTILE FABRIC

A. Woven or non-woven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.

B. Grab Strength: 270 psi in any principal direction (ASTM D-4632), Mullen burst strength exceeding 200 psi (ASTM D-3786), and the equivalent opening size between 50 and 140.

C. Furnish ultraviolet inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0^0F to 120^0F.

~~D. Representative Manufacturers: Mirafi, Inc., Synthetic Industries, or equal.~~

PART 3 – EXECUTION

3.01 GENERAL

A. Follow ~~Section 01572 – Erosion and Sedimentation Control~~ FAA Specification P-156, Temporary Air and Water Pollution, Soil Erosion, And Siltation Control.

B. Do not clear, grub, or rough cut until erosion and sedimentation control systems are in place, unless otherwise approved by City Engineer.

C. Maintain existing erosion and sedimentation control systems located within the project site installed by others prior to start of construction under this contract until acceptance of the project or until directed by the City Engineer to remove and dispose the existing systems.

D. Inspect and repair or replace components of all erosion and sedimentation control systems as specified for each type of system. Unless otherwise directed, maintain the erosion and sedimentation control systems until acceptance of the project. Remove erosion and sedimentation control systems promptly when directed by the City Engineer and dispose of removed materials offsite.

E. Remove and dispose of sediments deposits ~~at the project spoil site. If a project spoil site is not designated on Drawings, dispose sediment~~ at an offsite location. Contractor assumes responsibility for offsite disposal location. Sediment shall be disposed of at an offsite location not in or adjacent to a stream or floodplain. Spread, compact, and stabilize sediment placed at the project site in accordance with the directions of the City Engineer. Do not allow sediment to flush into a stream or drainage way. If sediment is contaminated, dispose of sediment in accordance with federal, state and local regulations.

F. Do not maneuver equipment or vehicles on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damages caused by construction traffic to erosion and sedimentation control systems.

G. Employ protective measures to avoid damage to existing trees to be retained on the project site. Conduct all construction operations under this Contract in conformance with the erosion control practices described in ~~Section 01572 - Erosion and Sedimentation Control~~ FAA Specification P-156, Temporary Air and Water Pollution, Soil Erosion, And Siltation Control.

H. Contractor to prepare spill response and containment procedures to be implemented in the event of a significant materials spill. Significant materials include but are not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical required to be

reported pursuant to Section 313 of Title III of SARA; fertilizers; pesticides; and waste products such as slag, ashes and sludge that have the potential to be released with storm water discharges. In lieu of developing procedures stated above, Spill Containment Procedures enclosed in the airport's pollution prevention plan may be used. Spill procedures shall be kept on-site at the airport construction site.

I. Spill containment equipment appropriate to the size of operation is to be located in close proximity to the fueling area. Such equipment includes, but not limited to, suitable waste containers for significant materials, drip pans, booms, inlet covers, or absorbent.

J. All significant materials or waste containers used for airport construction activities and stored on-site at the airport overnight are to be properly labeled.

3.02 CONSTRUCTION METHODS

A. Provide fuel tank protection area and driveway as shown on the Drawings, or equivalent if prior written approval has been given by City Engineer.

B. Do not locate fueling area in or near a channelized flow area or close to a storm sewer conveyance system. Sufficient space must be provided to allow installation of other erosion and sediment controls to protect those areas.

C. Clear and grub the fueling area to remove unsuitable materials. Place geotextile fabric as permeable separator to prevent mixing of coarse aggregate with underlaying soil. Overlap fabric a minimum of 6 inches. Place coarse aggregate on top of the geotextile fabric to minimum depth of 8 inches.

D. Grade protection area and driveway to provide sufficient drainage away from stabilized areas. Use sandbags, gravel, boards, or similar methods to prevent sediment from entering public right-of-way, receiving stream or storm water conveyance system. The driveway to the fuel tank area shall have a minimum width of 15 feet for one way traffic and 30 feet for two-way traffic.

E. Place the aboveground storage tank on top of the cast-in-place or pre-cast foundation. The size and thickness of the foundation shall based on the size and weight of the tank to be used, with a minimum thickness of 6 inches. The concrete foundation shall be enclosed by a 5-inch by 5-inch concrete curb and shall extend a minimum of 1 foot beyond the tank and dispenser assemblies, so that leak and drip can be contained within the concrete foundation.

F. Slope the concrete foundation a minimum of 1 percent toward a 6-inch wide by 12-inch long by 4-inch deep sump pit. Install a minimum of 2-inch pipe inside the sump pit with a valve on the outside of the curb to allow draining of the concrete foundation.

G. Install a portable concrete jersey barrier around the concrete foundation. Provide a minimum clearance of 2 feet from the edge of the foundation. In lieu of the jersey barrier, Contractor can install 4-inch diameter steel pipe bollards around the foundation. The bollards shall be buried a minimum of 3 feet deep, 3 feet aboveground, and 4 feet on center, encased in a 12-inch wide concrete foundation.

3.03 MAINTENANCE

A. Inspect stabilized areas after every storm event and at least once a week. Provide periodic top dressing with additional coarse aggregate to maintain the required depth. Repair and clean out damaged control measures used to trap sediment.

B. Inspect fuel tank foundation's bermed area after every storm event and at least once a week. Visually examine storm water contained in the tank's bermed foundation area for oil sheen or other obvious indicators of storm water pollution. Properly dispose of the storm water when significant amount of pollutant is present (as defined in Federal Register, Vol. 60, No. 189, Friday, September 29, 1995). Record visual examination of storm water discharge in a Report noting the date and time of examination, name of examiner, observations of water quality, and volume of storm water discharged from the bermed area. The Report shall be kept together with all other storm water pollution control inspection reports on the site, in a readily accessible location. The Report shall be maintained for the duration of the construction activity~~, and thereafter in accordance with the provisions of Section 01571 - NPDES Requirements~~ Section 01410 – TPDES Requirements.

3.04 TEMPORARY FUELING AREA CLOSURE

A. The temporary vehicle and equipment fueling area shall be disposed of by removal of all sediment and erosion controls properly offsite. City Engineer will inspect the top soils in the fueling area and immediate vicinity for evidence of fuel leaks. If the City Engineer determines that sufficient pollutants have been released, the soil shall be removed and properly disposed offsite. Other remediation method may be required at no additional cost to the City.

END OF SECTION

Section 01 59 01

TEMPORARY CONSTRUCTION ITEMS

DESCRIPTION

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

MATERIALS

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

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

2.03 Steel Plates. Steel plates of adequate size and thickness shall be furnished as necessary to cover temporary excavations, unfinished structures or surfaces requiring

protection or for safety purposes. Plates shall be securely fastened down and shall be adequate to safely support any anticipated loadings to be imposed.

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

2.05 Haul Roads. The Contractor shall install, maintain, repair, and remove haul roads to be traversed by construction vehicles and equipment as indicated in the plans, or as required by the Contractor. Photos of the existing haul roads are attached to this specification.

The Contractor shall, in accordance with Section 01330 – Submittal Procedures, submit all proposed haul route improvements for review and approval prior to performing any proposed improvements.

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

2.07 Sweepers, Vacuum Trucks, and Additional Cleaning Equipment. The Contractor shall provide an adequate number of sweepers, vacuum trucks, and additional cleaning equipment to keep all haul routes, active airfield pavements within the limits of work, and any other pavement areas within 500 feet of any construction area traversed by the Contractor’s vehicles and equipment clean and free of mud, dirt, debris and other FOD. The Contractor shall provide a sweeper and vacuum truck at each active airfield pavement crossing, stationed outside the OFA. No less than two (2) sweepers and two (2) vacuum trucks shall be onsite for the duration of the project, regardless of the number of active airfield pavement crossings. The Contractor shall sweep and / or vacuum, as necessary, or as directed by the Owner's representative, immediately after each active airfield pavement crossing by the Contractor’s vehicles or equipment. The Contractor shall additionally ensure that all active airfield pavements affected by construction operations are kept free of any and all FOD deposited as the result of any source. The cost of all cleaning equipment, operation of said equipment, and labor and incidentals required for cleaning operations shall be included for payment under the item(s) of this specification.

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

CONSTRUCTION METHODS

3.01 Construction Barricades. Barricades shall be placed around each phase of the work in accordance with the phasing plans and shall remain in place until completion of work in each phase.

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

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

3.03 Portable Lighting Units. Portable lighting units are required for construction during periods of limited visibility (i.e., nighttime). Illumination requirements shall be those contained in Paragraph 01 59 01-2.02.

METHOD OF MEASUREMENT

4.01 No direct measurement will be made for the items of this specification. Payment will be made on a lump sum basis.

BASIS OF PAYMENT

5.01 Payment will be made at the lump sum price for the items listed herein. Some items have been provided as independent bid items. For construction items required by this specification but not specifically provided as independent bid items (01 59 01-5.1, 01 59 01-5.2, and 01 59 01-5.3), these items will collectively be bid as “Miscellaneous Temporary Construction Items”. “Miscellaneous Temporary Construction Items” shall include, but not be limited to portable floodlighting, steel plates, barricades, temporary haul roads, test pits, vacuum trucks and sweepers, portable bathroom facilities, waste disposal containers, and runway / taxiway closure markers.

Payment for all items shall be full compensation for furnishing all materials and labor for placing, moving and removing barricades and steel plates, providing flagmen, furnishing

portable floodlighting, test pitting, and for any other labor, materials, equipment, tools and incidentals necessary for temporary items required for construction of this work.

For pay items 01 59 01-5.1 and 01 59 01-5.4, partial payments will be allowed as follows:

a. With first pay request, 25%.

b. When 25% or more of the original contract is earned, an additional 25%.

c. When 50% or more of the original contract is earned, an additional 40%.

d. After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90-11 of the FAA General Provisions, the final 10%.

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

For pay items 01 59 01-5.2 and 01 59 01-5.3, partial payments 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 01 59 01-5.1	Haul Roads - Per Lump Sum
Item 01 59 01-5.2	Flagmen - Per Lump Sum
Item 01 59 01-5.3	Radios for Monitoring ATCT Communications - Per Lump Sum
Item 01 59 01-5.4	Miscellaneous Temporary Construction Items - Per Lump Sum

PHOTO 1

PHOTO 2

PHOTO 3

PHOTO 4

PHOTO 5

PHOTO 6

PHOTO 7

PHOTO 8

PHOTO 9

PHOTO 10

PHOTO 11

PHOTO 12

PHOTO 13

PHOTO 14

PHOTO 15

PHOTO 16

PHOTO 17

PHOTO 18

PHOTO 19

PHOTO 20

End of Section 01 59 01

Section 01610

BASIC PRODUCT REQUIREMENTS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Transportation, delivery, handling, and storage of products.

1. Follow manufacturers' instructions for same.
2. Repair damage resulting from product transportation, delivery, handling and storage to the satisfaction of the City Engineer.
3. Contractor salvaged products (CSP) are specified in Section 01110 – Summary of Work.

B. Metric conversion.

C. Volatile organic compound (VOC)-producing products.

D. Contractor's responsibilities for product design.

1.02 PRODUCTS

A. "Products" is defined in Section 00700 – General Conditions. "Products" does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing construction designated for reuse.

B. Do not reuse existing products, except as permitted in Section 01110 – Summary of Work.

C. Provide products from the fewest number of manufacturers as practical, to simplify spare parts inventory and to allow for maximum interchangeability of components. For multiple components of the same size, type or application, use the same manufacturer and model of component throughout the Work.

1. Furnish products of latest proven design, new and in current production. Do not use obsolete components or components to be phased out of production.

D. Do not use new or existing products containing asbestos or other hazardous materials except as permitted by governing agencies.

E. When using chlorofluorocarbon (CFC) containing materials, follow regulations governing the release of CFCs into the atmosphere during fabrication or installation.

1.03 TRANSPORTATION

A. Transport, deliver, and handle products as required for timely completion of the Work.

B. Consign and address shipping documents to the proper party giving name of Project, street number, and City. Deliver shipments to proper consignee.

1.04 DELIVERY

A. Deliver products in accord with construction schedule and in ample time for inspection prior to installation. Reduce lengthy storage or overburden of limited storage space due to excessively early deliveries.

B. Coordinate deliveries to avoid conflict with Work and conditions at the site and to accommodate the following:

1. Work of other contractors or City.
2. Limitations of storage space.
3. Availability of equipment and personnel for handling products.
4. City's use of premises.

C. Deliver products only after related submittal data are approved by City Engineer.

D. Deliver products when proper storage facilities are in place.

E. Deliver products to the site in manufacturer's original, unopened, labeled containers. Keep the City Engineer informed of delivery schedules for equipment to be incorporated in the Work.

F. Clearly mark partial deliveries of component parts of equipment to identify the equipment, to permit easy accumulation of parts, and to facilitate assembly.

G. Immediately upon delivery, including CSP, inspect shipment to assure:

1. Product complies with requirements of Contract Documents and reviewed submittals.
2. Quantities are correct.
3. Containers and packages are intact; labels are legible.
4. Products are properly protected and undamaged.
5. Process claims for damages and replacement.

1.05 PRODUCT HANDLING

A. Coordinate off-loading of products delivered to the site, including City-furnished products. If necessary to move stored products during construction, relocate products at no additional cost or time to the contract.

B. Provide handling equipment, personnel and additional protection as required to:

1. Prevent soiling or damage to products, packaging or surrounding work and existing facilities.
2. Prevent bending or overstressing.
3. Lift heavy components only at designated lifting points.
4. Follow manufacturer's recommendations and specified requirements.

C. Do not drop, roll, or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

1.06 PRODUCT STORAGE

A. Provide safe storage of products. Place salvaged products, excavated products, construction equipment, and other products to prevent damage to the Work or Base Facilities (Section 01726 – Base Facility Survey) and to maintain free access at all times to the Work and to City and applicable separate contractors with installations in the vicinity of the Work.

1. Keep products neatly and compactly stored in locations that with least inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants.
2, Arrange storage to provide easy access for inspection.

B. Store products on airport property at location(s) shown on Drawings or approved by City Engineer.

C. Provide bonded off-site storage and protection when on-site storage is not adequate. Submit copy of storage facility bond following Section 01340 – Shop Drawings, Product Data and Samples procedures for certifications.

D. Do not use lawns, grass plots, private property, occupied areas, sidewalks or roadways for storage.

E. Protect stored products against loss or damage.

F. Store in manufacturers' unopened containers, placed on solid supports (sloped to drain at exterior conditions) and covered if subject to erosion or deterioration, except open for inspection and immediately repackage if products are scheduled for immediate installation.

1. Maintain stored products within manufacturer's required environmental range. Provide supplemental ventilation as required to prevent condensation.
2. Store products with clearly visible part numbers, carton numbers, packing lists and other identification markings.

G. Neatly, safely, and compactly stack permitted excavation, fill, pavement and utility products stored along the line of paving and utility work to cause the least inconvenience and damage to Base Facility, occupants, airport operations and the general public, and:

1. No closer than 3 feet to fire hydrants.
2. Keep public and private drives and street crossings open.
3. Distribute evenly along the route of construction to maximum 1000 lineal feet, unless otherwise approved in writing by the City Engineer.

1.07 METRIC CONVERSION

A. The Drawings and Specifications are typically prepared in Imperial (inch and feet) measure, to establish the basis for the contract.

B. Contractor may use SI (metric) measure when SI material, fabrication methods, tolerances and other dimension-controlled characteristics is in normal use by manufacturers and fabricators. Use meters or millimeters only, not centimeters, on submittals.

C. Follow ASTM E380 and ASTM/ANSI E621 for conversion protocol.

1.08 VOC-PRODUCING MATERIAL

A. Provide products and use installation methods producing the least practical amount of volatile organic compounds (VOCs).

B. Schedule and sequence work to allow maximum possible VOC release of products to occur off-site. Follow applicable laws and codes governing atmospheric release of VOCs.

C. For VOC-producing products which by nature must be fabricated or installed on-site, schedule and sequence work to allow initial VOC release as early as possible before Substantial Completion. Follow Section 01630 – Product Options and Substitutions for proposal of products with less VOC than specified products.

D. Contain odors following Section 01505 – Temporary Facilities.

1.09 CONTRACTOR'S RESPONSIBILITIES FOR PRODUCT DESIGN

A. Drawings and Specifications intend for the Contractor to provide product design expertise where actual conditions cannot be anticipated by the Drawings and Specifications or where the Contractor's expertise or suggestions could substantially improve performance of the Work to the benefit of the Work without increase of Contract Sum or Time.

B. The Drawings and Specifications establish the general design concept for the Work.

1. Drawings show “sight-line,” profile, units or modules, alignments and other visual characteristics of work.
2. Specifications state performance requirements including types of materials, fabrication and installation requirements, applicable performance criteria and other aspects of application of work.

C. Drawings and Specifications intentionally address performance and visual characteristics in order to employ Contractor's expertise and choice of fabrication processes and techniques, coordination of the trades and Separate Contracts, correlating and confirming dimensions and other aspects of construction control, or because concealed conditions are not known to Designer.

D. Product engineering design, design of details, and construction procedures within the general design concept is Contractor's responsibility. Supplement general designs with submittal data showing how general design requirements are fulfilled.

1. By accepting a contract for this work, Contractor agrees the requirements shown or specified for known conditions adequately establish the scope, location and other performance and visual requirements for the Work without additional cost or time.
2. If performance and visual requirements are unclear, obtain direction before expenditure of non-recoverable costs including preparation of submittal data, fabrication or acquisition of products and on-site preparatory work. When required, make subcontractors available for consultation at no additional cost.
3. Design, fabrication, erection, and installation of products shall be based on local applicable building codes and local environmental conditions:
   a. Normal Site Elevation, feet ASL: 98.0 (IAH)
   b. Seismic Zone: 0
   c. Highest Wind Velocity, mph: 110 (IAH)
   d. Temperature:
      Coldest Winter Month High: 60 degrees F Low: 41 degrees F
      Warmest Summer Month High: 94 degrees F Low: 73 degrees F
      Lowest Expected: 11 degrees F
      Highest Expected: 107 degrees F
   e. Rainfall:
      Annual: 45 Inches
   f. Design Relative Humidity: 98%
   g. Station Barometric Pressure: 29.5 Inches Hg Abs., average annual

E. When product engineering design is required, use designers licensed to practice the applicable discipline in the State of Texas.

1. Seal design drawings, calculations and submittal data where specified, and process as submittal data.
2. Where seal is not required, provide letter of certification or statement of compliance signed by Subcontractor(s) and countersigned by Contractor stating products are fabricated and installed to meet or exceed requirements.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01630

PRODUCT OPTIONS AND SUBSTITUTIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Procedure for requesting substitution of products in lieu of those specified. These requirements supplement Paragraph 3.10 of Sections 00700 – General Conditions and 00800 – Supplementary Conditions.

B. After submittal period expires, requests for substitutions will be considered only when a specified product becomes unavailable because of conditions beyond Contractor's control.

1.02 DEFINITIONS

A. Process*:* Any proprietary method for installing products that results in an integral, functioning part of the Work. For this Section, the word "product" includes "process."

1.03 SUBMITTALS

A. Submit 5 copies of each separate product substitution request, within time period stated in Section 00700 – General Conditions, including:

1. Full submittal data for specified products, following Section 01340 – Shop Drawings, Product Data and Samples.
2. Full data substantiating compliance of proposed substitutions with Contract Documents and substantiating equivalency with specified products:
   a. Product identification, including manufacturer's name and address.
   b. Manufacturer's literature with precise product description, and directly applicable performance and test data and reference standards.
   c. Samples, as applicable.
   d. Name and address of projects on which proposed product was used in similar or equivalent conditions within the last 3 years, and date of installation.
   e. Name, address and telephone number of owner, designer, and installing contractor.
   f. For process substitutions, detailed description of proposed method and drawings illustrating methods.

B. Detailed reason(s) for substitution, and tangible benefits accruing to City.

C. Itemized comparison of proposed substitutions with specified products and full description of deviations.

D. Fully describe all effects of substitutions on the Work and on separate contracts and work by City. Include full cost data comparing proposed substitution with specified products and amount of change in Contract Sum. Indicate changes in construction schedule (Section 01325 – Construction Schedules).

E. Substitutions are not permitted when:

1. They are not processed following Section 00700 – General Conditions and this Section.
2. Acceptance will require revision of Contract Documents or will change the design concept.
3. Delay in construction will occur.
4. No provisions for substitutions are stated in the Contract Documents.

F. Burden of proof of merit of proposed substitution remains solely with Contractor.

1.02 CONTRACTOR'S OPTIONS

A. Options, stated as "Contractor's option(s)" in Contract Documents, are intended to benefit the Work through reduced cost, decreased construction time, or better performance within designated range of criteria.

B. Volunteer options are not permitted.

C. Notify in writing City Engineer of options chosen.

1.03 QUALITY ASSURANCE

A. To the maximum extent possible, provide products of the same type or function from a single manufacturer, make, or source. Where more than one choice is available, select the product which is compatible with other products already selected, specified, or which is in use by City.

1.04 DESIGNER'S ACTIONS

A. Decision to accept or deny proposed substitute products, or selection of one product instead of another, is solely the responsibility of Designer; such decisions and selections are final.

1.05 COSTS FOR REVIEW OF SUBSTITUTIONS

A. Pay costs related to Designer's review and examination of proposed substitutions. Assume liability for obtaining acceptance of substitutions.

B. Reimburse City for actual evaluation costs of Designer's(s') if proposed substitute does not meet requirements of Contract Documents, or acceptance of proposed substitute requires changes to the Work.

C. Reimburse City for associated design costs, including redesign, additional submittal reviews, investigations, Designer's fees and revision of Contract Documents required because of the requested substitution. Design costs are the full price for additional work performed, paid at the rates established by Designer's contract with City for Design and Contract Documents phase of the Project.

D. Pay for laboratory testing required to obtain information upon which equivalency can be determined.

E. If Designer determines that proposed substitutions are not equivalent to specified products, furnish one of the specified products without delay in time or additional cost to City.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01725

FIELD SURVEYING

PART 1 – GENERAL

1.01 CONTRACTOR'S SURVEYOR

A. Contractor shall employ a State of Texas Registered Public Land Surveyor acceptable to City Engineer.

B. Responsibilities include, but are not limited to:

1. Recovering control points established by City;
2. Verifying benchmarks furnished by City;
3. Establishing temporary benchmarks and construction control points;
4. Recording location(s) and elevation(s) of temporary benchmarks and construction control points;
5. Setting control for grading, cut and fill, and topsoil placement;
6. Establishing horizontal layout and vertical elevations for proposed pavements, storm drainage, airfield lighting and signage, markings, and other project improvements.

1.02 SUBMITTALS

A. Submit to City Engineer the name, address, and telephone number of Surveyor before starting survey work.

B. On request, submit documentation verifying accuracy of survey work.

C. Submit 3 original copies of certificate, signed by surveyor and sealed, stating that horizontal and vertical control lines, elevations, and benchmarks follow Contract Documents.

1.03 PROJECT RECORD DOCUMENTS

A. Maintain a complete and accurate log of control and survey work as it progresses.

B. Prepare a certified survey setting forth dimensions, locations, angles, and elevations of construction and sitework upon completion of the Work.

C. Submit Record Documents following Section 01770 – Contract Closeout.

1.04 EXAMINATION

A. Establish benchmarks, control points, lines and elevations prior to starting work. Notify City Engineer immediately of discrepancies discovered between stated

attributes of City-furnished data and surveyor's verification, using Section 00685 – Request for Information.

1.05 SURVEY REFERENCE POINTS

A. Control datum for survey is that established by City-furnished survey following Section 00700 – General Conditions and indicated on Drawings.

B. Locate and protect benchmarks, control points, lines and elevations prior to starting site work. Preserve permanent reference points during construction.

C. Notify City Engineer 48 hours in advance of need for relocation of reference points due to changes in grades or other reasons.

D. Report promptly to City Engineer the loss or destruction of reference points.

E. Reimburse City for cost of reestablishment of permanent reference points disturbed by Contractor's operations.

1.06 SURVEY REQUIREMENTS

A. Utilize recognized engineering survey practices.

B. Establish a minimum of 2 permanent benchmarks on site, referenced to established control points. Record locations, with horizontal and vertical data, on Record Documents.

C. Establish elevations, lines and levels to provide quantities required for measurement and payment and to provide appropriate controls for the Work. Locate and lay out by instrumentation and similar appropriate means.

D. Periodically verify layouts by same means.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

Section 01726

BASE FACILITY SURVEY

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. "Base Facility" is defined in Section 01423 – References.

B. Survey of Base Facility and related existing conditions.

C. Notification of discoveries.

D. Contractor's survey of Base Facility is intended to identify and describe actual as-found conditions to supplement information contained in Base Facility documents and in the Drawings and Specifications.

E. Necessary changes in location of the Work may be made by City Engineer to avoid unanticipated concealed conditions, following Section 01255 – Modification Procedures.

F. If permanent relocation or reworking of existing conditions is required and not otherwise provided for in the Contract Documents, City Engineer will direct Contractor following Section 01255 – Modification Procedures.

1.02 BASE FACILITY DOCUMENTS

A. Drawing and Specifications for the Work are based on City-furnished Base Facility documents.

1. Contract Documents do not necessarily completely describe all details of Base Facility at interfaces with the Work.

B. Obtain available Base Facility documents from the City Engineer.

1.03 SEQUENCING AND SCHEDULING

A. Sequence and schedule survey to properly coordinate with other construction operations.

B. Complete survey work, process one or more Section 00685 – Request for Information, obtain responses, evaluate and submit cost or schedule impact of responses, and process accepted modifications before commencing work of affected Sections.

C. Obtain or designate and protect control samples of Base Facility work during survey and maintain until required submittals pertinent thereto are processed.

1.04 BASE FACILITY CONDITIONS

A. Base Facility intended or required to remain takes precedence of fact and control over details and construction of interfaces, dimensions, clearances, openings, alignments, and substrate conditions between Base Facility and the Work.

B. Base Facility is intended to remain except as shown on Drawings or as specified.

1.05 DIMENSIONS

A. Control dimensions are indicated by nominal value on the Drawings within parenthesis. This designation means, in addition to other requirements, the Contractor is responsible for finding the actual dimension following this Section, and using actual dimensions to govern placement of work including relationship to and coordination with related work.

1. Follow Section 01255 – Modification Procedures to resolve discrepancies between existing conditions and Contract Documents.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 GENERAL

A. Survey Base Facility affecting or affected by the Work by on-site examination of existing conditions.

B. Explore ahead of trenching and excavation work to uncover obstructing underground structures sufficiently to determine location, to prevent damage and to prevent interruption of services. Restore to original condition damages to underground structure at no cost or time increase to the contract, following Section 01731 – Cutting and Patching.

C. Note discovered discrepancies between the Base Facility and Contract Documents.

1. Use one set of prints of Drawings and Specifications (made from reproducibles furnished following Section 01110 – Summary of Work) for the sole purpose of documenting discoveries. Designate as “SURVEY DOCUMENTS.”
2. Prepare and issue Section 00685 – Request for Information for each discrepancy, following Section 01255 – Modification Procedures.
3. Supplement data noted on survey documents with video or photographs following Section 01321 – Construction Photographs as required to clearly and fully describe conditions.

D. Coordinate survey of semi-exposed and concealed conditions with proposed work.

END OF SECTION

Section 01761

PROTECTION OF EXISTING SERVICES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Requirements to protect existing services and minimize impact of interruptions.

1.02 DEFINITIONS:

A. *Service* is defined to include utilities (natural gas, water, or power); lighting and emergency lighting; data and telecommunications; closed-circuit video, control and monitoring circuits, and air conditioning, heating, and ventilating. Service types include, but are not limited to:

1. Power.
2. Lighting, and emergency lighting.
3. Paging.
4. Telephone.
5. Video.
6. Data and computer networks.
7. Water.
8. Natural gas.
9. Heating, ventilating, and air conditioning

B. *Data and Telecom Service* is defined to include:

1. Wiring and cable used for the transmission of data, voice, or video information.
2. Wiring for low voltage monitoring and control of various types of devices.

C. *Service interruption* is defined to include any temporary or permanent inability to provide the service as contracted or as intended and includes interference with or disruption to source, distribution, or terminal items of a service system.

D. *Response time* is defined to be the time elapsed between the time that a Service Interruption becomes known to the Contractor and the time that a person is at the site of the interruption or, if the site of the interruption is not immediately known, at the job site to diagnose and locate the service interruption.

1.03 PERFORMANCE REQUIREMENTS

A. Contractor is required to protect and maintain existing services to those operating areas of the Airport.

1. Where services are affected by construction activities and interruption of service is required to complete the Work, schedule service interruption to minimize impact.
2. Where services cannot be interrupted, provide alternate services or circuits as required to maintain affected services. Design and implement service "cut-over" so that services are maintained without interruption.

B. Train employees and subcontractors to ensure that accidental service interruptions are promptly recognized and appropriate responses can be initiated.

C. Maintain personnel, equipment, and parts at hand or on call to provide the response times indicated.

D. Interruptions to Existing Service are classified as follows:

1. Security Service Interruption:

a. Any service interruption of power, lighting, or data and telecom service that affects and compromises one of the following:

(1) FAA Security
(2) Airline Security
(3) Airport Security
(4) Other government entity charged with enforcing security at the Airport (Houston Police Department, FBI, Secret Service, etc.).

b. Security Services must be active at all times.

2. Life Safety Service Interruption:

a. Any service interruption of power, lighting, or data and telecom service affecting or compromising one or more of the following life safety systems.

(1) Fire/smoke alarms.
(2) Emergency lighting.
(3) Elevator operations in "Fire" mode.
(4) Emergency intercom systems.

b. Life Safety Services must be active at all times.

3. Business Service Interruption:

a. Any service interruption of utility service (power, lighting, natural gas, data and telecom, etc.) that affects and compromises the ability of a profit-seeking entity to earn revenue, including:

(1) Airline: Includes FIDS network, reservation/confirmation systems, paging systems.
(2) Tenants Other Than Airlines: Point of sale systems, reservation/confirmation systems, utilities for storing, cooking, or maintaining food for sale to the public.

b. Business Services must be active at all times in the areas of the Airport served by Airlines or other tenants during hours of their operation.

4. Comfort / Convenience Service Interruption:

a. Any service interruption of power, lighting, or data and telecom services affecting or compromising the comfort or convenience of those using the Airport (passengers, visitors, employees, concessionaires, etc.) including:

(1) Lighting.
(2) Air Conditioning.
(3) Heating.
(4) Public telephones.
(5) Elevators.

b. Minimize Comfort/Convenience Service Interruptions except in construction areas.

1.04 SUBMITTALS

A. Schedule of service interruptions.

B. Emergency Response Plan.

1.05 QUALITY ASSURANCE

A. Develop emergency response plan for each class of service interruption indicated. Notify other contractors responsible for services and obtain contact information. Where possible, obtain written instructions for emergency repairs

from the contractor responsible for each service. Where required, arrange for contractor personnel to be available to meet required response times.

1.06 COORDINATION AND SEQUENCING

A. Schedule and execute construction activities to prevent service interruption or, where service interruption is required to complete the Work, minimize service interruption.

1.07 SCHEDULING

A. Follow Section 01325 – Construction Schedules.

B. Develop a schedule of required service interruptions. Coordinate with the schedules required by Section 01325 – Construction Schedules and revise as required by the City or project conditions.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES:

A. Follow Section 01726.

B. Scheduled Service Interruptions: Notify the City Engineer in writing not less than 7 days in advance of a scheduled service interruption. Use the attached form and include the following information in addition to the information required on the form:

1. Type and classification of service.
2. Location.
3. Area(s) affected.
4. Entities affected.
5. Expected duration.

C. Unscheduled Service Interruptions to Data and Telecom Service:

1. Immediately notify IAH 24-Hour Emergency Dispatch Service at (281) 230-3024. Do not attempt to repair these lines. Include the following information:

a. Location.
b. Area(s) affected.

c. Type and classification of service (if known).
d. Entities affected (if known).

2. In addition to the notification requirements above, immediately notify the City Engineer of interruption.

D. Unscheduled Service Interruptions to Service Other Than Data and Telecom Service:

1. When executing Work in an area known to have existing services, maintain on-site or on-call capability to initiate repairs to unscheduled service interruptions within the response times required.
2. Immediately notify the City Engineer of interruption.

a. Location.
b. Area(s) affected.
c. Type and classification of service (if known).
d. Entities affected (if known).

3. Response Times to Interruptions to Existing Service:

a. Security Service Interruption: 15 minutes.
b. Life Safety Service Interruption: 15 minutes.
c. Business Service Interruption:

(1) Service Interruptions to Airlines: 15 minutes.
(2) Service Interruptions to Tenants other than Airlines: 1 hour.

d. Comfort/Convenience Service Interruption: 1 hour.

END OF SECTION

SERVICE INTERRUPTION REQUEST/NOTIFICATION

TO: IAH Operations	**DATE RECEIVED:**
ATT:	**REF:**

(General Contractor to Complete this Block)

GENERAL CONTRACTOR:		**PROJECT NUMBER:**
PHONE NUMBER:	**PAGER NUMBER:**	**FAX NUMBER:**

(Subcontractor to Complete this Block)

SUBCONTRACTOR:	**PHONE NUMBER:**
	FAX NUMBER:
	PAGER NUMBER:
TYPE AND CLASSIFICATION OF SERVICE:	
LOCATION OF INTERRUPTION:	**DATE OF INTERRUPTION**
AREAS AFFECTED:	**TIME OF INTERRUPTOIN**
ENTITIES AFFECTED:	**EXPECTED DURATION**
SIGNATURE	**DATE:**

Do not write below this line

RESPONSE:

Construction Request

IAH AIRPORT OPERATIONS - CONSTRUCTION

Once WAN is approved, this will change from a red "Construction Request" to a green WAN "Approval".

TO: Airport Operations	**WAN #**
ATT: Construction – IAH Operations	**CONTRACTOR:**
OFFICE NUMBER	**DATE:**
FAX NUMBER:	**TIP PROJECT NUMBER:**
E-MAIL: Cynthia.Straughan@houstontx.gov Robert.Vinson@houstontx.gov Darril.Diemer@houstontx.gov	**Onsite contact / phone #'s:**

FROM:
OFFICE NUMBER:
MOBILE NUMBER:
FAX NUMBER:

LOCATION	DESCRIPTION	DATE OF REQUEST	TIME OF REQUEST	COMMENTS

Operations - Construction Response:

Section 01770

CONTRACT CLOSEOUT

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Submittal of Operation and Maintenance (O & M) manual, lien releases, record documents, badges, and keys.

B. O & M manual format and contents.

C. Final cleaning. Interim cleaning is specified in Section 01505 – Temporary Facilities.

D. Systems demonstrations and personnel training.

E. Notification of Substantial Completion.

F. Contractor's punch list.

G. Record of the Work.

1.02 SUBMITTALS

A. One month before Substantial Completion inspection, submit 2 sets of Preliminary O & M manual (Paragraph 1.03), 1 copy to Designer and 1 copy direct to City Engineer.

B. Subsequent to Preliminary O & M manual submittal and precedent to final Certificate for Payment, submit the following:

1. Five (5) sets of final O & M manual with one (1) original executed warranty plus four (4) copies, in same format as preliminary O & M manual.
2. Release or Waiver of Liens and consents of sureties following Sections 00700 – General Conditions and 00800 – Supplementary Conditions.
3. Record Documents following Section 00700 – General Conditions and Paragraph 1.08 below.
   a. Bind documents, material as directed by City Engineer, with metal folding clasps (such as used for file folders) at top and bottom along binding edge. Collate into separate sets for Drawings, shop drawings, and other drawings.
   b. Bind Project Manual, product data and similar page-type data in separate 3-ring “D” binders, contents marked on spine.
   c. CADD diskettes in plastic file box.
   d. Videotapes and photographs following Section 01321 – Construction Photographs.

e. Other data as directed.
4. Security identification badges.
5. Construction and other master keys.

1.03 O&M MANUAL CONTENTS AND FORMAT

A. Provide O & M Manual with full information to allow matching products under future contracts to products under this contract, and to allow City to operate, maintain and repair (for user-serviceable aspects) products, including trade names, model or type numbers, colors dimensions, and other physical characteristics.

B. Format:

1. Produce on 8-1/2-inch x 11-inch pages, and bind in 3-ring/D binders with durable plastic covers.
2. Label binder covers with printed title “OPERATION AND MAINTENANCE MANUAL”, title of project, and subject matter and “Number _ of _” of binder when multiple binders are required.
3. Separate each “Part” with substantial dividers tabbed and titled by Part number

C. Contents:

1. Table of Contents for each volume, naming each Part.
2. Part 1: Directory with name, address, and telephone number of Designer, Contractor, and Subcontractors and Suppliers for each Project Manual Section.
3. Part 2: Operation and maintenance instructions, arranged by Project Manual Section number where practical, and where not, by system. Include:
   a. For finish materials, maintenance instructions prepared by manufacturers, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
   b. Utility, door and window hardware, HVAC, plumbing and electrical products, prepared by product manufacturer, including:
      1) Product design criteria, functions, normal operating characteristics, and limiting conditions.
      2) Assembly, installation, alignment, adjustment, checking instructions, and troubleshooting guide.
      3) Operating instructions for start-up, normal operation, regulation and control, normal shutdown, and emergency shutdown.
      4) Lubrication and detailed maintenance instructions; detailed drawings giving location of each maintainable part and lubrication point and detailed instructions on disassembly and reassembly of products.
      5) Spare parts list for operating products, prepared by manufacturers, including detailed drawings giving location of each maintainable part;

describe predicted life of parts subject to wear, lists of spares recommended for user-service inventory, and nearest source of in-stock spares.

6) Outline, cross-section, and assembly drawings; engineering data; wiring diagrams.
7) Test data and performance curves.

4. Part 3: Project documents and certificates, including:
   a. Shop drawings, product data, and where practical, samples.
   b. Air and water balance reports.
   c. Certificates of occupancy or use.
   d. Product certifications and mix designs.
   e. Material Safety Data Sheets.
5. Part 4: Copy (not original) of each warranty form containing language of final warranty.
6. Part 5: Meeting notes from systems demonstrations.
7. Revise content and arrangement of preliminary Manual until approval by City Engineer.

1.04 FINAL CLEANING

A. Execute final cleaning prior to Substantial Completion of each Phase.

B. Not Used.

C. Remove and legally dispose of waste and surplus products and rubbish from site.

D. Not Used.

E. Not Used.

F. Remove temporary facilities and controls.

G. Leave project site in such condition that no further cleaning of construction is required by City.

H. Adjust products to proper operating condition.

I. Correct defective function of products.

1.05 SYSTEMS DEMONSTRATIONS AND PERSONNEL TRAINING

A. Demonstrate proper operation and maintenance of each product to City’s maintenance personnel precedent to Substantial Completion inspection.

B. Precedent to submittal of O & M Manual, train City's maintenance personnel in proper operation, adjustment, and maintenance of products and systems, using

the preliminary O & M Manual as the basis of instruction. Continue training until City's personnel demonstrate proper knowledge and skills.

C. Take minutes of meetings, including sign-in sheet, and record subjects covered in each session. Bind minutes in O&M Manual.

1.06 NOTIFICATION OF SUBSTANTIAL COMPLETION

A. When Contractor considers the Work (or a designated portion or stage thereof identified in Section 01326 – Construction Sequencing) substantially complete, submit written notice and Punchlist (Paragraph 1.04) to City Engineer.

1. Do not claim Substantial Completion until authorities having jurisdiction issue certificates of occupancy or use and related inspections affirming compliance.
2. Attach copy of each certificate to Substantial Completion form.

B. Within a reasonable time after receipt of certificates, an inspection will be made by City Engineer and Designer to determine status of completion.

C. Should the Work be determined by City Engineer as not substantially complete as a result of any Substantial Completion inspection, Contractor will notified in writing.

1. Remedy deficiencies.
2. Send written notice of Substantial Completion as above.
3. City Engineer and Designer will re-inspect the Work.
4. Pay costs of Designer’s second and subsequent Substantial Completion inspections, by Change Order.

D. When the Work is determined as substantially complete, the Certificate of Substantial Completion will be executed.

1.07 CONTRACTOR'S PUNCHLIST

A. Prior to and in connection with Substantial Completion procedures, prepare a written Punchlist for each Phase and as follows:

1. Designer will provide one reproducible copy of then-current contract plans. These drawings are the basis of Contractor’s Punchlist.
2. Inspect the Work and mark applicable comments on the contract plans. Prepare written notes as required to supplement notes made on drawings.
3. Continue completion of the Work including Punchlist items, marking off completed items.
4. Forward the annotated Drawings to City Engineer as directed, accompanied by notification that Substantial Completion Inspection is ready.

B. Schedule Punchlist Inspection and other closeout inspections through City Engineer.

C. Punchlist inspection will be attended by the following as a minimum:

1. Contractor, Contractor's Superintendent, and applicable Subcontractors' superintendents. Attend with Punchlist drawing.
2. City Engineer.
3. Designer.
4. Others of City Engineer's choice.

D. Substantial Completion inspection will be made during one or more mutually agreed times to inspect the Work, to review and amend Contractor's Punchlist. If the work is substantially complete, Section 00645 – Certificate of Substantial Completion will be executed.

1. Amendments to the Contractor's Punchlist will be made on the reproducible.
2. Within 5 days of execution of Section 00645 – Certificate of Substantial Completion, provide 4 copies of the amended Punch List and original Section 00645 – Certificate of Substantial Completion to City Engineer.

E. Expeditiously correct work.

F. Process each re-inspection as above and in Paragraph 1.04.

G. Punchlist items and corrections required after execution of Section 00650 – Certificate of Final Completion will be processed as warranty work following Section 00700 – General Conditions, Paragraph 3.12.

1.08 RECORD OF THE WORK

A. Following requirements expand Paragraph 3.16 of Sections 00700 – General Conditions and 00800 – Supplementary Conditions.

B. Record information concurrently with construction progress. Do not conceal work until required information is recorded.

C. Keep in a secure location in the contractor's field office (Section 01505 – Temporary Facilities) and timely record the Work as actually built as the Work progresses.

1. Use one set of Drawings made from reproducibles and one set of Project Manual furnished under Section 01110 – Summary of Work. Use one set of submittal data, video and photographic data, and other record data as required by Contractor to support and supplement records made on Drawings and Project Manual.

2. Legibly note variations from Contract Documents on Drawings, Project Manual and submittal data, whichever most clearly shows the change.
3. Clearly mark each document in red ink "RECORD OF THE WORK. Use only for recording field deviations and actual constructed conditions and arrangements."

D. Keep documents current and make available for inspection by City Engineer.

E. Show following minimum information, as applicable to type of work, marked in fine-point red ink:

1. Measured depths of foundation elements in relation to finish first floor datum.
2. Measured horizontal locations and elevations of underground utilities and appurtenances, referenced to permanent surface improvements.
3. Elevations of underground utilities referenced to City's benchmark utilized for project.
4. Measured locations of internal utilities, environmental systems and appurtenances concealed in construction, referenced to visible and accessible features of construction.
5. Field changes of dimension and detail.
6. Changes made by RFI (Section 00931 – Request for Information).
7. Changes made by Modifications.
8. Details not on original Contract Documents.
9. References to related shop drawings, product data, samples, RFIs and Modifications.

F. Upon completion of the Work, collect marked-up Drawings, one single-sided copy of marked-up Project Manual, one set of shop drawings (including diskettes of CAD files prepared as part of the Contract, such as data required by Section 01340 – Shop Drawings, Product Data, and Samples), one original set of product data (Section 01340 – Shop Drawings, Product Data and Samples), one set of RFIs, one set of Modifications, one set of originals of video tapes and one copy of photographs (Section 01321 – Construction Photographs), and other required documents.

1. Clearly mark each document, immediately adjacent to the "RECORD OF THE WORK" mark, in red ink thus:

   "CERTIFIED AS THE CORRECT AND COMPLETE RECORD OF WORK PERFORMED.
   _____(Contractor Firm Name)
   _____(Authorized Signature)
   _____(Date)"

G. Transmit all records to City Engineer.

H. Transmit reproducible copies of Drawings (see Section 01110 – Summary of Work) to City Engineer.

I. Submit proper record of the Work, in addition to other requirements in the Contract Documents, precedent to City Engineer's authorization for release of final payment.

1.09 FORWARDING CSP AND EXTRA PRODUCTS (Not Used)

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SSection 01785

PROJECT RECORD DOCUMENTS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Maintenance and submittal of record documents and Samples.

1.02 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Maintain one record copy of documents at the site in accordance with Document 00700 - General Conditions,

B. Store record documents and Samples in field office, if a field office is required by the Contract, or in a secure location. Provide files, racks, and secure storage for record documents and Samples.

C. Label each document "PROJECT RECORD" in neat, large, printed letters.

D. Maintain record documents in a clean, dry, and legible condition. Do not use record documents for construction purposes. Do not use permit drawings to record Modifications to the Work.

E. Keep record documents and Samples available for inspection by Project Manager.

F. Bring record documents to progress review meetings for viewing by Project Manager and, if applicable, Design Consultant.

1.03 RECORDING

A. Record information legibly with red ink pen on a set of blueline opaque drawings, concurrently with construction progress. Maintain an instrument on site at all times for measuring elevations accurately. Do not conceal work until required information is recorded

B. Contract Drawings and Shop Drawings: Mark each item to record completed Modifications, or when minor deviations exist, the actual construction including:

1. Measured depths of elements of foundation in relation to finish first floor datum.

2. Measured horizontal locations and elevations of Underground Facilities and appurtenances, referenced to permanent surface improvements.

3. Elevations of Underground Facilities referenced to City of Houston benchmark utilized for the Work.

4. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.

5. Dimensions and details of field changes.

6. Changes made by Modifications.

7. Details not on original Drawings.

8. References to related Shop Drawings and Modifications.

C. Survey all joints of water mains at the time of construction. Record on Drawings, water main invert elevation, elevation top of manway, and centerline horizontal location relative to baseline.

D. For large diameter water mains, mark specifications and addenda to record:

1. Manufacturer, trade name, catalog number and Supplier of each Product actually Installed.

2. Changes made by Modification or field order.

3. Other matters not originally specified.

E. Annotate Shop Drawings to record changes made after review.

1.04 SUBMITTALS

A. At closeout of the Contract, deliver Project record documents to Project Manager.

PART 2 P R O D U C T S - Not Used

PART 3 E X E C U T I O N - Not Used

END OF SECTION

Section 02221

REMOVING EXISTING PAVEMENTS AND STRUCTURES

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Removing pipe culverts, sewers, and sewer leads.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for removing and disposing of pipe culverts, sewers, and sewer leads, is on linear foot basis for each diameter and each material type of pipe removed.
2. No payment will be made for work outside maximum payment limits indicated on Drawings, or for pavements or structures removed for Contractor's convenience.

1.03 REGULATORY REQUIREMENTS

A. Conform to applicable codes for disposal of debris.

B. Coordinate removal work with utility companies.

PART 2 P R O D U C T S - Not Used.

PART 3 E X E C U T I O N

3.01 PREPARATION

A. Obtain advance approval from Project Manager for dimensions and limits of removal work.

B. Identify known utilities below grade. Stake and flag locations.

3.02 PROTECTION

A. Protect following from damage or displacement:

1. Adjacent public and private property.
2. Trees, plants, and other landscape features designated to remain.
3. Utilities designated to remain.

4. Pavement and utility structures designated to remain.
5. Bench marks, monuments, and existing structures designated to remain.

3.03 REMOVALS

A. Remove pavements and structures by methods that will not damage underground utilities. Do not use drop hammer near existing underground utilities.

B. Minimize amount of earth loaded during removal operations.

3.04 BACKFILL

A. Backfill of removal areas shall be in accordance with requirements of FAA Specification D-751 Manholes, Catch Basins, Inlets and Inspection Holes.

3.05 DISPOSAL

A. Inlet frames, grates, and plates; and manhole frames and covers, may remain City property.

B. Remove from site, debris resulting from work.

END OF SECTION

Section 02222

ABANDONMENT OF SEWERS

PART 1 G E N E R A L

1.1 SECTION INCLUDES

A. Abandonment in place of existing sewers, junction structures, manholes, and force mains.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for grout fill and abandonment of existing sewers, including boxes and elliptical shaped sewers, is on linear foot basis for each diameter of sewer being abandoned. Measurement will be along centerline of sewer from centerline to
centerline of manholes.

2. Payment will be full compensation for all material, equipment, and labor required for complete abandonment grouting, including air venting, testing, temporary plugs, fill lines, excavations, and incidentals.

3. No separate payment will be made for plugging and abandoning sewer force mains. Include cost of such abandonment in related work.

4. Acceptability of grout material is based on achieving average strength within range of 75 to 150 psi as defined in Paragraph 2.01B.1. Grout that is out of range after placement may be accepted with price adjustment of 1.0 percent price deduction for each psi average compressive strength below 75 psi and 0.5 percent price deduction for each psi average compressive strength above 150 psi, as applicable to material volume represented by test series. Shrinkage in grout material placements shall be remedied by Contractor according to Paragraph 3.04H without additional compensation.

1.3 DEFINITIONS

A. Abandonment. Sewer abandonment consists of demolition and removal of portion of manholes existing within specified depth of surface, and abandonment in place of sewer lines and manholes as specified in this Section.

B. Flowable Fill. Flowable fill (abandonment grout) shall be controlled low-strength material consisting of fluid mixture of cement, fly ash, aggregate, water and with admixtures as necessary to provide workable properties. Placement of flowable fill may be by grouting techniques in sewer pipes or other restricted areas, or as mass placement by chutes or tremie methods in unrestricted locations with open access. Long-term hardened strength shall be within specified range.

C. Ballast. Large aggregate either replaced with voids subsequently filled with flowable fill injected by grouting method; or in areas with open access, placed individually and sequentially at same time as flowable fill placement.

D. Backgrouting. Secondary stage pressure grouting to ensure that voids have been filled within abandoned sewer. Backgrouting will only be required at critical locations indicated on
Drawings or if there is evidence of incomplete flowable fill placements.

1.4 REFERENCE STANDARDS

A. ASTM C 150 - Standard Specification for Portland Cement.

B. ASTM C 494 - Standard Specification for Chemical Admixture for Concrete.

C. ASTM C 618 - Standard Specification for Fly Ash and Raw or Calcinated Natural Pozzolan for use as Mineral Admixture in Portland Cement Concrete.

D. ASTM C 937 - Standard Specification for Grout Fluidifier for Pre-placed Aggregate Concrete.

E. ASTM C 940 - Standard Test Method for Expansion and Bleeding of Freshly Mixed Grout for Replaced Aggregate Concrete in the Laboratory.

F. ASTM C 1017 - Standard Specification for Chemical Admixture for Use in Producing Flowing Concrete.

G. ASTM C 1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)

1.5 SUBMITTALS

A. Flowable fill mix design report:

1. Flowable fill type and production method. Describe if fill will be mixed to final proportions and consistency in batch plant or if constituents will be added in transit mixer at placement location.

2. Use of ballast. Provide percentage of ballast of total placement and size limits for ballast if fill is intended to be used with ballast.

3. Aggregate gradation of fill. Aggregate gradation of mix (excluding ballast) shall be used as pilot curve for quality control during production.

4. Fill mix constituents and proportions including materials by weight and volume, and air content but excluding ballast. Give types and amounts of admixtures including air entrainment or air generating compounds.

5. Fill densities and viscosities, including wet density at point of placement.

6. Initial time of set.

7. Bleeding and shrinkage.

8. Compressive strength.

B. Technical information for equipment and operational procedures including projected slurry injection rate, grout pressure, method of controlling grout pressure, bulkhead and vent design, and number of stages of grout application.

C. Experience record for proposed crew, showing minimum of 100 cubic yards of flowable fill placed using proposed or similar equipment and methods.

D. At least 60 days prior to commencing abandonment activities, submit plan for abandonment, describing proposed grouting sequence, bypass pumping requirements and plugging, if any, and other information pertinent to completion of work.

PART 2 P R O D U C T S

2.1 FLOWABLE FILL

A. Design Mix Criteria. Provide design of one or more mixes to meet design criteria and conditions for placement. Present information required by Paragraph 1.05B in mix design report including following:

1. Cement: ASTM C 150 Type I or II. Volume and weight per cubic yard of fill. Provide minimum cement content of 100 pounds per cubic yard.

2. Fly ash: ASTM C 618 Class C or F. Volume and weight per cubic yard of fill. Provide minimum Fly ash content of 200 pounds per cubic yard.

3. Potable water: Volume and weight per cubic yard of fill. Amount of water determined by mix design testing.

4. Aggregate gradation: 100 percent passing 3/8-inch sieve and not more than 10 percent passing No. 200 sieve. Mix design report shall define pilot gradation based on following sieve sizes 3/8-inch, Nos. 4, 8, 16, 30, 50, 100, and 200. Do not deviate from pilot gradation by more than plus or minus 10 percentage points for any sieve for production material.

5. Aggregate source material: Screened or crushed aggregate, pit or bank run fine gravels or sand, or crushed concrete. If crushed concrete is used, add at least 30 percent of natural aggregate to provide workability.

6. Admixtures: Use admixtures meeting ASTM C 494 and ASTM C 1017 as needed to improve pumpability, to control time of set, and reduce bleeding.

7. Fluidifier: Use fluidifier meeting ASTM C 937 as necessary to hold solid constituents in suspension. Add shrinkage compensator if necessary.

8. Performance additive: Use flowable fill performance additive, such as Darafill or approved equal, to control fill properties.

B. Flowable Fill Requirements

1. Unconfined compressive strength: minimum 75 psi and maximum

150 psi at 56 days as determined based on an average of three tests for same placement. Present at least three acceptable strength tests for proposed mix design in mix design report.

2. Placement characteristics: self-leveling.

3. Shrinkage characteristics: non-shrink.

4. Water bleeding for fill to be placed by grouting method in sewers: not to exceed 2 percent according to ASTM C 940.

5. Minimum wet density: 90 pounds per cubic foot.

2.2 BALLAST

A. Ballast Material: Natural rock or concrete pieces with minimum size equal to at least 10 times maximum aggregate size of flowable fill and maximum size of 24 inches. Maximum dimension shall not be more than 20 percent of minimum dimension of space to be filled.

B. Ballast Composition: Free of regulated waste material.

2.3 PLUGS FOR FORCE MAINS

A. Grout Plugs: Cement-based dry-pack grout conforming to ASTM C 1107, Grade B or C.

B. Manufactured Plug: Commercially available plug or cap specifically designed and manufactured to be used with pipe being abandoned.

PART 3 E X E C U T I O N

3.1 PREPARATION

A. Have fill mix design reports and other submittals required by Paragraph 1.05 accepted by Project Manager prior to start of placement. Notify Project Manager at least 24 hours in advance of grouting with flowable fill.

B. Select fill placement equipment and follow procedures with sufficient safety and care to avoid damage to existing underground utilities and structures. Operate equipment at pressure that will not distort or imperil portion of work, new or existing.

C. Clean sewer lines and video with closed circuit television to identify connections, locate obstructions, and assess condition of pipe. Locate previously unidentified connections, which have not been redirected and reconnected as part of this project, and report them to Project Manager. During placement of fill, compensate for irregularities in sewer pipe, such as obstructions, open joints, or broken pipe to ensure no voids remain unfilled.

D. Perform demolition work prior to starting fill placement. Clean placement areas of sewers and manholes of debris that may hinder fill placement. Remove excessive amounts of sludge and other substances that may degrade performance of fill. Do not leave sludge or other debris in place if filling more than 2 percent of placement volume.

E. Remove free water prior to starting fill placement.

3.2 EQUIPMENT

A. Mix flowable fill in automated batch plant and deliver it to site in ready-mix trucks. Performance additives may be added at placement site if required by mix design.

B. Use concrete or grout pumps capable of continuous delivery at planned placement rate.

3.3 DEMOLITION OF SEWER MANHOLES, PIPELINE STRUCTURES, AND FORCE MAINS PRIOR TO ABANDONMENT

A. Remove manhole frames and covers and castings from other existing pipeline structures. Deliver castings to nearest City of Houston maintenance facility for future use. Alternatively, salvaged castings may be used upon approval by Project Manager, for constructing new manholes on this project.

B. Demolish and remove precast concrete adjustment rings and corner section, or brick and mortar corbel and chimney, or other pipeline structure, to minimum depth of 4 feet below finished grade. Structure may be removed to greater depth, but not deeper than 18 inches above crown of abandoned sewer.

3.4 INSTALLATION

A. Abandon sewer lines by completely filling sewer line with flowable fill.

Abandon manholes and other structures by filling with flowable fill, together with ballast as applicable, within depth of structures left in place.

B. Place flowable fill to fill volume between manholes. Continuously place flowable fill from manhole to manhole with no intermediate pour points, but not exceeding 500 feet in length.

C. Have filling operation performed by experienced crews with equipment to monitor density of flowable fill and to control pressure.

D. Temporarily plug sewer lines which are to remain in operation during pouring/pumping to keep lines free of flowable fill.

E. Pump flowable fill through bulkheads constructed for placement of two 2-inch PVC pipes or use other suitable construction methods to contain flowable fill in lines to be abandoned. These pipes will act as injection points or vents for placement of flowable fill.

F. Place flowable fill under pressure flow conditions into properly vented open system until flowable fill emerges from vent pipes. Pump flowable fill with sufficient pressure to overcome friction and to fill sewer from downstream end, to discharge at upstream end.

G. Inject flowable fill through replaced ballast using grouting equipment and series of grout pipes discharging at bottom of placement, allowing fill to rise through ballast effectively filling all voids. Alternatively, sequentially place individual pieces of ballast at same time as flowable fill is placed. Do not fill with ballast more than 50 percent of volume at any level, to prevent nesting and void formation.

H. Remediate placement of flowable fill which does not fill voids in sewer, in manhole or other structures, or where voids develop due to excessive shrinkage or bleeding of fill, by using pressure grouting either from inside sewer or from surface.

I. Plug each end of force main being abandoned.

J. Backfill to surface, above pipe or structures left in place, with flowable fill in restricted areas, compacted bank run sand in unrestricted areas to be paved or select fill in unrestricted areas outside of pavement. Place and compact backfill, other than flowable fill, in compliance with Section 02317 - Excavation and Backfill for Utilities.

K. Collect and dispose of excess flowable fill material and other debris.

3.5 FIELD QUALITY CONTROL

A. Provide batch plant tickets for each truck delivery of flowable fill. Note on tickets addition of admixtures at site.

B. Check flow characteristics and workability of fill as placement proceeds.

C. Obtain at least three test cylinders for each placement area for determination of 56-day compressive strength and bleeding. Acceptance of placement will be based on average strength of three tests.

D. Record volume of ballast together with flowable fill placement for same space to demonstrate that voids have been filled.

3.6 PROTECTION OF PERSONS AND PROPERTY

A. Provide safe working conditions for employees throughout demolition and removal operations. Observe safety requirements for work below grade.

B. Maintain safe access to adjacent property and buildings. Do not obstruct roadways, sidewalks or passageways adjacent to work.

END OF SECTION

Section 02322

FLOWABLE FILL

PART 1 G E N E R A L

1.1 SECTION INCLUDES

A. Flowable Fill for furnishing, mixing, transporting and placing flowable fill.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for flowable fill under this Section.

1.3 REFERENCES

A. ASTM C 31 – Making and Curing Concrete Test Specimens in the field.

B. ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens.

C. ASTM C 40 – Organic Impurities in Fine Aggregates for Concrete.

D. ASTM C 94 - Ready-Mixed Concrete.

E. ASTM C 150 - Portland Cement.

F. ASTM C 192 – Making and Curing Concrete Test Specimens in the Laboratory.

G. ASTM C 260 – Air-Entraining Admixtures for Concrete.

H. ASTM C 494 - Chemical Admixtures for Concrete.

I. ASTM C 618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Concrete.

J. ASTM C 4318 – Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.4 SUBMITTALS

A. Submit proposed mix design.

B. Submit a copy of delivery tickets accompanied by batch tickets, providing the information required by ASTM C 94 to Engineer in the field at time of delivery.

PART 2 P R O D U C T S

2.1 GENERAL

A. Provide material conforming to:

1. Cement- ASTM C 150, Type I.

2. Fly Ash – ASTM C 618, Class C, with a minimum CaO content of 20 percent.

3. Water- ASTM C 94.

4. Fine Aggregate – Natural or manufactured fine aggregate, or a combination there of, free from deleterious amounts of salt, alkali, vegetable matter or other objectionable material. The plasticity index shall be 4 or less when tested in accordance with ASTM D 4318. Organic impurities, when tested in accordance with ASTM C 40, shall not show a color darker than the standard color. It is intended that the fine aggregate be fine enough to stay in suspension in the mortar to the extent required for proper flow. The fine aggregate shall conform to the following gradation:

Sieve Size Passing	Percent
3/8 inch	100
No. 200	0-10

If flowable mixture cannot be produced, the fine aggregate may not be approved.

5. Admixtures – ASTM C 260 and /or C 494.

2.2 MIX DESIGN

A. Mix design shall state the following information:

1. Mix design number or code designation to order the concrete from the supplier.
2. Design strength at 7 days (unless otherwise noted on the Plans).
3. Cement type and brand.
4. Fly ash type and brand.
5. Admixtures type and brand.
6. Proportions of each material used.

B. Minimum strength requirement is 100 psi in 7 days unless otherwise noted on the Plans.

PART 3 E X E C U T I O N

3.1 BATCHING, MIXING AND TRANSPORTATION

A. Batch, mix and transport flowable fill in accordance with ASTM C 94, except when directed otherwise by the Engineer.

B. Mix flowable fill in quantities required for immediate use. Do not use portions which have developed initial set or which are not in place within 90 minutes after the initial water has been added.

C. Do not mix flowable fill while the air temperature is at or below 35 degrees F. without prior approval of the Engineer.

3.2 PLACEMENT

A. Seal off the area to be repaired.

B. Monitor and control the fluid pressure during placement of flowable fill prior to set. Take appropriate measures to avoid excessive pressure that may damage or displace structures or cause flotation. Cease operations if flowable fill is observed leaking from the repair area. Repair or replace damaged or displaced structures at no additional cost.

3.3 CLEAN UP

A. Clean up excess flowable fill discharged from the work area and remove excess flowable fill from pipes at no additional cost.

END OF SECTION

Section 02 41 13.14

SAWCUTTING

DESCRIPTION

1.01 This work shall consist of sawcutting existing concrete and / or asphaltic concrete pavements to provide uniform joint alignments in sound material, as shown on the plans. Sawcutting of existing pavements may be required for the abutment of new pavement to existing pavement. This item shall include the furnishing of all labor, materials, equipment and incidentals necessary to perform the work.

EQUIPMENT

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

CONSTRUCTION METHODS

3.01 The Contractor shall establish the line to be cut using chalkline or similar means. The face of any sawcut shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/4 inch and no gradual offset greater than one (1) inch when tested in a horizontal direction with a 16-foot straightedge.

3.02 The sawcut depth shall be full depth so that spalling or other breakage of the existing pavement along the bottom of the pavement does not occur. If spalling or other breakage of the pavement does occur, the Contractor shall relocate the sawcut line to a point deeper in the existing pavement to remove completely any spalled or broken pavement so that the underlying base and / or subbase layers is not damaged and the new pavement can be constructed up against the existing pavement without either the new or existing pavement strength and pavement section being compromised. Sawcutting depth may vary nominally and no extra payment will be allotted for varying depths.

3.03 A vacuum truck shall be required for use during all sawcutting operations in order to collect all dust, chips, slurry, or waste material as a result of sawcutting operations. All waste material shall be carefully collected and removed from the site in accordance with the general safety requirements of the Contract and disposed of legally off the airport property.

METHOD OF MEASUREMENT

4.01 The quantity of sawcutting of existing pavement shall not be measured for payment.

BASIS OF PAYMENT

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

End of Section 02 41 13.14

Section 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This item is intended to supplement the specifications for the Airfield Electrical, Lighting and Lighting Control requirements of this contract. It is the intent and meaning of the Plans and Specifications that the Contractor shall provide an electrical installation that is operational and complete, including all items and appurtenances necessary, reasonably incidental or customarily included, even though each and every item is not specifically called out or shown.

B. Installations and construction under these provisions shall be coordinated with the Airport Construction Manager. Specification requirements for approvals, reviews, or other involvements of the Engineer shall be transmitted by the Contractor through the Construction Manager to the Engineer.

1.02 APPLICABLE CODES AND STANDARDS.

A. Codes. All electrical work shall conform with the requirements and recommendations of the latest edition of the National Electrical Code. In conflicts among drawings, specifications and codes, the most stringent requirements shall govern.

B. Standards. The specifications and standards of the following organizations are by reference made part of these specifications and all electrical work, unless otherwise indicated, shall comply with their requirements and recommendations wherever applicable.

1. Institute of Electrical and Electronic Engineers (IEEE)
2. American National Standards Institute (ANSI)
3. American Society for Testing and Materials (ASTM)
4. Insulated Power Cable Engineers Association (ICEA)
5. National Institute of Standards and Technology (NIST).
6. National Electrical Contractor's Association (NECA)
7. National Electrical Manufacturer's Association (NEMA)
8. National Fire Protection Association (NFPA)
9. Underwriter's Laboratories, Inc. (UL)
10. National Electrical Safety Code (NESC)

PART 2 QUALITY ASSURANCE

2.01 REQUIREMENTS OF REGULATORY AGENCIES

A. Airport lighting equipment and materials covered by FAA specifications shall be certified under the Airport Lighting Equipment Certification Program described in Advisory Circular (AC) 150/5345-53, current edition, and be listed in the current Addendum of the AC. All Advisory Circulars referenced in these specifications shall be the latest edition.

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

C. The requirements and recommendations of the latest edition of the Occupational Safety and Health Act are by reference made a part of these specifications and all electrical work shall comply with their requirements and recommendations wherever applicable.

2.02 WORKMANSHIP AND PERSONNEL REQUIREMENTS

A. All electrical work shall be performed by workmen skilled in the electrical trade and licensed for the work either by the City of Houston or State of Texas. The Houston Airport System Airport Building Official will recognize the credentials of Master Electricians with valid current licenses from Houston. Credentials will be recognized of Journeyman Electricians with valid current licenses from Houston or other licensing entities having established reciprocal agreements with these municipalities.

B. A licensed Master Electrician will be required for the issuance of a building permit for constructing, installing, altering, maintaining, repairing or replacing any electrical wiring, apparatus, or equipment on any voltage level in the jurisdiction of the Airport.

C. A licensed Master Electrician or a licensed Journeyman Electrician is required to be on the job site whenever any electrical work is performed. Any airfield electrical work or associated electrical installations shall be accomplished under the direct supervision of a licensed Journeyman Electrician.

D. To insure compliance with Paragraph "c" above, only a documented Electrical work force with a ratio of a maximum ration of 3 licensed Apprentices for each licensed Journeyman Electrician shall be allowed to work on the airfield electrical systems.

E. Contractor shall prepare documentation associated with the electrical work force confirming adherence to the requirements of Paragraph "d" above.

These documents shall be submitted to the Construction Manager for approval. Also, any work force changes or revisions which affect compliance with paragraph "d" above shall also be submitted to the Construction Manager for approval.

F. All airfield circuits will be handled throughout the installation process by qualified licensed electrical personnel.

G. Every airfield lighting cable splicer shall be qualified in making airfield cable splices and terminations on cables rated above 1,000 volts A.C. The Contractor shall submit for approval of the Construction Manager proof of the qualifications of each proposed cable splicer for the cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splice medium voltage cable at airports.

H. At least thirty (30) days prior to performing any cable splicing/terminating, Contractor shall submit to the Construction Manager a written list of proposed cable splicing/terminating personnel, including written evidence that the proposed personnel have had a minimum of eight (8) hours of technical training by authorized splice/termination kit manufacturer personnel. Approved training shall include a thorough review of kit components and splicing/terminating techniques and procedures. Field splices shall only be installed by technicians approved by the Construction Manager and by HAS maintenance superintendent.

I. In addition, each trained cable splicer shall be required to install a splice and a connector on type and size of the cable to be used under this contract. Sample connections shall be accomplished in accordance with the manufacturer's instructions and in the presence of the Construction Manager.

J. All communications work shall be performed under the direct supervision of a Building Industry Consulting Service International, Inc. (BICSI) registered Cabling Installer/Technician level.

K. The Contractor performing construction on the airfield electrical and/or communication system shall have a minimum of 5 years of experience on construction of projects of similar type of work and of similar size and complexity. The owner will require all Electrical Contractors bidding on this project to submit proof of experience that they have successfully completed at least two projects of comparative size and complexity within the past 5 years.

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

1. Installed at least 500 L868 bases into existing facilities that were paved via a slipform method.

2. Modify existing airfield lighting control systems in at least two installations of the size and complexity of this project.
3. Installed semiflush and elevated runway guard light systems.
4. Perform construction activities within an active CAT II/III AOA.

2.03 EQUIPMENT, MATERIAL AND INSTALLATION REQUIREMENTS

A. The Contractor shall furnish and install all materials, equipment, accessories, connections and incidental items in accordance with the approved recommendations of the manufacturer and the best practices of the trade to provide a complete installation ready for use and operational by the Owner.

B. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the manufacturer's name, trademark and ASME, UL, and/or other labels in every case where a standard had been established for the particular item.

C. Where applicable, equipment shall be FAA approved design of a standard product of a manufacturer regularly engaged in the production of the required type of equipment, and shall be supported by a service organization reasonably convenient to the site, as determined by the Construction Manager.

D. The Contractor shall promptly notify the Construction Manager in writing of any conflict between any requirements of the Contract Documents and equipment manufacturer's directions and shall obtain written instructions from the Construction Manager before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's directions or such written instructions from the Construction Manager, Contractor shall bear all costs arising in correcting deficiencies.

E. After review of equipment submittals, and instructions by the Engineer to proceed, equipment installations may require arrangements or connections different from those shown on the drawings. It is the responsibility of the Contractor to install the equipment to operate properly. The Contractor shall provide any additional equipment and/or materials required for installations to operate in accordance with the intent of the drawings and specifications.

F. It is the responsibility of the Contractor to insure that items installed fit the space available with adequate room for proper equipment operation and maintenance. Contractor shall make field measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that the final installation provides a complete and operational system that complies with the requirements of the drawings and specifications.

G. The Contractor shall be responsible for coordinating proper location of roughing in and connections by other trades. Changes associated with coordination requirements shall be made at no increase in the Contract amount or additional costs to other trades.

H. The Contractor shall support work and equipment plumb, rigid and true to line. The Contractor shall determine how equipment, fixtures, conduit, etc., are to be installed, as required by codes, drawings and specifications. Foundations, bolts, inserts, stands, hangers, brackets and accessories required for proper support shall be provided by the Contractor, whether or not specifically indicated on the drawings.

I. Uniform illumination levels for similar lighting systems throughout the airfield shall be installed. Contractor shall insure illumination levels for installed airfield edge or centerline lighting systems do not vary due to faulty installations from illumination levels of similar airfield lighting systems.

2.04 SUBMITTALS

A. Submit manufacturer's data or shop drawings of the following items giving full information as to the dimensions, materials, and other information required to define compliance with the specifications. Other items to be submitted are listed in the specification sections.

Handholes/Manholes/ Pull Boxes and Accessories	S-1 Plug Cutouts and Cabinet
Ductbanks	Constant Current Regulator
Conduit	ALRCS
Support Hardware	Multi-hole Adapter Ring
#8 5KV L-824C Cable	Fixture Bases, and accessories
#6 Stranded Counterpoise Wire	L-823 Connectors
Airfield Lighting Fixtures	Splice Kits
Airfield Fixture Lamps	Identification Tags
Isolation Transformers	Ground Rods
Cadweld	Grounding
Airfield Guidance Signs/ Panels	Support Hardware
Guidance Sign Foundation	Shop Drawings
316 Stainless Steel Bolts	Tape 3/8+ -
Fixture Installation and Location	

B. When requested by the Engineer, samples of these items shall be submitted for approval. Equipment/installation diagrams shall also be submitted for approval, as required by project specifications and/or requested by the Engineer.

C. Contractor submittal package shall include a typewritten list indicating each bid item, with a breakdown of all item components and all parts that are assembled or associated with bid item installation.

D. Submittal package list shall indicate: (1) Bid item number, (2) Part numbers of associated item components, as required and (3) Reference page number where item and components information is located in the submittal package. The contractor shall organize submittals so that common components to multiple bid items are not duplicated in the submittals.

E. Checking of submittals by the Engineer is done only as an aid to the Contractor and approval of submittals shall not relieve Contractor of responsibility for any errors or omissions in the submittals, nor shall it relieve the Contractor of total responsibility for proper and complete execution of the job.

2.05 INSPECTION AND TESTING

A. All work performed by the Contractor shall be subject to periodic inspections by the City Engineer, the Owner's Representative, and the Owner's Construction Manager to verify that the installation is in compliance with the applicable requirements of these specifications.

B. System and component testing shall be performed as specified in Section 26 0820 - Airfield Electrical Installation Testing. Test results shall be evaluated by the Engineer, HAS PDC and the Construction Manager based upon the criteria indicated.

C. Any installation found which does not conform to the required technical provisions of these specifications or any specimen which does not meet the test criteria defined in Section 26 08 20 - Airfield Electrical Installation 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 Section 26 0820 - Airfield Electrical Installation Testing.

PART 3 CONSTRUCTION PROVISIONS

3.01 AOA AREA INSTALLATION PROVISIONS

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

3.02 ELECTRICAL WORK PROVISIONS.

A. Existing Underground Utilities. At least forty-eight (48) hours prior to beginning any excavation within the AOA, locations of all utility lines and FAA cables in the construction area will be identified and marked with surveyor flags by appropriate utility and/or FAA personnel. The Contractor shall be responsible for maintaining the location flags. Any flags displaced shall be replaced by the Contractor. The Contractor shall coordinate with Construction Manager any additional prior notification time required during weekend and/or holiday work periods.

B. Also at least forty-eight (48) hours prior to beginning any excavation within the AOA, the contractor shall request the HAS construction manager to have airport staff identify circuits in proposed excavation areas. The Contractor shall coordinate with Construction Manager any additional prior notification time required during weekend and/or holiday work periods.

C. Required work items outside of the identified phase limits/barricaded areas (typically preparatory, complementary, or conclusive in nature with respect to the work specified within the primary phase limits) should be performed in a manner so as to minimize the number, frequency, and duration of additional pavement closures. The contractor is expected to work in a manner to help meet this intended goal, including coordination and organization of contractor and subcontractor work forces. Additional pavement closures for all necessary related work outside of the identified phase limits/barricaded area shall be coordinated in accordance with the airport safety requirements provided on sheet G04.02 and may require an airport operations escort.

D. 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.

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

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

G. Lockout Procedure. Contractor shall adhere to requirements of latest edition of Section 26 08 10 - Recommended Lockout Procedure for Airfield Lighting Circuit.

3.03 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.

1. General Requirements. Contractor shall review the requirements in the specifications and Construction Documents, including, but not restricted to: Phasing and Sequencing Plans, Demolition Plans and Wiring Diagrams. Contractor shall determine locations, sizes and quantities of temporary/bypass wiring and conduits required for project construction.
2. At least 14 days prior to commencement of installation of temporary/bypass wiring, the Contractor shall submit a layout of proposed temporary/bypass conduits and circuits to the Construction Manager for review and approval, including proposed installation protection provisions.
3. Equipment and Materials. Temporary/bypass wiring shall meet the requirements of Section 26 0540 - Installation of Underground Cable for Airports (Item L-108), and shall also conform to the Construction Plans. Temporary/bypass wiring shall be identified at junction points with brass tags as approved by the Construction Manager.
4. Installation. Temporary/bypass circuits shall be installed with due consideration to personnel safety and circuit protection against physical damage. All damage to existing circuits as a result of Contractor action or inaction shall be corrected accordingly at the Contractor's expense and corrective action approved by the Owner.
5. Temporary/bypass, high voltage lighting system cables shall be protected from damage by vehicles with suitable fencing, barriers and/or adequately sized boards or timbers.
6. Temporary/bypass circuits shall be removed immediately upon completion of construction or purpose for which the wiring was installed. Upon removal of boards or timbers fastened to the pavement surface to protect temporary/bypass circuits, the Contractor shall repair the pavement with materials and methods approved by the Construction Manager. Temporary/bypass cable and counterpoise shall be removed and discarded off the Airport by the Contractor.

3.04 EXISTING ELECTRICAL EQUIPMENT AND MATERIALS

A. The Contractor shall remove all existing wiring and electrical equipment made unnecessary by the new installation. All materials removed shall become property of the Contractor and disposed of by the Contractor. The Contractor shall list materials according to type, class and/or size, and store or dispose of materials as directed by the Construction Manager.

3.05 POWER SERVICE CONTINUITY

A. Provide labor, materials and supervision required to maintain full capacity power service continuity when connection or modifications are made to existing systems and facilities. Do not interrupt service without prior consent of the Construction Manager, with a definite understanding of time and duration of outage. All outages will take place at a time for minimum disruption of facility activity. Coordinate with Owner.

3.06 AS-BUILT DRAWINGS

A. The Contractor shall maintain a set of as-built drawings on the job site as required the General Provisions of the Contract. Contractor shall mark on the as-built drawings all work details, alterations installed to meet site conditions and changes made by Change Notices. As-built drawings shall be kept available for inspection by the Construction Manager and/or the City Engineer at all times.

B. Airfield wiring verification diagrams shall be maintained throughout the project and later submitted to HAS Planning, Design, and Construction upon completion. These field wiring diagrams shall depict the exact routing and number of cables installed in each conduit originating from the airfield lighting vaults and extending to each manhole, handhole, pullbox, sign, and lighting fixture for each new circuit or circuit revision.

PART 4 MEASUREMENT AND PAYMENT

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

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Section 26 05 05

ALTERATIONS, REMOVAL AND DEMOLITION

PART 1 DESCRIPTION

1.01 DEFINITIONS

A. Alterations shall mean any change or rearrangement in the component parts, including structural, mechanical, electrical systems, or internal or external arrangements of an existing structure.

B. Removal shall mean the dismantling of existing materials, components, equipment, and utilities. Removed items shall be handled, prepared for storage, transported to storage areas as specified.

C. Demolition shall mean the dismantling and disposal of existing materials, components, equipment, and utilities which cannot or will not be reused or which will have no salvage value, or which cannot be reused due to 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.

D. All items to be turned over to the Owner shall be properly enclosed or boxed to protect the items from damage and transported by the Contractor to a location on the Owner's property, designated by the Engineer and/or the Owner.

E. The installation and/or removal of lighting equipment may be critical to airport operations; therefore, the Contractor shall follow the work schedule established in the plans and specifications or as directed by the Engineer. The system shall be installed in accordance with the National Electrical Code and/or local code requirements.

F. The Contractor shall provide temporary wiring as required to reconnect existing circuits to provide guidance for aircraft to pass through the construction areas on those taxiways/runways which must remain open. The Contractor shall check all temporary circuits before dark each day to assure that they are operational. In the event of failure, the Contractor shall immediately take steps to restore operation. The cost of temporary and reconnected lighting shall be absorbed in the various work items.

1.02 CONDITION OF EXISTING FACILITIES

A. The Contractor shall verify the areas, conditions, and features necessary to

tie into existing construction. This verification shall be done prior to submittal of shop drawings, fabrication or erection, construction or installation. The Contractor shall be responsible for the accurate tie-in of the new work to existing facilities.

B. Special attention is called to the fact that there may be piping, fixtures or other items in the existing systems which must be removed or relocated in order to perform the alteration work. All conduit, wiring, boxes, etc., that do not comply with these specifications shall be removed or corrected to comply with these specifications. All unused conduit not removed shall be identified and a pull line shall be installed. The work shall include all removal and relocation required for completion of the alterations and the new construction.

C. Whenever the scope of work requires connection to an existing circuit, the circuit's insulation resistance shall be tested, in the presence of the Owner and Engineer. The Contractor shall record the results on the forms included in these specifications. When the circuit is returned to its final condition, the circuit's insulation resistance shall be checked again in the presence of the Owner and Engineer. The Contractor shall record the results on the forms included in these specifications. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance Manuals as described in Section 16010 – General Provisions - Electrical.

1.03 OCCUPANCY AND USE OF EXISTING FACILITIES

A. The Owner will occupy and use the facilities within the areas of work during the entire construction period. The Contractor shall be required to plan and coordinate his activities in order to provide all necessary controls for the abatement of dust, noise, and inconvenience to the Owner personnel during all phases of the work.

1.04 VACATING OCCUPIED AREAS

A. The Owner will remove all portable items of furniture, equipment, and fixtures prior to the start of work.

1.05 SAFETY REQUIREMENTS

A. The Contractor shall conduct alterations and removal operations in a manner that will ensure the safety of persons in accordance with the requirements of CFR 29 PART 1926 and 1910.

1.06 CLASSIFICATION OF REMOVED/DEMOLISHED ITEMS

A. Existing materials and equipment indicated to be removed will be classified as "salvageable" and shall remain the property of the Owner or will be classified as "debris" and shall be disposed of legally off the airport.

B. Salvageable Items

1. Reusable salvaged items:
   a. Salvaged materials and equipment shall be reused in the work as described on the contract drawings, unless noted otherwise.
2. Retained salvaged items:
   a. Salvaged materials and equipment to be retained by the Owner but not reused in the work shall be turned over to the Owner at a site at the facility to be determined by the Owner. Retained salvaged items shall be stored on Owner property where indicated by the Owner.

C. Debris Items

1. Items classified as debris shall be legally disposed of off the airport property. The cost of such disposal shall be included in the cost of other items of work.

1.07 TEMPORARY PROTECTION

A. The Contractor shall provide and maintain the following requirements.

1. Protection of persons and property shall be provided throughout the progress of the work in accordance with these specifications.
2. Provide temporary facilities and infrastructure prior to starting alterations and removal of work. Such items shall protect existing materials, equipment, and other remaining building or system components from damage by weather and construction operations.
3. Provide temporary enclosures to isolate space utilized by equipment during construction, from dirt, dust, noise, and unauthorized entry.
4. Provide temporary exits, entrances, and protected passages where work prevents the use of existing facilities.
5. 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.
6. Provide temporary exterior wall construction which will be designed and fabricated to resist an applied horizontal wind pressure of not less than 130 mph.
7. 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.

8. 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.
9. Provide temporary jet blast structures which will withstand the jet blast with a safety factor of 2.

PART 2 EXECUTION

2.01 DISCONNECTING UTILITIES

A. Prior to the start of work, the necessary utilities serving each area of alteration or removal will be shut off by the Owner and shall be disconnected and sealed by the Contractor, as required. Lockout/Tag/Try procedures shall be utilized in accordance with Section 26 0810 – Recommended Lockout Procedure for Airfield Lighting Circuit.

2.02 TEMPORARY UTILITY SERVICES

A. The Contractor shall install temporary utility services in satisfactory operating condition before disconnecting existing utilities. Such temporary services shall be maintained during the period of construction and removed only after new permanent services have been tested and are in operation.

2.03 TEMPORARY AIRFIELD ELECTRICAL SERVICES

A. The Contractor shall install temporary electrical airfield services in satisfactory operating condition before disconnecting existing electrical services. Such temporary services shall be maintained during the period of construction and removed only after new permanent services have been tested and are in operation. Temporary electrical airfield provisions shall include, but not be limited to new electrical conductors installed in existing pathways, above ground or in new conduit. Temporary sign panels and blanking out of existing light fixtures as required by HAS airport operations to close or re-route traffic around the construction area and all associated electrical incidentals such as conduit or cable protection, connector kits, splicing of cables, etc. as required for a complete temporary airfield electrical system. Approved methods for blanking out of the existing fixtures shall include the following:

1. Elevated Fixtures: Install PVC pipe to cover the complete fixture. Pipe to be nominal 18”H x 6”-8” diameter as needed with cap.

2. In-pavement Fixture: Mask fixture light source using tape. Use only heavy duty black duct tape. Do not allow sticky surface of tape to touch fixture lens. Install a section of tape double upon itself so there is no sticky surface over the lens portion of the fixture. Provide overall taped covering with sticky surface attached to fixture housing only for complete

fixture cover.

2.04 REMOVAL WORK

A. The Contractor shall not disturb the existing construction beyond that indicated or necessary for installation of new work. Temporary shoring and bracing for support of building components to prevent settlement or other movement shall be as indicated and as required to protect the work.

B. The Contractor shall provide protective measures to control accumulation and migration of dust and dirt in all areas of work, particularly those adjacent to occupied areas. The Contractor shall remove dust, dirt, and debris from the areas of work daily.

2.05 SALVAGEABLE MATERIALS AND EQUIPMENT

A. The Contractor shall remove all salvageable materials and equipment in a manner that will cause the least possible damage thereto. Removed items which are to be retained by the Owner shall be carefully handled, stored, and protected.

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

2.06 BUILDINGS AND STRUCTURES

A. The Contractor shall perform removal operations in existing buildings as indicated and as otherwise required to complete the work.

B. Existing concrete shall be demolished, removed, and disposed of. Square, straight edges shall be provided where existing concrete adjoins new work and at other locations where indicated. Existing steel reinforcement shall be protected where indicated; otherwise, it shall be cut off flush with face of concrete.

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

D. The use of flame-cutting torches will be permitted only when other methods of dismantling are not practical, and when approved in writing by the Owner and/or Engineer.

2.07 ELECTRICAL EQUIPMENT AND FIXTURES

A. Wiring systems and components shall be salvaged. Loose items shall be boxed and tagged for identification.

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

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

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

E. The Contractor shall remove and salvage switches, receptacles, fixtures, transformers, constant current regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. These items shall be boxed, and tagged for identification according to type and size.

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

PART 3 DEMOLITION, DISPOSAL, AND ALTERATION

3.01 DEMOLITION OPERATIONS

A. Demolition operations shall be conducted to ensure the safe passage of persons to and from facilities occupied and used by the Owner and to prevent damage by falling debris or other cause to adjacent buildings, structures, and other facilities.

B. The sequence of operations shall be such that maximum protection from inclement weather will be provided for materials and equipment located in partially dismantled structures.

3.02 MAINTAINING TRAFFIC

A. Demolition operations and removal of debris to disposal areas shall be conducted to ensure minimum interference with runways, taxiways, aprons, roads, streets, walks, and other facilities occupied and used by the Owner.

B. Streets, walks, runways, taxiways and other facilities occupied and used by the Owner shall not be closed or obstructed without written permission from the Owner.

3.03 REFERENCE STANDARDS REQUIREMENTS

A. Demolition operations shall be conducted to ensure the safety of persons in accordance with ANSI A 10.6 Safety Requirements for Demolition.

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

3.04 DISPOSAL OF DEMOLISHED MATERIALS

A. General

1. The Contractor shall dispose of debris, rubbish, scrap, and other non-salvageable materials resulting from demolition operations. Demolished materials shall not be stored or disposed of on Airport property.

B. Removal From Property Owner

1. Materials classified as debris shall be transported from Owner property and legally disposed of at no additional cost to the Owner. Permits and fees for disposal shall be paid by the Contractor.

3.05 ALTERATION WORK

A. General

1. Cutting, patching, repairing, and other alteration work shall be done by tradesman skilled in the particular trade or work required.

2. Where required to patch or extend existing construction, or both, such alteration work shall match existing exposed surface materials in finish, color, texture, and pattern.

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

PART 4 MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. Electrical Visual-Aid Demolition. This item includes all materials, labor, transportation incidentals and services required for the airfield Visual-Aid demolition as shown on the plans. It is the intent of the demolition pay item that all equipment, devices, fixtures, boxes, 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, concrete encasement, boxes, isolation transformers, structures, disconnect of the wiring, repair of the disturbed area to match surrounds, etc for a complete removal of the item and its components. Furthermore, this item shall include disposal or salvage as directed by owner or as noted on the contract drawings. Separate

measurement will be made for each Visual-Aid type only. There is no separate measurement for installed location, Visual-Aid size variations, etc.

B. Electrical Infrastructure Demolition. This item includes all materials, labor, transportation incidentals and services required for the airfield electrical infrastructure demolition as shown on the plans. It is the intent of the demolition pay item that all equipment, devices, fixtures, wiring, materials, systems and appurtenances, etc. which are no longer required as a result of the project to be removed shall be measured by the lineal foot. Demolition of conduit and ductbanks are 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, counterpoise cables and 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. Where wires are to be abandoned in each, this item includes the tagging and labeling at each end or accessible area of the cable. There is no separate measurement of conduit or ductbank size or type.

C. Remove and salvage light fixture, base can to remain in existing pavement areas with new blank steel cover. This item includes all materials, labor, transportation incidentals and services required for the fixture demolition as shown on the plans and shall be measured by each item removed. It is the intent of the demolition pay item that the light fixture is carefully removed and salvaged. The existing base can will remain. The contractor shall install a blank cover on the base can (L-867B or L-868B as applicable). The salvaged lights will be turned over to the owner for use as spare parts. Removal of the item shall include the associated isolation transformer, disconnect of the wiring, etc for a complete removal of the light and abandonment and protection of the base can unless noted otherwise. There will be no separate measurement for Visual-Aid type.

D. Removal and disposal of runway guard light: “Y” connectors. This item includes all materials, labor, transportation incidentals and services required to remove an existing runway guard light “Y” connector, and associated secondary cables that are installed on each pair of in pavement runway guard lights. Some in pavement runway guard lights may not be associated with “Y” connectors. It is the intent of the demolition pay item that all equipment, devices, fixtures, wiring, materials, systems and appurtenances, etc. which are no longer required as a result of the project to be removed shall be measured per each “Y” connector and cable set removed.

E. Temporary Electrical Provisions shall be measured by the lined footage for all project phases and scope and shall include installation of temporary L-824C, #8 5KV cables, associated conduit where required by operations, trench

where required by operations. Blanking signs as directed by Operations, blanking out of existing fixtures including both in-pavement and elevated as required by Operations, splicing of existing cables, L-823 connectors, removal, site restoration and all incidentals, complete in place. There is no separate measurement for work zone or project phase.

F. The number of temporary sign modules needed for construction phases shall be measured per each per location, installed and accepted by the Engineer. This item will include all materials, labor, transportation and services required to provide a temporary operational system.

4.02 BASIS OF PAYMENT

A. Payment will be made at the contract price for the required fixture 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 Visual-Aid type.

B. 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.

C. Payment will be made at the contract price for required temporary electrical provisions. This item includes all materials, labor, transportation, incidentals and services required for the temporary electrical provisions needed to maintain the airfield electrical systems to the satisfaction of the Airport Authority during each noted construction phase shown on the plans. This item includes any temporary wiring, fixtures, sign panels, blanking of fixtures or sign panels, etc. required to maintain the existing airfield lighting systems to the satisfaction of the Owner and Engineer. It is the intent of the temporary electrical provisions pay item that all temporary electrical modifications necessary to properly close the work area for construction while maintaining adjacent utilities is complete during construction and removed following construction and set back to proper operation. There is no additional payment for work zones.

Payment will be made under:

26 05 05 - 1	Remove and salvage elevated edge light, remove base can in modified pavement areas - Per Each
26 05 05 - 2	Remove and salvage in-pavement light, remove base can in modified pavement areas - Per Each
26 05 05 - 3	Remove and salvage elevated edge light, base can to remain in existing pavement areas - Per Each
26 05 05 - 4	Remove and salvage in-pavement light, base can to remain in existing pavement areas - Per Each
26 05 05 - 5	Remove and salvage light, base can to remain and add new steel coverplate in existing pavement areas - Per Each
26 05 05 - 6	Remove and dispose of existing “Y” connector and associated cables used on in-pavement Runway Guard Lights. - Per Each
26 05 05 - 7	Remove Empty base Can in Modified Pavement Areas - Per Each
26 05 05 - 8	Remove sign including foundation – Per Each
26 05 05 - 9	Remove abandoned sign foundation – Per Each
26 05 05 - 10	Remove and Salvage Sign, Remove Sign Foundation – Per Each
26 05 05 - 11	Remove #8 AWG, L-824C in conduit or ductbank - Per Linear Foot
26 05 05 - 12	Remove conduit in modified pavement areas – Per Linear Foot
26 05 05 - 13	Remove conduit in earth – Per Linear Foot
26 05 05 - 14	Remove ductbank in modified pavement areas - Per Linear Foot
26 05 05 - 15	Remove ductbank in earth - Per Linear Foot
26 05 05 - 16	Remove L-867D Pullbox or Handhole (smaller than 3’x3’x3’) – Per Each
26 05 05 - 17	Remove existing handhole 3'x3'x3' or larger – Per Each

26 05 05 - 18 No. 8 AWG, L-824C Cable, including 2" Conduit and Other Electrical Provisions for Temporary Power - per Linear Foot

26 05 05 - 19 Provide Temporary Sign Panels during construction for Phasing – per Each

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Section 26 05 10

WORK IN EXISTING BUILDINGS - ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Relocate, rewire, or abandon electrical equipment and systems required in conjunction with work in existing building.

B. Temporary provisions for all existing and/or new circuits to maintain power to occupancies in adjacent areas.

C. Coordinate disposition of all removed equipment with the Owner.

1.02 DEFINITIONS

A. Abandoned: Refers to electrical equipment and systems which are no longer in use and are to be de-energized, disconnected and left in place.

B. Removal: Refers to electrical equipment and systems which are not to be reused and are to be removed from the job site and disposed of as directed by the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials to match existing construction unless specified elsewhere in these contract documents. Provide materials which comply to local codes and UL, and properly apply to their intended function.

PART 3 EXECUTION

3.01 PREPARATION

A. Visit and inspect the job site prior to bidding and become familiar with all existing conditions. Include the cost of the work required to accommodate the existing conditions in the bid proposal.

B. Provide a typed inventory (include pictures as necessary) of all equipment and facilities, which are damaged or not operating properly at the time construction commences. Any damage or inoperative equipment, which is

discovered during the course of construction and is not itemized on the written inventory will be assumed to have been caused by the contractor, and the contractor will be responsible for repair or replacement at no additional costs

3.02 RENOVATION

A. Relocate all existing material required to accommodate the new construction whether or not the existing material is shown on Drawings.

B. Removal of all equipment or systems identified on drawings to be removed, including all supports, appurtenances and accessories associated with equipment or systems.

C. Coordinate the work with other Divisions. Determine which items and equipment are to remain, to be relocated, or be removed.

D. Connect all loads, which are existing and are to remain to the new distribution system as required to maintain their proper operation.

3.03 EXISTING RACEWAYS

A. Reuse existing raceways where possible and where permitted by local codes. Remove old conductors from raceway. Clean raceway with mandrel followed by clean mop/pig. Rework existing raceways where required. Secure all existing raceways reused, which are loose or not properly connected. Paint existing raceways when exposed to view to match surroundings.

B. Fasten existing boxes securely.

3.04 NEW RACEWAYS

A. Provide new raceways where existing raceways cannot be reused or where raceways do not exist in order to provide a complete system as shown on the drawings.

B. Where raceways must be exposed to view, use surface metal raceway such as Wiremold, securely fastened, painted to match surroundings. Provide number of coats of paint as required to cover primer coat or original finish of wiremold or raceway.

3.05 EXISTING WIRING DEVICES

A. Remove foreign material from existing junction boxes to be reused.

3.06 EXISTING TELEPHONE OUTLETS

A. Remove foreign material from existing junction boxes to be reused.

B. Replace all telephone outlet coverplates with new coverplates.

3.07 EXISTING LIGHT FIXTURES

A. Existing light fixtures to be reused:

1. Clean reflective surfaces, lenses, and exposed surfaces.
2. Relamp with new lamps.
3. Repair or replace lampholders, ballasts, wiring, and door latching and hinging mechanisms.
4. Reconnect to branch circuit wiring; tighten connections.

B. Existing light fixtures to be reused may be replaced with new fixtures to match existing, if in Contractor's opinion, costs to Owner would be lower.

3.08 EXISTING PANELBOARDS

A. Existing panelboards to be reused:

1. Clean interiors and exteriors.
2. Inspect for damage. Notify A/E if repairs or damaged components need replacing.
3. Tighten conduit and wire terminations.

B. Verify panelboards and panelboard feeders are of adequate capacity for loads to be served.

1. Activate loads connected to panelboards to achieve full load condition.
2. Measure and record amperage readings of phase and neutral conductors of panelboard's feeders.
3. Provide typewritten record of recorded measurements to the A/E for review.

C. Provide new typewritten circuit directory.

D. Provide new nameplate for each panelboard.

3.09 EXISTING WIRING

A. Inspect existing wiring which is to be disturbed for damage. Repair or replace damaged wiring.

B. Assure integrity of existing wiring insulation:

1. Megger wiring phase to phase, phase to neutral, phase to ground, and neutral to ground.
2. Record megger results. Provide typewritten record of results to A/E for review.

3. Repair defective insulation to a dielectric value equal to that of wire of the same type and age.

C. Secure and label existing wiring, which is to be disturbed.

D. Tighten existing wiring terminations and connections.

3.10 SHUTDOWNS OF ELECTRICAL SERVICES

A. Establish a schedule of shutdown(s) complete with starting time and duration.

B. Present schedule to Owner for approval.

C. Revise schedule as necessary to coordinate with Owner.

D. Beyond any scheduled shutdowns, maintain continuity of electrical service to all existing facilities.

E. Provide all temporary power for both the North and South vaults during the construction activities as required to maintain full operational capabilities of the associated equipment.

3.11 PHASING

A. Provide temporary circuits as required to allow existing building functions to continue during day construction period. Comply with all schedules and phasing conditions as described in contract documents.

3.12 FINAL CLEANUP

A. Airfield lighting vault shall be cleaned upon final installations. Ceilings, walls and floors shall be painted in the construction area. Equipment shall be wiped clean of dust.

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION

Section 26 05 33.13

CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Raceway Systems:

1. Rigid metal conduit and fittings.
2. Electrical metallic tubing and fittings.
3. Liquidtight flexible metal conduit and fittings.
4. Nonmetallic conduit and fittings.
5. Innerduct.

1.02 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.

B. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated.

C. ANSI/NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.

D. NEMA RN 1 - PVC Externally-Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.

E. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).

F. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.03 RELATED SECTIONS

A. Section 26 05 53 - Electrical Identification

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Rigid Metal Conduit, Electrical Metallic Tubing and Fittings:

1. Allied Tube and Conduit Corporation.
2. Triangle PWC, Inc.

B. Flexible Conduit, Innerduct and Fittings:

1. Electri-Flex Co.
2. Anamet, Inc.
3. Triangle PWC, Inc.

C. Nonmetallic Conduit, Innerduct and Fittings:

1. Carlon.
2. Can-Tex Industries.
3. Certain-Teed.

2.02 PRODUCTS

A. Rigid Metal Conduit and Fittings:

1. Rigid Steel Conduit: ANSI C80.1; hot-dip galvanized.
2. PVC Externally Coated Conduit: NEMA RN 1; rigid steel conduit with external PVC coating and internal galvanized surface.
3. Fittings and Conduit Bodies: ANSI/NEMA FB 1; threaded type, material to match conduit.

B. Electrical Metallic Tubing (EMT) and Fittings:

1. EMT: ANSI C80.3; hot-dipped galvanized tubing.
2. Fittings and Conduit Bodies: ANSI/NEMA FB 1; steel set-screw, insulated deep throat type.

C. Liquidtight Flexible Conduit and Fittings:

1. Conduit: Flexible metal conduit with PVC jacket and integral grounding conductor.
2. Fittings and Conduit Bodies: ANSI/NEMA FB 1; liquidtight, zinc coated steel.

D. Nonmetallic Conduit and Fittings:

1. Conduit: NEMA TC 2; Schedule 40 PVC.
2. Fittings and Conduit Bodies: NEMA TC 3.

E. Innerduct:

1. Conduit Systems: Solid-wall polyethylene. Extruded coilable tubing per Belcore performance criteria TR-TS4-000356, color coded

PART 3 EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT AND SUPPORT

A. Minimum size of conduit is 3/4 inch. Minimum size of homerun and feeder conduits is 3/4 inch. Indicated sizes are minimum based on THW copper wire and larger sizes may be used for convenience of wire pulling.

B. Minimum size of innerduct is 1 ¼ inch.

C. Arrange conduit to maintain headroom and present a neat appearance.

D. Maintain minimum 6 inch clearance between conduit and piping. Maintain 12 inch clearance between conduit and heat sources such as flues, steam pipes, and heating appliances. Maintain minimum 6 inch clearance between innerduct and 240 volts or above power cabling.

E. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit securely to building structure using clamps, hangers and threaded rod.

3.02 GENERAL CONDUIT INSTALLATION

A. Cut conduit square using a saw or pipe cutter; de-burr cut ends before joining.

B. Bring conduit to the shoulder of fittings and couplings and fasten securely.

C. Install no more than the equivalent of three 90 degree bends between boxes.

D. Use conduit bodies to make sharp changes in direction, as around beams.

E. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point. Seal conduit which crosses a boundary between areas of extreme temperature difference.

F. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture.

G. Drawings indicate intended circuiting and are not intended to be scaled for exact conduit location.

H. Install conduit such that it does not interfere with fire-proofing of steel.

I. Do not install conduit in floor slab of ground floor of building.

3.03 NONMETALLIC CONDUIT INSTALLATION

A. Wipe nonmetallic conduit clean and dry before joining. Apply full even coat of cement to entire area that shall be inserted into fitting. Let joint cure for 20 minutes minimum.

3.04 METALLIC CONDUIT INSTALLATION

A. Make joints mechanically tight and all conduit electrically continuous.

B. Use conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations. Use sealing locknuts and other approved techniques for moisture proofing raceway in wet areas.

C. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch size.

D. Install expansion joints where conduit crosses building expansion joints and at 150 foot intervals in straight runs.

E. Provide fire-stop compound at all penetrations of floor slabs or fire walls such that fire rating integrity of barrier is not lessened.

3.05 UNDERGROUND

A. Follow Section 26 0543 – Installation of Airport Underground Electrical Duct Banks and Conduits for underground electrical ducts related to airfield lighting.

3.06 CONDUIT INSTALLATION SCHEDULE

A. Exterior:

1. Exposed
   a. Rigid metal conduit.
   b. PVC coated rigid metal conduit at all concrete slab penetrations.
2. Underground:
   a. Rigid nonmetallic conduit as described in Section 26 0543 – Installation of Airport Underground Electrical Duct Banks and Conduits.
   b. PVC coated rigid metal factory elbows for all bends and for concrete slab penetrations.

B. Interior:

1. Exposed:
   a. Rigid metal conduit in areas subject to moisture, corrosive agents, or physical abuse.

b. Electrical metallic tubing in areas not subject to moisture, corrosive agents or physical abuse.

2. Concealed:
   a. Rigid nonmetal conduit in areas subject to moisture or corrosive agents.
   b. Electrical metallic tubing in areas not subject to moisture or corrosive agents.
3. Connections to Product:
   a. Liquidtight flexible metal conduit in areas subject to moisture, high humidity, or corrosive agents.
   b. Flexible metal conduit in dry, noncorrosive areas.
4. Cast-In-Concrete; rigid nonmetallic conduit.

C. BX and MC cable are not acceptable for use on this project.

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Section 26 05 33.16

BOXES

PART 1 GENERAL

1.01 DESCRIPTION

A. Furnish and install wall and ceiling outlet boxes, floor boxes, and pull and junction boxes.

1.02 RELATED SECTIONS

A. Section 26 05 53 - Electrical Identification.

B. Section 26 05 33.13 - Conduit.

1.03 REFERENCES

A. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. NFPA 70 - National Electrical Code.

PART 2 PRODUCTS

2.01 OUTLET BOXES

A. Provide galvanized steel outlet boxes suitable for the conditions of each outlet. Provide multi-gang outlets of single box design; sectional boxes will not be acceptable.

B. Provide deep type cast metal outlet boxes located in damp locations exposed to weather or exposed areas subject to damage, or where surface mounted below 8’ above finished floor, complete with gasketed cover and threaded hubs

C. Provide outlet boxes of sufficient volume to accommodate the number of conductors entering the box in accordance with the requirements of NFPA 70, and not less than 4 inches square and 1-1/2 inch deep unless shallower boxes are required by structural conditions and are specifically approved by A/E.

D. Provide non-metallic type outlet boxes only in corrosive areas.

E. Provide 4-inch octagonal ceiling outlet boxes.

2.02 PULL AND JUNCTION BOXES

A. Provide galvanized sheet metal boxes conforming to NEMA OS 1. Provide hinged enclosures for any box larger than 12 inches in any dimension.

B. Provide cast metal boxes for outdoor and wet locations conforming to NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight with cover and ground flange, neoprene gasket, and stainless steel cover screws.

C. Provide precast concrete for underground installations.

D. Provide pre-cast reinforced concrete type pull/splice boxes with flush cover as manufactured by Oldcastle Precast, for underground circuits. Size boxes as indicated.

E. Provide separate pull boxes and junction boxes for electric power, control, and communication systems.

PART 3 EXECUTION

3.01 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on Drawings are approximate unless dimensioned. Verify with A/E the location of floor boxes and outlets in offices and work areas prior to rough-in.

C. Locate and install boxes to allow access. Provide access doors where installation is inaccessible. Coordinate locations and sizes of required access doors with those specified in Division 15 - Mechanical.

D. Locate and install to maintain headroom and to present a neat appearance.

3.02 OUTLET BOX INSTALLATION

A. Do not install boxes back-to-back in walls. Provide minimum 6 inch separation, except provide minimum 24-inch separation in acoustic-rated walls.

B. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.

C. Provide knockout closures for unused openings. Provide blank plates for all junction boxes.

D. Securely fasten boxes to the building structure using an approved bracket (i.e., “H” bracket), independent of the conduit, except for splice boxes that are connected to two metal conduits, both supported within 12 inches of box.

E. Provide access to all boxes.

F. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

G. Install boxes in walls without damaging wall insulation.

H. Coordinate with A/E for mounting heights and locations of outlets mounted above counters, benches, and backsplashes.

I. Set boxes installed in concealed locations flush with the finish surfaces, and provide with the proper type extension rings and/or covers where required.

J. Position outlets to locate luminaires as shown on reflected ceiling plans.

K. In inaccessible ceiling areas, do not install junction boxes which are accessible only through luminaire ceiling opening.

L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use adjustable steel channel fasteners for flush ceiling outlet boxes.

M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices. Install all grouped device locations neat and symmetrical. Coordinate with A/E before rough-in.

3.03 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

B. Support pull and junction boxes independent of conduit.

C. Provide pull boxes in feeder circuits as required but at least every 150 feet in straight runs.

D. Identify all junction boxes by circuit number on cover with legible permanent ink marker.

E. Duct Bank Pull Boxes

1. Refer to Item L-110 – Airport Underground Duct Banks and Conduits.

F. Provide weatherproof pull boxes or junction boxes when installed outdoors with watertight gasketed covers fastened by means of corrosion resistant screws.

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION

Section 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish and install items for identification of electrical products installed under Divisions 16 where referenced.

1.02 SUBMITTALS

A. Submit product data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers include but are not limited to those listed. All proposed components and materials are subject to the approval of the engineer.

B. W.H. Brady Co.

C. Carlton Industries, Inc.

D. Seton Nameplate Co.

2.02 MATERIALS

A. Nameplates: Provide engraved three-layer laminated plastic nameplates with white letters on a black background.

B. Wire and Cable Markers: Provide stainless steel, 2” round with ¼” letters in all manholes and light bases and provide with stainless steel ties.

C. Underground Warning Tape

1. Manufactured polyethylene material and unaffected by acids and alkalies.
2. 3.5 mils thick and 6 inches wide.
3. Tensile strength of 1,750 psi lengthwise.
4. Printing on tape shall include an identification note BURIED ELECTRIC LINE, and a caution note CAUTION. Repeat identification and caution notes over full length of tape. Provide with black letters on a red background conforming to APWA recommendations.

D. Panelboard Directories: Provide a typed circuit directory for each panelboard. Mount circuit directory in a permanent, clear Lexan card holder located on inside of door on panelboard.

E. Conduit Markers: Flexible vinyl film with pressure sensitive adhesive backing and printed markings.

1. Electrical conduit markers shall include three identifying titles on an orange background except as noted.
   a. Typical.
      1) Type Example - AC 60 Hertz
      2) Load Example - Lighting and Power
      3) Voltage Example - 480 VAC/3 Phase
2. Conduit that contains protective or communication systems shall have the exact content and title on blue background and installed and located as specified for conduit.

F. Conduit Markers and Letter Size

1. Dimensions:

Outside Diameter of Conduit in Inches	Width of Color Band in Inches	Height of Letter & Numerals in Inches
1/2 to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/4 to 3-1/4	10	1
3-1/2 & Larger	12	1-1/4

G. Wiring Device Circuit Identification: Provide for each receptacle and light switch:

1. Flexible vinyl film with pressure sensitive adhesive backing and printed markings. Black 1/8” high letters.
2. Indicate panelboard and circuit number.

PART 3 EXECUTION

3.01 INSTALLATION

A. Degrease and clean surfaces to receive nameplates.

B. Install nameplates parallel to equipment lines.

C. Secure nameplates to equipment fronts using screws or rivets. Secure nameplate to inside face of recessed panelboard doors in finished locations.

D. Embossed tape will not be accepted.

E. Provide underground tape at all electrical installations.

3.02 WIRE AND CABLE LABELING

A. Provide wire markers on each conductor in splice boxes, pull boxes, and at first load connection on homerun. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

B. Identify branch circuit or feeder number for power and lighting circuits on cover of pull and junction boxes with indelible marker.

3.03 EQUIPMENT LABELING

A. Provide nameplates to identify all electrical distribution and control equipment.

B. Engraved, Laminated Plastic Nameplates: 1/4-inch letters, equipment designation; 1/8-inch letters, source circuit number. Provide for:

1. Switchboards including each individual device or piece of equipment within a switchboard or switchgear.
2. Regulators.
3. Enclosed switches, starters, circuit breakers and contactors. Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, design letter, service factor, and voltage/phase rating. Provide phenolic nameplate on cover exterior to indicate motor served.
4. ALRCS Cabinets
5. S1 Cutout Cabinets
6. Series Circuit Modem and Filter/ Transformer Cabinets

C. Identify all junction boxes by circuit number with legible permanent ink marker.

3.04 BOX COLOR CODING

A. Boxes and covers for fire alarm wiring shall be painted red.

B. Boxes and covers for emergency system wiring shall be painted yellow.

3.05 CONDUIT MARKERS

A. Location of Identifying Markers: At each end of conduit run and at intermediate points 50' on center maximum.

3.06 WIREWAY AND CABLE TRAY LABELING

A. Provide continuous label on outside edge of wireway or cabletray for all 5KV cables, 600V cables and low voltage cables. One on the outside edge of wireway and cabletray and one label shall be located on the bottom of the wireway. Cable tray labels to be on both outside edges.

B. Label shall be permanently attached to wireway and color coded. The label shall be a minimum of 3 mils thick and 4 inches wide and run the full length of the wireway. Label font shall be in bold letters 3 inches tall. Use the following color scheme:

1. Low voltage control cables light blue background and black letters
2. 600 Volt Conductors- Yellow background with black letters
3. Warning 5KV conductors- Red background and black letters

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will be no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION

Section 26 05 83

WIRE CONNECTIONS AND DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish and install splicing and terminating devices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers include but are not limited to those listed. All proposed components and materials are subject to the approval of the engineer

B. Burndy Corp.

C. Dossert Manufacturing Corp.

D. Ideal Industries, Inc.

E. Ilsco Corp.

F. Minnesota Mining and Manufacturing Co.

G. Thomas & Betts Co., Inc.

2.02 MATERIALS

A. Cable and wire connections for splicing or terminating shall be made with compression deforming type connectors. Connectors for cable sizes 250 kcmil and larger shall be the long barrel type for double indentation. Soldered connections will not be permitted. Twist-on insulated connectors may be used which are resistant to vibration and are used in the proper sizes.

B. Provide terminal connectors with hole sizes and spacing in accordance with NEMA standards. Provide terminal connectors with two holes in tongue for use on conductor sizes 250 kcmil and larger. Terminal connectors will not be required for connections to the circuit breakers in the lighting and/or receptacle panels.

C. Provide connections made with non-insulated connectors with three layers of plastic tape, each layer being half lapped. Provide No. 33+ plastic tape.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide electrical connections to equipment furnished under other contracts and furnish wiring, conduit, outlet boxes, and safety switches, as required. Verify locations, horsepower, and voltages of equipment prior to installation of feeders. If apparent conflict arises in power wiring, advise the project manager immediately for clarification.

B. Provide switches as required by national or local codes.

C. If the motor is integral to the equipment, isolate the entire piece of equipment with a short section of liquidtight flexible metal conduit to prevent vibration and/or noise amplification to be transferred to the building structure.

D. If the motor is adjustable, install an additional length of flexible metal conduit at the motor.

E. Connect a ground wire from the conduit termination to the motor frame on the inside of flexible conduit. Use approved grounding lugs or clamps or the conduit connection.

F. Major equipment furnished under mechanical and other sections of specifications may require different rough-in requirements than those indicated on Drawings. Secure detailed drawings from source furnishing equipment to determine actual rough-in locations, conduit and conductor requirements to assure proper installation.

G. Before connecting any piece of equipment, verify the name plate data corresponds with information shown on Drawings. Discrepancies shall be called to attention of the project manager.

H. Change any feeders installed incorrectly as a result of not verifying equipment requirements, of equipment provided by others, prior to feeder installation.

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION

Section 26 08 10

RECOMMENDED LOCKOUT PROCEDURE FOR AIRFIELD LIGHTING CIRCUIT

PART 1 GENERAL

1.01 DESCRIPTION

A. The Contractor is required to lockout the power source feeding any airfield lighting circuit that he will come in contact with (either by hand or with equipment) during the course of the workday. Coordinate with the Construction Manager and IAH Electric Shop, Airfield lighting circuits can be locked out with the approval of the Owners representative. They must be returned to service the same day unless prior arrangements have been made. Cloudy or overcast days may delay or cancel a scheduled lockout.

B. In order to gain access to the circuit power source, the Contractor will contact his Construction Manager (CM) at least 48 hours prior to the day and hour when the circuit lockout is required. The Contractor will identify, in writing, his work area and the circuit to be locked out.

C. The CM will then contact the Owners Representative or Center Point at least 24 hours in advance, with all the pertinent information, so the work may be scheduled, and verify that the circuit can be turned off as requested. The Owners Representative or Center Point will determine if the circuit can remain de-energized outside of daylight hours. Request for lockouts that occur on recognized holidays, or Saturdays and Sundays, or after normal working hours, (0800 to 1600), will require special notice. In this case the Owners Representative or Center Point must be notified a minimum of two regular working days in advance of the lockout occurrence. The Contractor, the CM, and the Owners Representative, if required, will meet at the vault for the lockout. The Contractor shall provide a 5000-volt, direct current megger. The megger shall be a 120-volt A.C. device, as opposed to a hand crank type, and calibrated within the last three months. The Owners Representative will de-energize the circuit. *(See note at the end of the procedure). The Contractor will install his lock on the scissor clip, locking out the disconnect.

D. The Contractor will insulate between the field contact of the S-1 switch of all 6.6 AMP or 20 AMP series circuits to be locked out prior to megging. The insulating piece(s) will remain in place until all circuits are meggered for release of lockout. The Contractor will megger the circuit in the presence of the Owners Representative and the CM. 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 CM will notify the Owners Representative to report the circuit lockout time and the megger reading.

E. The Contractor will install an appropriate Safety Tag on the locked out disconnect switch. The tag will show the name of the Contractor, and the date.

F. As soon as practical after the work is complete, but no later than the same day unless prior arrangements have been made, the Contractor will notify the CM, who will in turn notify the Owners Representative that the circuit is ready to be re-energized. The Contractor, the Owners Representative and the CM will meet at the vault to re-test the circuit.

G. The Contractor will megger the circuit for five minutes in the presence of the Owners Representative and the CM and record the reading on the form. He will also, at this time, megger across the field connections of the S-1 switch if present to insure continuity and correct field connections. If the readings are acceptable to the Owners Representative and the CM, then the Contractor will remove his safety tag and lock. If the readings are not acceptable, then the Contractor must correct the problem immediately or prove that the problem is not in his work area. An acceptable megger reading must be registered before the circuit can be released (acceptance of the circuit at this time does not relieve the Contractor of liability for damage discovered later which results from faulty workmanship). If the circuit is to be left off after dark, the CM must notify the Owners Representative with detailed information concerning the outage. Some outages will require continued work to re-energize circuits.

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

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

PART 4 MEASUREMENT AND PAYMENT

4.01 There will be no separate measurement or payment of the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION

Section 26 08 20

AIRFIELD ELECTRICAL INSTALLATION TESTING

PART 1 DESCRIPTION

1.01 SECTION INCLUDES

A. This item shall consist of furnishing all equipment, materials and appliances necessary for testing of airfield lighting circuit installations and associated systems.

B. The Contractor shall provide testing to confirm installations are acceptable for ground rod testing and airfield lighting circuit testing.

C. Requirements under this item shall be coordinated with the Airport Construction Manager. Specification requirements for approvals, reviews or other involvement of the Engineer shall be transmitted by the Contractor through the Construction Manager to the Engineer.

1.02 RELATED SECTIONS

A. Section 26 08 10 - Recommended Lockout Procedures for Airfield Lighting Circuit

B. Section 26 05 40 - Installation of Underground Cable for Airports

C. Section 26 35 53 – Installation of Vault Equipment

D. Section 26 55 90 – Installation of Airport Lighting Systems

E. Section 26 55 95 - Airfield Lighting Remote Control System

PART 2 EQUIPMENT AND MATERIALS

2.01 GENERAL

A. Materials and equipment covered by this item shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the Engineer.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. The Contractor shall furnish all necessary equipment and appliances for testing installations as indicated below.

3.02 GROUND ROD TESTING.

A. Contractor shall provide equipment and personnel to measure the resistance to earth for all ground rods installed. Earth resistance measurement tests shall adhere to recommendations of IEEE Standard 142, latest edition. Contractor shall submit testing procedure, equipment and report form to the Construction Manager for approval.

B. As each rod is installed, tests shall be administered. Any rod that does not have a resistance to ground of 25 ohms or less shall be augmented by an additional rod not less than 10 feet away. No testing of the additional rod is required. Testing results, including confirmation of installation of augmenting ground rods, shall be submitted to the Engineer for approval.

3.03 AIRFIELD LIGHTING CIRCUITS TESTING.

A. The Contractor shall notify the CM and Facilities Maintenance 24-hours prior to cable testing. All testing shall be conducted in the presence of the CM and Airport Facilities Maintenance. All test results shall be simultaneously recorded by the Contractor and IAH Electrical Maintenance. Contractor shall provide test report information to the CM and IAH Electrical Maintenance for approval. Test procedures for the following required tests, including field test report forms, shall be submitted to the CM for approval prior to testing.

1. Testing Requirements.
   a. All Circuits. Prior to commencement of work on any circuit the Low Voltage Tests shall be performed in accordance with procedures below.
   b. All Circuits. Upon completion of all rewiring of each circuit, the Low Voltage Tests shall be performed on the completed circuit following paragraph 2 below, to determine if the circuits are free of grounds. Circuits tested shall meet the requirements of paragraph 3 below. Any faults indicated by these tests shall be corrected before proceeding with additional testing. All test results shall be submitted to the CM for approval.
2. Testing Procedures.
   a. Low Voltage Tests. Low Voltage Continuity and Insulation-Resistance (Megger) Tests
      1) Test Required. As noted in Part A above, circuits and portions of circuits shall be subjected to a low voltage (1000 volt) continuity

test and a low voltage (1000 volt) insulation-resistance (megger) test.

2) Test Products. Contractor shall provide a 5000-volt direct current Megger for low voltage testing. Megger tester shall be non-crank type, as manufactured by Associated Research Meg-Check, the James Biddle Megger, General Radio Mega-Ohmmeter or approved equivalent. The Contractor shall be responsible for providing any required 120V AC power source at testing locations remote from available power. Products calibration information shall be readily available for review by the CM, as requested.

3) Test Procedures. Refer to Section 26 0810 – Recommended Lockout Procedure for Airfield Lighting Circuit for lock-out procedure requirements. Test procedures for the required tests, including field test report forms, shall be submitted to the CM for approval prior to testing.

4) Test Results. Test values not meeting the requirements of paragraph 3 below shall be considered faulty and shall be corrected accordingly. Refer to paragraph D below for cables not meeting testing requirements.

3. Testing Results.
   a. New Circuits and New Portions of Existing Circuits.
      1) Low Voltage Tests shall demonstrate to the satisfaction of the HAS the following:
      2) All circuits are properly connected following the applicable wiring diagrams.
      3) All lighting power and control circuits are continuous and free from short circuits.
      4) All circuits are free from unspecified grounds.
      5) The insulation-resistance to ground is equivalent to or greater than 100 mega-ohms for all new non-grounded series circuits.
4. Deficient Testing Results (Circuits Not Meeting Requirements).
   a. New Circuits and New Portions of Existing Circuits.
      1) Cables not meeting the requirements of sub-paragraph 3 above shall be considered faulty. Faulty cables shall be corrected, if possible, and re-tested. If acceptable test values cannot be obtained, cables shall be removed from the conduit and replaced with new cable at Contractor's expense, as directed by the CM. Required testing of new cable in place shall then be implemented.
5. Submittal of Testing Data.
   a. Low Voltage Tests. Contractor shall submit 5 copies of tests reports for approval by the HAS, IAH Airport Electrical Maintenance, and the Engineer-of-Record. Report shall include all measured data including applied voltage, time length of voltage application of cable within a circuit.

DATE	CABLE NUMBER
START TIME	OPERATING VOLTAGE
END TIME	MAX. TEST VOLTAGE
CABLE B/M NO.	FROM PRODUCTS
DESCRIPTION	TO PRODUCTS
TEMP. MEASURE EQUIP. NO.	HUMID. MEASURE EQUIP. NO.
CALIBRATION DUE DATE	RELATIVE HUMIDITY
AMBIENT TEMPERATURE	

3.04 SYSTEM TESTS

A. After the airfield lighting systems installation is complete and at such times as the Engineer may direct, the contractor shall conduct airfield lighting systems operating tests for approval.

B. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the Engineer or his authorized representative. The contractor shall furnish all equipment and personnel required for the test.

C. Each applicable switch in the control tower lighting panels shall be operated so that each switch position is engaged at least ten times. During this process, all lights and associated equipment shall be observed to determine that each control device properly commands the corresponding circuit. Radio communication between the operator and the observers shall be provided by the Contractor.

D. The above tests shall be repeated from the local control switches on the regulators. Each installed or revised lighting circuit shall be tested by operating the lamps throughout the range of applicable steps and shall be operated separately at Step 3 or Step 5 as appropriate for full intensity or as directed by the Engineer, for not less than 1 hour. Visual examination shall be made at the beginning and at the end of this test to determine that the installed airfield light fixtures are illuminating at full intensity.

E. If circuit regulators are installed under project construction, regulator output ampacity shall be adjusted for proper outputs following manufacturer's recommendations and requirements to insure proper circuit operation.

F. Systems tests shall confirm by demonstration in service that all lighting circuits are in good operating condition to the satisfaction of the Engineer if the tests are unsatisfactory, lighting systems installed shall be corrected and systems tests shall again be implemented.

3.05 ALRCS SYSTEM

A. Following final installation and calibration of the ALRCS, the supplier shall perform a demonstration of system performance to the satisfaction of the Engineer. An acceptance test shall be conducted by an independent testing firm selected by the City 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 printout functions shall be demonstrated. All performance requirements in Section 26 5595 – Airfield Lighting Remote Control System 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, and shall bear all associated costs including the cost of performing the test again. Any changes to the system as submitted shall be subject to the approval of the engineer.

3.06 CONSTANT CURRENT REGULATOR

A. Following final installation or modification and calibration of the CCRs, the supplier shall perform a demonstration of system performance to the satisfaction of the Engineer. An acceptance test shall be conducted by an independent testing firm selected by the City to determine if the CCR meets the functional and performance requirements of the specification. Satisfactory performance of the CCR power system, control functions, monitoring and display functions, alarming shall be demonstrated. All performance requirements in the CCR specification 26 3553 are subject to testing and verification. If the CCRs do not meet the performance requirements of this specification, the supplier shall make modifications so that the requirements can be met, and shall bear all associated costs including the cost of performing the test again. Any changes to the system as submitted shall be subject to the approval of the engineer.

PART 4 METHOD OF MEASUREMENT AND PAYMENT

4.01 There will no separate measurement or payment on the work discussed in this section. All work will be considered incidental for the completion of the component of the work to which it is related.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

Section 26 35 53

INSTALLATION OF VAULT EQUIPMENT

PART 1 DESCRIPTION

1.01 GENERAL

A. This item provides for modification and installation of equipment in the North Vault, including the following items:

1. Calibration of the CCRs in the North Vault for reconfigured loading.

2. Addition of the cabling and conduits and filter enclosures for two Runway Guard Light Circuits for entrances to Runway 8R-26L - one existing and one new.

3. Modification of an existing thyristor CCR to a Ferroresonant CCR in the designated cell of the switchgear CCR lineup as shown on drawings

4. Isolation of the 5KV Runway Guard Light circuits for 8R-26L in a separate conduit and new cables between the regulator and proposed isolated S-1 cutout enclosure and installation of a proposed filter/ transformer enclosure for the 8R-26L Runway Guard Lights circuit and associated conduits and new cables as shown on contract drawings

5. Isolation of the 5KV Land and Hold Short circuits as shown on contract drawings in a separate conduit and new cables between the power unit in the vault and proposed isolated S-1 cutout enclosure

B. Refer to contract drawings and documents for details on the electrical vault.

1.02 RELATED SECTIONS

A. Section 26 05 00 - General Provisions - Electrical

B. Section 26 55 95 - Airfield Lighting Remote Control System

1.03 QUALITY ASSURANCE

A. Codes and Standards

1. Comply with the provisions of the following specifications and standards, except where more stringent requirements are shown or specified.

2. AC 150/5345-10 – Specification for Constant Current Regulator and Regulator Monitors.

3. AC 150/5345-56 - Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)

4. AC 150/5347-7 - Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits.

5. AC 150/5340-30 - Design and Installation Details for Airport Visual Aids

1.04 SUBMITTALS

A. Shop Drawings. Follow Section 26 05 00 – General Provisions - Electrical and other sections for product data, shop drawings and samples.

PART 2 PRODUCTS AND REQUIREMENTS

2.01 RECONFIGURATION AND RECALIBRATION OF CONSTANT CURRENT REGULATORS.

A. The existing stackable CCRs cell size includes 20KW and 30 KW CCRs with CCRs of both ratings in the same size enclosure, with a difference in internal components and circuit breaker.

B. The designated regulators for the modifications are indicated on contract drawings. The modification shall include but not be limited to:

1. Setting the CCRs designated to operate in a 5 step mode that are currently set for 1 or 3 step operation, or vice versa
2. Recalibration of the CCRs with changed loading or step designation.
3. Adjust CCR for stable and efficient operation at with new load levels based on project circuit reconfiguration.
4. Conversion of CCRs designated on contract drawings from thyristor to Ferroresonant, including all necessary components and upgrades to provide a full and working CCR.

C. Salvaged Components

1. Return any salvageable components to HAS electrical maintenance.

D. Additional Performance Requirements

1. Regulator shall support proper stable operation of the regulator and connected load, on the entire population of series circuit components that is shown on contract drawings. The contractor shall follow manufacturer's instructions and recommendations concerning the combinations of loads on

each circuit, and coordinate the selection of regulators and lighting components for compatibility of operation. The compatibility must be ensured for the combinations of elements that include but are not limited to LED fixtures, and flashing loads. Refer to AC 150/5340-30, appendix 6 for application notes regarding these components.

2. Regulators shall support stable regulation when presented with non linear loads from Light Emitting Diode (LED) fixtures, or other electronic components that are required for this project.
3. Constant current regulators shall support stable regulation when presented with synchronous flashing loads.
4. Constant current regulators shall support stable regulation when presented with reactive loads that might be present on a circuit with a number of open secondary isolation transformers as described in the qualification test of AC 150-5345/10.

E. Control & Monitoring Requirements

1. The regulator shall be controlled and monitored with a Digital Control Unit (DCU). The DCU shall be door mounted, or in a protected enclosure and include an integrated display and keypad.
2. The DCU shall include a compact card cage mounted on the rear of the regulator door or in a protected enclosure in the regulator. The card cage shall include, but not be limited to, separate circuit boards for specific functions. All circuit boards shall be easily replaced without removing fasteners or disconnecting power or control wires. Circuit boards shall be provided on separate assemblies for the following functions.
   a. Power supply circuit board for card cage backplane.
   b. Processor circuit board with digital signal processor.
   c. Input circuit board for a minimum of 14 separately opto-isolated circuits control inputs.
   d. Output relay circuit board for a minimum of 14 separate circuits.CCR status.
   e. Analog to Digital circuit board and all electronics for a fully self-contained Insulation Resistance Measuring System (IRMS).
   f. Dual Ethernet communication circuit board for connection to the ALRCS vault network.
   g. The Dual Ethernet communications ports shall support redundant operation with a failover mechanism that shall seamlessly switch from a failed network to the operational network, and continue normal operations with the ALRCS.
   h. All control components that connect to the series circuit shall be electrically isolated from the digital and communications portionportions of the control interface.
   i. All analog measured values shall be converted instantaneously to digital codes and processed using an optimized algorithm specifically designed for use in the regulators.

j. The display of the DCU shall be an alphanumeric type consisting of a minimum of 4 rows of 20 characters each. The DCU shall display, but not be limited to the following information.
   1) Regulator On/Of
   2) Regulator incoming power supply normal
   3) Open circuit alarm
   4) Overcurrent alarm
   5) Status of regulator; OK/Failure, and cause of fault
   6) Output current
   7) Brightness step
   8) Control source, Local/Remote

k. All settings, adjustments, configuration and calibration shall be done digitally using the integrated display and membrane function keys.

l. Failsafe Control: In the event of communication/control system failure, the CCRs shall enter the failsafe state. The CCR shall provide the failsafe function internally.

m. Each regulator failsafe function shall be independently programmable such that upon communication or system failure, the regulator shall automatically revert to either remain in the last state or switch to OFF, Brightness B1, B2, B3, B4 or B5.

n. If failsafe mode occurs, all regulators and circuits will set to their failsafe settings.

o. The failsafe settings shall be determined by the airport operations and maintenance staff and shall be field adjustable without changing the software.

p. A watchdog timer shall be installed to check the status of the control system and communications and the failsafe mode shall be entered if malfunction occurs.

q. When the control system returns to normal, control shall automatically be transferred back to the tower.

r. The DCU shall provide text messages and information on the display panel to guide a user through all menus by means of clear instructions on the display.

s. Configuration changes to the regulator for the number of brightness steps, brightness step current setting or any other configuration or calibration value shall be with a suitable access code that can be entered using the DCU function keys.

t. All configuration settings and calibration values shall be stored to a suitable non-volatile memory chip on the Processor circuit board.

u. The DCU shall be capable of being operation to the L-829 specification with a menu selection The L-829 monitoring shall include:
   1) Lamp failure and alarm (two settings)
   2) Number of failed lamps
   3) Additional user configurable warning and alarm output relays
   4) Display of input voltage, current and power measurement
   5) Display of output voltage and power measurement

v. The DCU shall support insulation resistance monitoring system (IRMS) functionality with the following features.
   1) Insulation measurement warning and alarm (two settings)
   2) Insulation resistance value

w. The DCU shall be powered from 120 Volts AC supplied by the regulator electronics, and as a backup, from 24 Volts DC supplied externally as shown on contract drawings. Turning off the regulator shall cause the DCU to automatically select the 24 Volt DC power source.

x. The CCR shall be supplied with an insulation-monitoring unit, which shall be integral to the CCR. The insulation monitoring unit shall be capable of automatically or manually monitoring and reporting the insulation value of the airport series lighting circuit cable. The insulation-monitoring unit shall also be capable of measuring the cable leakage current and display the actual insulation resistance in ohms, display the readings for view on the CCR control panel, and transfer all collected data to the ALRCS PLC via the dual Ethernet interface.

y. The keypad button functions shall be either labeled on each button or indicated based on the context, on the alphanumeric display

2.02 LABELS AND NAMEPLATES

A. CCR Labels and nameplates, and the labels and nameplates in the S-1 cutout cabinets shall reflect the proposed configuration of circuits and CCRs. The contractor shall verify that the circuit connected to the CCR is correct and that all labels are present and correct on the CCR and in the cutout cabinets, including circuit tags. Cable labels and S1 Cutout Nameplates in the S1 Cutout cabinets shall be added if missing to all North Vault Circuits. Separate nameplates shall be installed for the switchgear cell number and circuit name, so the circuit can be assigned to a CCR in a different cell without renumbering the cell number and simply moving the circuit nameplate.

B. Nameplates of laminated phenolic material with engraved letters shall be installed to designate the regulator cubicles, components, circuit descriptions and circuit numbers. Nameplates shall be white phenolic material with black engraved letters.

C. The minimum height of letters used shall be 3/16 inch. Main titles for circuit or cubicle designations shall be in letters 3/8 inch in height.

PART 3 EXECUTION

3.01 MODIFICATION OF CONSTANT CURRENT REGULATOR

A. General Construction

1. Stackable Regulator KW ratings shall be available in the standard ratings

and designs as indicated on the Contract Drawings.

2. Regulators shall be 6.6 A constant current output, and provide L-829 functionality as indicated on the contract drawings.
3. Regulators modified Thyristor to Ferroresonant shall match the enclosure type of the existing CCR to be modified.
4. All regulating, control and power components, including output transformer shall be contained within the regulator cubicle.
5. Primary control voltage for each regulator shall be obtained internally not from an external source.
6. The solid state power devices and essential components of their control, regulating and protective circuits shall be mounted on a subassembly in the unit. The entire subassembly shall be readily removable to facilitate maintenance and trouble-shooting.
7. The regulating controls shall be mounted on printed circuit boards with plug-in connectors for quick exchange if necessary. Control relays shall also be of the plug-in type, except where mounted on printed circuit boards.
8. The inside and outside of the regulator enclosure shall be given one coat of primer and one finish coat of grey semi-gloss enamel in areas where any paint has been removed or is damaged. The paint finish shall be durable, shall not chip, flake or become chalky.

B. Basic Requirements

1. The regulator shall have a main contactor that interrupts the input power before it reaches the main regulating device. It shall be operable by remote control and shall not interrupt internal control power. The contactor shall have an interrupting rating of 65,000A.
2. The power component shall be a convection air-cooled solid state switch controlled by a Digital Control Unit (DCU). The power component shall be installed on a suitable heat sink and mounted on the rear of the regulator door.
3. Each regulator shall contain an integral dry-type, ferroresonant step-up output transformer.
4. The efficiency of the regulator at room temperature, operated with rated input voltage into a full load having unity power factor, shall not be less than 93%, at full tapping and not less than 90% at the lower three taps.
5. There shall be no interruption of current to the airfield lighting circuit when switching from one brightness level to another.
6. The regulator shall include an overcurrent protective device that shall operate to limit the output current to the selected brightness step.
7. The regulator shall include an over voltage shut down capability based on its rated set maximum output. The threshold voltage shall be field configurable via the keypad on the CCR. This shall function within 1 second of an overvoltage condition.
8. The regulator shall include an open-circuit protective device to de-energize the regulator within 1 second after an open circuit condition occurs in the

field circuit. The open circuit protective device shall not be tripped by switching of load circuits or other transients.

9. Regulators shall be capable of operating at three and five brightness steps, configurable in the field with the Digital Control Unit (DCU).
10. Output current settings for each brightness level shall be adjustable with a suitable menu on the display panel of the DCU.
11. Local status and fault indication shall be provided with the display panel of the DCU on each regulator. As a minimum, these shall include local and remote brightness level indication, on/off status and overcurrent and overvoltage trip indication.
12. Each unit shall be provided with safety door interlocks to de-energize the regulator before access is gained, and to prevent energizing the unit with the door(s) opened.
13. The regulator shall contain a Load Disconnect Test (LDT) type cutout to allow the isolation of the outgoing field cables for the purpose of insulation resistance measurements by means of a 5,000-volt megger. When the test plate is inserted, the device shall short out the regulator output terminals and provide access to the field load circuit by means of binding posts. When the ground search plate is inserted, the isolator shall also provide ground search capability.
14. Modified CCRs shall include a 1 year warranty as stated in the warranty section of this specification, for all components, new and remaining, in the modified CCR. Replace any components that are damaged or not suitable for the 1 year warranty.

3.02 INSTALLATION OF CONSTANT CURRENT REGULATORS

A. The existing stackable CCRs cell size includes 20KW and 30 KW CCRs with CCRs of both ratings in the same size enclosure, with a difference in internal components and circuit breaker.

B. The designated regulators for the modifications are indicated on contract drawings. The modification shall include but not be limited to:

1. Installation of new step up transformer to support rated KW output on contract drawings.
2. Replacement of the circuit breaker with one of proper rating for the modification.
3. Recalibration of the electronics for the changed rating.
4. Modify any labels and documentation as a result of the modification.

3.03 INSTALLATION OF PRODUCT IN VAULT

A. The Contractor shall furnish, install, and connect all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to insure a complete and operable electrical distribution center for the airport

lighting system as specified herein and shown in the plans. When specified an emergency power supply and transfer switch shall be provided and installed.

B. The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction.

C. Provide housekeeping pad beneath all regulators.

D. Provide and install an S1 cutout and associated wiring and labeling in the cutout cabinet as shown on drawings.

3.04 INSTALLATION AND COMMISSIONING

A. The contractor shall install the equipment according to the final review shop drawings and the equipment manufacturer's recommendations.

B. Final adjustments to the equipment shall include verification of the proper mechanical operation, verification of the regulator operation and review of the protective features and devices.

C. The equipment manufacturer shall provide a qualified factory trained service engineer to provide technical direction for the installation and final verification of the equipment.

D. The service engineer shall certify that the equipment has been installed according to the equipment manufacturer's recommendations.

E. A site acceptance test shall be completed according to additional requirements in Section 26 0820 – Airfield Electrical Installation Testing.

F. Following final installation and calibration of the CCRs, 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 CCR meets the functional and performance requirements of the specification. Satisfactory performance of the CCR power system, control functions, monitoring and display functions, alarming shall be demonstrated. All performance requirements in the CCR specification 26 35 53 are subject to testing and verification. If the CCRs do not meet the performance requirements of this specification, the supplier shall make modifications so that the requirements can be met, and shall bear all associated costs including the cost of performing the test again.

3.05 TRAINING

A. Provide a qualified factory-trained service engineer to conduct on-site familiarization, operation, and maintenance training program for the CCRs. Training shall be conducted after the CCRs are fully commissioned.

B. Provide 8 hours of on-site training for maintenance personnel covering the changes reflected in any new configuration. Training session to be recorded onto DVD and turned over to IAH Electrical Section for future reference.

C. Provide updates to the operations and maintenance manuals two (2) weeks prior to formal training.

3.06 WIRING AND CONNECTIONS

A. The Contractor shall make all necessary electrical connections in the vault following the wiring diagrams furnished and as directed by the Engineer. In wiring to the terminal blocks, the Contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

3.07 MARKING AND LABELING

A. All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

B. Wire Identification: The Contractor shall furnish and install wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks.

3.08 WARRANTY

A. Products in this specification shall be warranted for a period of 1 year from acceptance. This includes any and all costs of repair and all spare parts shall be included in this 1 year warranty.

B. The same 1 year warranty applies warranty the modification to the CCR, and shall include the CCR in its entirety, for new and remaining components.

PART 4 MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. The North Vault Upgrade for Circuit Modifications shall be measured per lump sum. This shall include reconfiguration of cables, S-1 Cutouts, Labels and Nameplates as required and adding of new conduits, enclosures, Labels and Nameplates to new or reconfigured S1 Cutouts and regulators; recalibration and reconfiguration of the regulators, as described in this specification and shall include all material, labor, installation, coordination, training and documentation updates, testing and commissioning and all incidentals required for a complete and working system.

4.02 METHOD OF PAYMENT

A. Payment for the North Vault Upgrades for Circuit Modifications covered in this section and subsidiary items shall be paid for per lump sum as shown below and shall be full compensation for furnishing all products and for preparation, assembly installation and testing of this item, and for all labor, equipment, tools, and incidentals necessary to complete the North vault Upgrades for Circuit Modifications in accordance with the provisions and intent of the plans and specifications.

Payment will be made under:

26 33 53 - 1 North Vault Upgrades for Circuit Modifications - Per Lump Sum.

END OF SECTION

Section 26 55 90

INSTALLATION OF AIRPORT LIGHTING SYSTEMS

PART 1 DESCRIPTION

1.01 SECTION INCLUDES. This section shall consist of all lighting systems furnished and installed following the project plans and specifications and the applicable advisory circulars.

A. The systems shall be installed at the locations and following the dimensions, design and details shown on plans. It is the intent and meaning of the plans and specifications that the Contractor shall provide an electrical installation that is complete, including all items and appurtenances necessary, reasonably incidental or customarily included, even though each and every item is not specifically called out or shown.

B. Installations and construction under these provisions shall be coordinated with the Airport Construction Manager, hereby referred to as the CM. Specification requirements for approvals, reviews or other involvement of the City Engineer shall be transmitted by the Contractor through the CM to the City Engineer.

C. This item shall include the furnishing of all products, labor and incidentals necessary to place the systems in operation as completed units to the satisfaction of the CM. Refer to provisions of Section 26 05 00 – Common Work Results for Electrical.

D. Airport lighting and products covered by Federal Aviation Administration (FAA) specifications shall have the prior approval of the FAA and shall be listed in latest edition of Advisory Circular (AC) 150/5345-1, Airport Lighting Equipment.

E. All Advisory Circulars referenced in this specification shall be the edition indicated or the latest edition.

1.02 RELATED SECTIONS

A. Section 26 08 10 - Recommended Lockout Procedure for Airfield Lighting Circuit

B. Section 26 08 20 - Airfield Electrical Installation Testing

C. Section 26 05 53 - Electrical Identification

D. Section 26 05 40 - Installation of Underground Cable for Airports

E. Section 26 05 43 – Installation of Airport Underground Electrical Duct Banks and Conduits

F. Section 26 35 53 – Installation of Vault Equipment

G. Section 26 55 95 - Airfield Lighting Remote Control System

1.03 RELATED DOCUMENTS

A. AC 150/5340-18 Standards for Airport Sign Systems

B. AC 150/5340-30 Design and Installation Details for Airport Visual Aids

C. EB-67 Light Sources Other Than Incandescent and Xenon For Airport and Obstruction Lighting Fixtures.

PART 2 PRODUCTS

2.01 GENERAL

A. All commercial items of electrical products not covered by Federal Aviation Administration specifications shall conform to the applicable rulings and standards of the National Electrical Code.

B. Some products shall be City Furnished for installation by the Contractor, as indicated in these specifications and/or on the construction plans and details.

2.02 APPROVAL PROCESS REQUIREMENTS

A. As part of the approval procedure, a sample of all proposed models and/or types of the following products, shall be submitted and become the property of the Airport.

1. Taxiway Centerline Light (LED)
2. Connector splice kit.

B. Submittal information shall include, but shall not be limited to, the following, where applicable.

1. Bolt pattern information for fixture bases.
2. Insulating transformer ratings
3. Sign legend, module information, and technical information.

C. Submittals shall comply with Section 26 05 00 – Common Work Results for Electrical on submittals.

2.03 LIGHT FIXTURES.

A. Light fixtures and lamps specified shall be low wattage and energy efficient, unless noted otherwise.

B. The fixtures shall meet the latest edition of FAA Specifications in the applicable Advisory Circulars listed and shall be approved under the Airport Lighting Equipment Certification Program described in AC150/5345-53.

C. The lighting fixtures shall be ADB, Crouse-Hinds, or approved equivalent.

D. All new guidance signs shall be LED, and match existing signs, or approved equivalent.

E. The guidance sign replacement panels shall be supplied by the manufacturer of the sign, to ensure continued photometric performance.

2.04 PRODUCTS COMMON TO ALL SYSTEMS

A. Primary Cable. Primary L-824 cable shall as specified in Section 26 05 40 – Installation of Underground Cable for Airports.

B. Counterpoise Wire. Counterpoise wire shall as specified in Section 26 05 40 – Installation of Underground Cable for Airports.

C. Isolation Transformers. Isolation transformers shall be of rating compatible with associated light fixture and conforming to requirements of AC 150/5345-47.

D. Fixture Bases. Provide L-868 and L-867, Class I bases that conform to the requirements of AC 150/5345-42 for all fixtures.

1. Certain applications shall require additional entrance hubs, as shown on the plans.
2. Provide drain coupling in base cans where noted on the contract documents.
3. All fixture mounting holes in base top shall be drilled completely through and then tapped.
4. Provide L-868, Class I, two-piece bases with factory installed anti-rotation tabs.
5. Coordinate bolt hole patterns for bases with fixtures to be installed. Stainless Steel Hardware to include nylon insert locking nuts. Reference bolt circle dimensions on fixture schedule noted on plans. In general, to match fixtures, bolt hole pattern for bases off concrete pavement shall be 10-1/4 inch diameter and bolt hole pattern for bases in concrete pavement, other than bases for runway edge lights, shall be 11-1/4 inch diameter.

6. All bases to include internal and external ground lug.

E. Connectors. L-823 connectors used to splice the L-824 primary cables shall be as specified in Section 26 05 40 - Installation of Underground Cable for Airports. Fixtures shall be provided with a single connecting lead plug for connection to L-830 transformers.

F. Ducts and Conduits. Ducts and conduits shall be as specified in Section 26 0543 – Installation of Airport Underground Duct Banks and Conduits.

G. Tape and Heat Shrinkable Splices. Tapes and splices to be used on primary L-824 cable shall be as specified in Section 26 05 40 - Installation of Underground Cable for Airports.

H. Concrete. Concrete shall adhere to requirements of Structural Portland Cement Concrete Item P-610. Reinforcing steel shall conform to provisions of Item P-610.

I. Sealer Products. Products used shall conform to applicable requirements of Joint Sealing Filler Item P-605. Submit materials with satisfactory adhesive and waterproofing qualities for approval of the CM.

J. Joints. Use joint sealing material conforming to Section Item P-605 across concrete pavement joints. Where conduit is being installed in saw cut trench in existing pavement, OZ Gedney Type DX Expansion Fitting shall be installed at intersection of conduit installation and existing concrete pavement expansion joints.

K. Fixture Hold Down Bolts. Fixture hold down bolts and installations shall adhere to the following requirements.

1. Bolts shall 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 City 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 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. City to retain additional spacers as spare parts.

2.05 PRODUCTS FOR TAXIWAY CENTERLINE LIGHTING

A. Light Fixtures. Fixtures shall be furnished complete, ready for installation on a base and shall comply with requirements of AC 150/5345-46. All fixtures shall be style 3. Drawings will indicate use of LED or Quartz Fixtures.

1. Taxiway centerline light fixtures shall be L-852C for straight sections and L-852K for curved sections and L852F for omnidirectional installations, as noted on the contract drawings. Fixtures shall be bi-directional with green/green or green/amber color lenses or uni-directional with green or amber lens, as indicated on construction plans and light fixture schedule. Fixture lamps shall be as shown on plans, or as manufacturer provides.
2. Taxiway centerline clearance bar fixtures shall be L-852C and shall have uni-directional yellow color lenses, unless indicated otherwise on construction plans and/or light fixture schedule. Fixture lamps shall be as shown on plans.
3. Fixtures shall be provided with connecting leads for power connections, optical system, lamp and mounting assembly.

B. Isolation Transformer. Transformers shall be L-830, isolation transformers complying with requirements of AC 150/5345-47 for 6.6 ampere series circuits. Transformer wattage rating shall be as shown on plans.

C. Light Base and Transformer Housing. Fixtures shall be installed on L-868 base complying with requirements of AC-150/5345-42.

1. Bases shall house isolation transformer and shall be 12” diameter, two - piece cylindrical body with a top flange having an 11-1/14 inch bolt circle.
2. Empty bases installed for future use shall be as specified above.

2.06 PRODUCTS FOR TAXIWAY EDGE LIGHTING SYSTEM

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(L). Fixtures shall be furnished with blue color omni-directional lens as indicated on construction plans and light fixture schedule. Fixture lamps shall be series lamp, LED, 6.6 ampere.
2. Taxiway semi-flush edge light fixtures shall be L-852T(L). LED. Fixtures shall be omni-directional with blue color lens, as indicated on construction plans and light fixture schedule. Fixtures shall be as shown on plans.

3. Fixtures shall be provided with connecting leads for power connections, optical system, lamp and mounting assembly.

B. Isolation Transformer. Transformers shall be L-830, isolation transformers complying with requirements of AC 150/5345-47A for 6.6 ampere series circuits.

C. Light Base and Transformer Housing. Fixtures shall be installed on new or existing L-867 base (except L-852T, is on an L-868 2 piece base) complying with requirements of AC 150/5345-42. Furnish all elevated edge lights in new base cans installed in shoulder pavement with telescoping base cans. Furnish all elevated edge lights in new base cans installed in earth with one-piece base cans.

1. Bases shall house isolation transformer and are 12 inch diameter, cylindrical body with a top flange having an10-1/4 inch bolt circle. Base shall be provided with 1, 2 or more factory installed cable entrance hubs. Contractor to field verify entrances.

2.07 LED RUNWAY GUARD LIGHTS

A. Light Fixtures.

1. Fixtures shall be furnished complete, ready for installation on a new or existing base and shall comply with requirements of AC 150/5345-46, AC150/5340-30 and EB-67. See Section 26 55 92 for additional runway guard light requirements. The flashing of the in pavement RGLs and the monitoring of the light and flashing functionality shall be integrated in the fixture.
2. In-pavement runway light fixtures shall be LED L-852G (L). Fixtures shall be unidirectional yellow, as indicated on construction plans and light fixture schedule. Light fixture shall consist of an optical system as shown on plans, mounted in a suitable housing and mounting assembly.
3. Fixtures shall be provided with connecting leads for power connections.

B. Isolation Transformer. To facilitate RGL communication, transformers shall be low inductance L-830 isolation transformers complying with requirements of AC 150/5345-47 for 6.6 ampere series circuits. Leakage inductance shall not exceed 40 microhenries. Transformer wattage rating for runway guard light fixture, as shown on plans.

C. Light Base and Transformer Housing. Fixture light bases for the in-pavement guard lights shall be type L-868 base complying with requirements of AC 150/5345-42.

1. Bases shall house isolation transformer and and shall consist of a two-piece cylindrical body with a top flange having a bolt circle as indicated

below. Base shall be provided with one, two or more factory installed cable entrance hubs, as indicated on the plans.

2. L-852G (L) Semi-flush guard light fixtures shall be mounted on an L-868 base with an 11-1/4 inch bolt circle.

2.08 ADDITIONAL REQUIREMENTS FOR LED FIXTURES OR SIGNS

A. LED fixtures shall comply to the FAA EB-67, Light Sources Other Than Incandescent and Xenon For Airport and Obstruction Lighting Fixtures latest version, and support the dimming curve as stated in EB-67.

B. Out of tolerance circuit current behavior. The fixture shall not fail or enter the failed or open circuit state automatically, when the input current is applied starting from zero amps RMS, and increasing linearly, to the maximum allowed by the constant current regulator. This shall include current levels that not at the correct nominal steps defined in AC 150/5345-10 for CCRs.

C. LED fixtures and signs shall limit their start up voltage requirement so the circuit shown on the drawings power on properly and operates with stability. LED fixtures and signs shall not cause an open circuit faults on startup on the circuits.

D. Light Output Dependency on Current waveform. The light output level of the fixture shall not depend on the duty cycle or crest factor of the input current. Light output shall operate at the nominal steps with full conduction sinusoidal current with a crest factor of 1.414 and partial conduction waveform up to and including a maximum crest factor as specified in AC 150/5345-10 for CCRs. If the RMS current is set for a given step, the fixture shall not change the light output anywhere within the full range of current crest factors.

E. 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.

F. LED Fixture Dimming. LED Fixtures shall provide linear dimming as described in EB-67. The fixtures shall average the RMS input current to determine the brightness of the fixture, and not reflect momentary or transient current dips or surges in the light output. Discrete step fixtures are not acceptable.

G. 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

H. Fixture Step Support. The LED fixture shall support both 3 and 5 step brightness levels as specified in AC 150/5345-10.

2.09 PRODUCTS FOR AIRFIELD GUIDANCE SIGNS SYSTEM

A. General. Signs shall be internally lighted by LED light sources and shall comply with requirements of AC 150/5345-44.

1. Signs shall be provided with the required transformers and regulators.
2. The signs shall be style 5 installed on a fixed 5.5 Ampere circuit and shall be considered a part of the dedicated sign circuit system for electrical power supply.
3. All guidance signs shall be Size 3.

B. Isolation Transformers. Isolation transformers for signs shall be of wattage recommended by sign manufacturer for particular sign installation and shall comply with requirements of AC 150/5345-47.

C. Bases. Install one L-867, 16 inch base in sign support pads complying with requirements of AC 150/5345-42. Base cover shall be as indicated on plans. Furnish all bases with minimum 2~~1~~” drain coupling.

D. Concrete Pads. Install reinforced concrete pad for signs and indicated on the plans and in accordance with sign manufacturer's recommendations. Pad construction shall conform to requirements of Item P-610.

PART 3 CONSTRUCTION METHODS

3.01 GENERAL

A. Install conduit, cables, counterpoise and supports necessary to insure a complete and operable electrical installation for lighting systems as specified and shown on the plans.

B. Install and mount the products to comply with the requirements of the National Electric Code, Section 26 08 20 – Airfield Electrical Installation Testing, and Section 26 05 40 – Installation of Airport Underground Cable for Airports.

C. General Light Fixture Base Installation Requirements.

1. Caution shall be exercised during light base installation to prevent the collection of foreign matter in products and on operating components. All installation residue shall be collected as installation progresses. As directed by CM, a cover shield shall be used to protect components from foreign matter during installation.

2. Fixture base shall be installed in existing reinforced concrete or asphalt pavements with connecting conduit as shown on the plans.
3. Light bases shall be set level. Leveling jig shall be required as specified and as directed by the CM.
4. Flexible, seal tight steel conduit shall not be used unless specifically approved by the CM. If approved for use, a maximum length of two (2) feet of flexible, 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.
5. Light or bases shall have 1, 2 or more 2-inch threaded metallic hubs for all required conduit entrances, or as indicated on the plans. Grommeted conduit entrances are strictly prohibited. The cable entrance hubs shall be oriented in the proper direction so as to align with the connecting conduit.
6. Stub-in conduit connections into existing light bases shall be Meyers Hub installation, where required on the plans and as noted on plan details.
7. When existing light fixtures are removed for the purpose of installing new conductors, or cover plates are installed, new SS CEC lockwashers shall be 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.
8. Breakage of fixture hold down bolts normally and regularly occurs in the field during fixture removal or fixture installation. When breakage occurs, the Contractor shall adhere to the following requirements:
    a. The Contractor shall submit a broken bolt removal process for approval of the CM.
    b. Submittal shall include information about the planned broken bolt removal process and jig required to effectively drill and tap broken bolts, when necessary.
    c. Whenever encountered, broken bolts shall be removed.
    d. Where drilling and tapping is required, a jig approved for use by the CM shall be used. Use Jaquith Industries L867B/L868B drill repair fixture or equivalent.
    e. All broken bolts shall be replaced with 3/8”-16 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.

D. General Cable Installation Requirements

1. The primary cable shall enter the light base and transformer housing as shown on the plans.
2. Primary cable slack shall be provided inside the light fixture base following Section 26 05 40 – Installation of Underground Cable for Airports. In general, enough slack shall be left in the cable to permit installation aboveground of the connections between the primary cable and the isolation transformer primary leads. A similar length of primary cable slack shall be provided for any unconnected cable installed in a fixture base can.
3. The transformer secondary leads shall be connected to the lamp leads with a disconnecting plug and receptacle. The secondary connection shall not be taped; the cable connections to the insulating transformer's leads shall be made following Item Section 26 05 40 – Installation of Underground Cable for Airports.
4. The connector joints in the primary circuit shall be wrapped with at least 1 layer of synthetic rubber tape and 2 layers of plastic tape, one-half lapped, extending at least 1-1/2 inches on each side of the joint.
5. Ends of cables shall be sealed with heat shrinkable tubing until the splice is made to prevent the entrance of moisture.

E. General Duct and Conduit Installation Requirements. Trenching, installation of ducts and conduits, concrete backfilling, trench backfilling, installation of duct markers and the type of material used shall conform to Section 26 05 43 – Installation of Airport Underground Electrical Duct Banks and Conduits.

F. Installing Light Fixtures at Existing Bases

1. At locations indicated on the plans, the Contractor shall install light fixtures at existing fixture bases. This shall include providing the following items, as required and directed by the CM.
   a. Remove and salvage existing base cover plates.
   b. Refurbish and prepare the base flange with flange rings or spacer rings, as required and directed by the CM, in order to properly install the specified light fixture.
   c. If no ground lug exists on the interior, provide new ground lug with ground strap following base manufacturer’s recommendations. Do not weld to galvanized base can.
   d. Clean out and refurbish the interior of the bases, including conduits.
   e. Install primary airfield lighting circuit cable.
   f. Provide new 304 stainless steel bolts and CEC stainless lock washers

g. Install fixture isolation transformers of proper specified rating and wattage.
h. Install specified fixtures.

G. Demolition and Salvage. At locations noted on plans, the following shall be required.

1. Existing light fixtures, bases, cables and other materials identified as salvageable by the CM shall be removed. Salvageable materials shall be delivered to City salvage area or disposed of as directed by the CM.

3.02 LIGHT FIXTURE INSTALLATIONS IN RIGID PAVEMENT AREAS

A. Toe-In Requirements. Taxiway centerline light fixture installations require that the base shall be angled from a straight set to provide toe-in.

1. Taxiway toe-in for curved taxiway centerline light fixture installations require that the base shall be angled from a straight set to provide toe-in. Taxiway centerline light toe-in shall be left or right, as required, 4 degrees from a line parallel to the centerline of the runway. The Contractor shall submit his written installation method to the CM for approval prior to installation, to provide the proper toe-in as the bases are being set.

B. Light Base Installation Requirements for Class I Bases. Install light fixture bases as per general requirements as noted below.

1. Conduit trench shall be filled with a concrete slurry of well graded aggregate mix with a top size aggregate of 3/8 inches. This concrete shall have a minimum cement content of six (6) sacks per cubic yard and a slump of 5 to 6 inches. The aggregate and other material shall meet the requirements of Item P-610. The level of the slurry fill shall remain 1 (1) inch below the bottom of the pavement slab as shown on the plans.
2. Concrete anchor block around the light base shall be constructed in accordance with Plan details.
3. Light base setting and leveling jig shall not be removed until concrete has set and sufficiently cured to allow stable installation for remainder of system.
4. Before the paving operation, the 1/8 inch mud plate shall be installed over the 5/8 inch construction ring and 3/4 inch plywood cover.
5. After placement of the overlay, the center of the light base is to be located. A properly sized core is to be centered over the base and the asphalt is to be cored and removed. Obtain measurement from the top of the L-868 bottom section to the top of the pavement and custom fabricate the L-868 top section, allow for installation of 1/8” spacer ring between top section and multi-hole adapter ring. Remove construction ring and cover plate and

replace with custom made L-868 top section, spacer ring and fixture as shown in plan details.

6. After installation of the light fixture, the azimuth of the light beam shall not vary more than +1/2 degree from the required direction. The elevation of the light fixture outside edge shall be flush with the surrounding surface elevation such that the elevation of the fixture is not more than +0 inches higher than or -1/16 inch lower than the elevation of the pavement. If this tolerance is not met, the Contractor shall, at his expense, remove and replace the fixture to the satisfaction of the City.
7. In-concrete light bases shall have 1, 2 or more 2-inch threaded metallic hubs for all required conduit entrances, as indicated on the plans. Grommeted conduit entrances are strictly prohibited.

C. Light Fixtures. Assemble the light fixture following the manufacturer's instructions. Connect the secondary leads of the transformer to the fixture leads with a disconnecting plug and receptacle conforming to AC 150/5345-26A without taping the joint. Install a lamp of the proper rating in the fixture. Level each fixture as recommended by the manufacturer.

3.03 LIGHT FIXTURE INSTALLATION IN SHOULDER AREAS

A. Light Base Installation Requirements. Install light fixture bases as per general requirements noted in as noted below.

1. Approximately 4 inches of concrete shall be placed under and around the outside of the base. Reference detail drawings for fixture base installation requirements.
2. The top of the concrete shall be sloped away from the flange portion of the base so that a minimum amount of concrete is exposed above the shoulder. The bituminous surface shall not extend over the concrete surface.
3. 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 concrete marker disk imbedded in the concrete encasement.
4. For installation in surface shoulder areas the Contractor shall utilize the following method of installation:
   a. Prior to the bituminous base and surface courses, but after the construction of the lime treated subgrade simultaneously install the edge light base and conduit. Set adjustable L-867 base in place using jig to keep alignment and elevation. Run conduit between bases, completing conduit installation. The conduit alignment shall be straight between bases.
   b. Install counterpoise and make all connections.
   c. Backfill the trench with 4000 PSI concrete and encase L-867 base up to top of lime stabilization. The steel shall extend 2 inch +1/4 inch above top of lime treated subgrade. The concrete and reinforcing steel

shall not be separate bid items and will be considered subsidiary to the conduit, or of the L-867 base, as applicable.

d. Place a protective cover on the adjustable L-867 base, bond breaker on top of concrete, which will also prevent asphalt from getting on concrete, and a protective cover on the reinforcing steel.
e. After placement of bituminous base and surface course, drill 4 inch core to locate center of base. After determining center of base, core a 24 inch diameter hole down to top of L-867 base.
f. Remove bituminous plug, extend adjustable base up to 1/2 inch above finish surface of shoulder.
g. Clean off concrete and steel, place remainder of reinforcing steel, then apply a 2 component epoxy. Place 3000 PSI concrete into void, tapering off concrete back to shoulder surface as required.
h. Install the concrete marker disk.

5. The Contractor may use alternate methods of installations, only if approved in writing by the City Engineer. The placement of conduit prior to liming operations and setting of bases after place of bituminous courses will not be allowed.
6. Submit planned installation process for approval of the CM.

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 noted in Section 26 05 40 – Installation of Underground Cable for Airports and Section 26 05 43 – Installation of Airport Underground Electrical Duct Banks and Conduits.

3.04 TAXIWAY CENTERLINE AND FLUSH MOUNTED EDGE LIGHTING SYSTEMS

A. Description. The taxiway centerline lighting system shall consist of single semiflush lights installed on a line parallel to the geometrical center of the taxiway.

1. Longitudinal Spacing. Light fixtures shall be spaced longitudinally as shown on the plans. A tolerance of plus or minus 10 percent of the longitudinal spacing specified to eliminate interferences shall be allowed and subject to the approval of the CM. Taxiway lights shall be displaced a

maximum of 2 feet from the geometrical centerline of the taxiway. This lateral tolerance shall be applied consistently to avoid abrupt and noticeable changes in alignment, i.e., "zigzagging" from 1 side to the other side of the centerline.

2. Long Radius Taxi Exits Greater Than 1,200 Feet. The configuration shown on the plans shall be used to establish the starting point on the runway, spacing, and other details necessary to provide guidance to aircraft from the runway centerline into the "throat" of a long radius taxi exit.
3. Taxiway Crossing or Intersecting Another Taxiway. Taxiway centerline lighting shall continue across the intersection when a taxiway intersects or crosses another taxiway. An omni-directional, L-852F fixture shall be installed at the point of intersection of the 2 centerline light systems as shown in the details in the plans.
4. Taxiways Crossing a Runway. Taxiway centerline lighting shall normally stop where taxiways intersect or cross a runway. Lights shall not encroach within the confines of an intersecting runway except where shown on the plans.
5. Orientation of light beams shall adhere to the following requirements.
   a. On Straight Portions. On all straight portions of taxiway centerlines, the axis of the light beam shall be parallel to the centerline of the taxiing path.
   b. On Curved Portions. The axis of the 2 beams of bi-directional lights shall be oriented parallel to the tangent of the nearest point of the curve designated as the true centerline of the taxiway path. The axis of a unidirectional light beam shall be oriented so that it is "toed-in" to intersect the centerline of the light fixture path radius at a point approximately equivalent to 4 times the spacing of lights on the curved portion. This spacing shall be measured along the chord of the curve.
6. Flush mounted edge lights shall be located as indicated on the drawings and shall be a part of the taxiway edge lighting system.

B. Installation. Taxiway centerline and flush mounted edge lights shall be installed following details shown on the plans.

C. Testing and Inspection

1. General. Because certain components may be inaccessible after final installation, lighting shall be tested concurrently with installation.
2. Elevation and Alignment. Light unit installation procedures shall be checked during construction and after the system has been completed to determine that the recommended fixture elevation and alignment is following design and manufacturer's installation requirements.
3. Securing Screws or Bolts. All fixture securing screws or bolts shall be tightened following the manufacturer's recommendations.

4. Light Channels and Lenses. Each light fixture shall be checked to determine that the lenses and the channels in front of the lenses are clean.
5. Cables, Wiring and Splices. All cables, wiring, and splices shall be tested following Item Section 26 05 40 – Installation of Underground Cable for Airports.
6. The airfield electrical installations shall be tested following the requirements of Section 26 08 20 – Airfield Electrical Installation Testing.
7. Systems Tests shall also be conducted following Item Section 26 08 20 – Airfield Electrical Installation Testing.
8. Any system installation errors or unacceptable discrepancies of installation shall be corrected, as directed by CM and to the satisfaction of the CM.

D. Phasing

1. Phase the centerline light installation separately from the paving schedule so that once the entire centerline circuit is completed and installed for the respective taxiway, the lights can be activated. IE: the centerline lights for the connector taxiways will be activated before the centerline lights on Taxiway NB. For all R/W 8R-26L centerline lead-on/lead-off lights, keep circuits active during construction using temporary cabling for as much of the circuit as possible and at a minimum the segment from the runway thru to the runway safety area hold bar.

3.05 TAXIWAY EDGE LIGHTING SYSTEM

A. Description. All taxiway edge lighting fixtures shall emit blue light. Light fixtures shall be located not more than 10 feet from the edge of the full strength pavement on each side of the taxiway and shall be spaced as indicated on the plans to define the lateral limits of the taxiing paths.

1. On a straight section, the lights on opposite sides of the taxiways are located on a line perpendicular to the taxiway centerline. Closer spacing of the lights at entrance to taxiways from runways or aprons may be required.
2. Taxiway edge lights are installed at runway/taxiway intersections to define the throat or entrance into the intersecting taxiing route. The taxiway edge lighting system shall be installed following the plans and these specifications.

B. Installation. Taxiway edge lights shall be installed following details shown on the plans and following the requirements AC 150/5340-30.

C. Testing and Inspection

1. General. The installation and alignment of all lighting fixtures of the completed system shall be checked to determine if the products has been installed as designed.
2. Each light fixture shall be checked to determine that a lamp has been installed and that each light fixture using masked lamps is properly oriented following specifications.
3. Products covered by FAA specifications shall be checked to determine if the manufacturers are approved suppliers. The products shall be checked for conformance with specification requirements.
4. The airfield electrical installations shall be tested following the requirements of Section 26 08 20 – Airfield Electrical Installation Testing.
5. Systems Tests shall also be conducted following Item Section 26 08 20 – Airfield Electrical Installation Testing.
6. Any system installation errors or unacceptable discrepancies of installation shall be corrected, as directed by CM and to the satisfaction of the CM.

3.06 AIRFIELD GUIDANCE SIGNS SYSTEM

A. Description. The signs shall be located as indicated on the plans. The side of the sign closest to the taxiway or apron edge shall be 50 feet from the edge of full strength pavement, as shown on plans. Other locations will be as directed by the Construction Manager.

B. All signs shall be oriented so that the face of the sign is approximately 90 degrees to the direction of the taxiing paths from which it is viewed, unless otherwise shown on the plans or directed by the Construction Manager.

C. Installation. Installation shall be in accordance with AC 150/5340-18 and the plans.

1. Airfield guidance signs shall be furnished and installed, or relocated, as noted in these specifications. Signs shall also be installed in conformity with the details and locations shown on the plans.
2. Sign installations or relocations shall include signs, bases, transformers, mounting assemblies and concrete foundations (pads). Installation and relocation shall also include all cable connections, all lamps, regulators, all internal or external conduit and wiring and all incidentals necessary to place the signs in operation as completed units.

D. Sign Modifications. General sign modifications include the removal of existing signs and the installation of new signs on existing bases, modified as required for installation of the new signs.

1. All panels that are removed shall be returned to the City at a location on the airport property directed by the Construction Manager. The contractor shall furnish all required or necessary materials.

E. Inspections and Tests. Each sign shall be inspected to insure that it is installed erect, level at the proper height, and at the location shown on the plans. Each sign identification number shall correspond to the number on the plans.

F. All cables, splices, and wiring shall be inspected to ensure that the installation is in accordance with the plans and specifications. All wiring shall be continuous and free of shorts. All circuits shall be wired in accordance with the manufacturer's instructions. Insulation resistance to ground of all underground conductors shall meet the requirements of Section 26 08 20 – Airfield Electrical Installation Testing. All signs shall be tested by operating the complete system continuously for a minimum of one hour and operating each control ten times. Test signs in accordance with AC 150/5345-44. The airfield electrical installations shall be tested in accordance with the requirements of Section 26 08 20 – Airfield Electrical Installation Testing. Systems Tests shall also be conducted as specified in Section 26 08 20 – Airfield Electrical Installation Testing. Any system installation errors or unacceptable discrepancies of installation shall be corrected, as directed by Construction Manager and to the satisfaction of the City.

G. Concrete Pad. A concrete pad for sign installation shall be constructed at the approximate location shown on the plans. The exact location and orientation shall be as shown on the coordinate schedule of the plans unless otherwise directed by the Construction Manager. The concrete pad shall be sized as shown on plans and shall be poured in place in undisturbed soil. Pad shall be reinforced as shown on the plans.

H. The surface of the concrete shall slope at 1/2 inch per foot, or 5% maximum. The exposed surface of the concrete shall be finished to a smooth finish with a steel trowel or by rubbing. Where required, place anchor bolts for additional flange supports in the concrete pad in accordance with the manufacturer's instructions. Anchors shall be drop in anchors manufactured by Hilti, or approved equivalent.

I. Leveling. The transformer base housing shall be firmly held in place during the construction of the concrete pad so that the machined upper surface of the base flange will be level within +2 degrees and not more than 1/4 inch above the surface of the pad. All other bearing areas for the additional flange supports shall be in the same horizontal plane as the transformer base flange, which shall be at the same elevation as the nearest edge of the taxiway shoulder. Provide grading of adjacent area, as directed by the Construction Manager.

J. Cable Connections. Primary cable slack shall be left inside the base as required in Section 26 05 40 – Installation of Underground Cable for Airports to permit all cable connections to the taxiway sign to be made above the ground. A similar length primary cable slack shall be provided for any unconnected cable in sign base.

K. Type of Supply Circuit Connection. Sign transformer primary leads shall be connected to the primary cable using L-823 connectors specified in section 26 05 40 – Installation of Underground Cable for Airports.

L. Identification Numbers. An identification number shall be assigned to each sign in accordance with the plans and as directed by the Construction Manager.

M. Assembling Airfield Guidance Sign. The taxiway sign shall be assembled in accordance with the manufacturer's instructions. The sign shall be installed so that the distance from finished grade to the top of the sign is as indicated on the plans and in AC 150/5345-44. The secondary leads of the transformer shall connect to the sign leads with a disconnecting plug and a receptacle, conforming to AC 150/5345-26.

N. Location of Airfield Guidance Signs. Signs shall be installed in the locations as shown on the plans. Deviations/changes shall only be made with prior written approval by the Construction Manager.

O. Existing signs and bases to be removed shall have the removed sign salvaged to HAS. Base shall be disposed of according to specifications.

P. Existing signs and bases to be modified to accept larger signs shall have the removed sign salvaged to HAS. Install new Unistrut or extend existing Unistrut in concrete base as required for larger sign. Finished sign base shall follow detail sheet.

3.07 FIELD PHOTOMETRIC TESTING OF THE NEW LIGHTING SYSTEM

A. Field photometric testing of all new runway and taxiway lights shall be performed as part of the final acceptance testing. Testing shall be performed by a firm with a demonstrated capability for the field measurement of the photometric performance of airfield lighting fixtures. The firm shall have experience in evaluating the test results against FAA standards (FAA AC 150/5345-46) for each type of light fixture. The main beam axis readings for each light fixture evaluated shall be displayed simultaneously on a computer screen for operator and Airport representative review and evaluation, and shall be recorded automatically by the computer. Testing will be performed using a photometric measurement arrangement that is driven by the fixtures installed in place. The measurement must measure intensity and light beam orientation consistent with 150/5345-46 and for LED fixtures, EB 67. Any

fixture not meeting the photometric requirements must be aligned, repaired or replaced at contractors expense and retested. A test report summarizing the photometric performance of each of the tested light fixtures, including conclusions and any recommendations for corrective actions shall be submitted. The testing firm shall re-test any fixtures that have deficient test results and require correction or replacement.

PART 4 MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. The number of light fixtures 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, L-868 Spacers, splice kits, heat shrinks, base can, drain line, base plate, multihole adapter ring, tag, concrete encasement collar, ground rods, ground rod terminations 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 light fixtures installed on existing base can to be paid for shall be measured per each per location, installed and accepted by the Engineer. This item will include the light unit, base plate, multihole adapter ring, can modifications for internal ground lug with safety ground, lenses, isolation transformer, splice kits, heat shrinks, tag, connector kit, terminations, new stainless steel hardware and CEC Lock washers, and all items necessary to complete installation and accepted by the Engineer. Separate measurement will be made for each fixture type.

C. The re-installation of an existing fixture on a new base can shall be measured per each fixture reinstalled. This item will include the fixture installation including new isolation transformer, connectors, base can, ground rod, splice kits, heat shrinks, base plate, multihole adapter ring, tag, concrete encasement, terminations, new stainless steel hardware and CEC Lock washers, and all items necessary to re-install the existing fixture and accepted by the engineer. There will be no separate measurement for fixture or base can type.

D. The number of new 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 for single or double sided signs.

E. The number of salvaged airfield signs installed on new sign foundations shall be measured per each per location, installed and accepted by the Engineer. This item will include installation of the salvaged sign structure with associated panels, new lamps, new 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. Incidental to this item is the re-installation of salvaged sign panels from one sign frame to a separate sign frame. There is no separate measurement for sign module quantities, sign size or for single or double sided signs.

F. The number of airfield sign modules shall be measured per each per location, installed and accepted by the Engineer. This item will include removing the existing sign module and installation of a new module. Also included with this item is removal and replacement of the isolation transformer and connector kit.

G. The quantity of bolts and threads repaired or replaced on existing base can to be paid for under this item shall be the number of base cans repaired, complete and in place, ready for operation, and accepted by the Engineer. This item includes the labor and materials required for the bolt removal and repair to thread repair including multi-hole adapter plate, threaded inserts, stainless steel bolting hardware and all incidentals required to provide a complete and operational system. There is no separate measurement for can type.

H. The isolation transformers shall be measured complete in place. This item will include installation of new splice kit, connector kit and isolation transformer. For guidance signs, this item includes replacement lamps. There will be separate measurement for major equipment types only (guidance signs vs. light fixtures), not for different varieties or sizes of similar equipment.

I. The photometric testing of the airfield lighting shall be measured per lump sum and shall include all labor, equipment, and materials necessary to perform photometric testing as specified, including retesting of the fixtures deficient in the initial testing and corrected by the contractor, and the furnishing of the report to the construction manager.

J. For in pavement Runway Guard Lights, separate payment under section 26 55 92 will be made for system calibration, setup and provision for the modifications to the existing Runway Guard Light Control and Monitoring System.

4.02 METHOD OF PAYMENT

A. The light fixture or lighting base 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 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.

C. Payment for Photometric testing will be paid per lump upon completion of the testing and the receipt of the report, in accordance with specifications. This price shall be full compensation for furnishing all materials, labor, tools and incidentals necessary to complete the testing and report.

Payment will be made under:

26 55 90 - 1	L-861T(L) LED MITL with L-867B base can in new shoulder pavement – Per Each
26 55 90 - 2	L-861T(L) LED MITL on existing L-867B base can – Per Each
26 55 90 - 3	L-852C(L) LED Bi-Directional Taxiway Centerline light on new L-868B base can in new full strength pavement – Per Each
26 55 90 - 4	L-852K(L) LED Bi-Directional Taxiway Centerline Light on new L-868B Base Can in New Full Strength Pavement – Per Each
26 55 90 - 5	L-852C(L) LED Uni-Directional Taxiway Centerline Light on new L-868B Base Can in New Full Strength Pavement – Per Each
26 55 90 - 6	L-852K(L) LED Uni-Directional Taxiway Centerline Light on new L-868B Base Can in New Full Strength Pavement – Per Each
26 55 90 - 7	L-852C(L) LED Bi-Directional Taxiway Centerline Light on existing L-868B Base Can – Per Each
26 55 90 - 8	L-852K(L) LED Bi-Directional Taxiway Centerline Light on

existing L-868B Base Can – Per Each

26 55 90 - 9 L-852C(L) LED Uni-Directional Taxiway Centerline Light on existing L-868B Base Can – Per Each

26 55 90 - 10 L-852F Omni-Directional Taxiway Centerline Light on existing L-868B Base Can – Per Each

26 55 90 - 11 L-852G(L) LED Runway Guard Light with integral flashing and monitoring, mounted on a new L-868B two-piece base in New Full Strength pavement - Per Each

26 55 90 - 12 L-852G(L) LED Runway Guard Light with integral flashing and monitoring, mounted on an existing L-868B base can - Per Each

26 55 90 - 13 New L-868B Base Can with Blank Cover in New Full Strength pavement - Per Each

26 55 90 - 14 Install Salvaged Fixture in new base can in new pavement - Per each

26 55 90 - 15 New LED guidance sign including foundation, 3-module, single face – Per Each

26 55 90 - 16 New LED guidance sign including foundation, 4-module, double face – Per Each

26 55 90 - 17 Install Salvaged Sign on new Foundation – Per Each

26 55 90 - 18 Remove and replace Size 3 sign panel – Per Each

26 55 90 - 19 Remove and repair bolts/threads on existing base can – Per Each

26 55 90 - 20 Install new isolation transformer, splice kit and fixture tag – Per Each

26 55 90 - 21 Install new isolation transformer, splice kit, lamps and sign tag – Per Each

26 55 90 - 22 Photometric testing of airfield lighting – Per Lump Sum

26 55 90 - 23 Pavement Block-Out for L-868B Base Can - Per Each

END OF SECTION

SECTION 26 55 92

RUNWAY GUARD LIGHTS CONTROL SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Upgrade existing In Pavement Runway Guard Light System on Entrances to Runway 8R-26L be compliant with this specification

B. Remove existing Light Monitor and switch units in the base of each in pavement RGL fixture, replace with L852G fixture with integral flashing and flash monitoring capability in same location with new cable and low inductance isolation transformer and in some locations lighting base. Provide the removed light monitor and switch unit to IAH electrical maintenance.

C. Upgrade vault equipment to support reconfiguration of the single RGL Circuit serving the entrances to Runway 8R-26L to two circuits as shown on contract drawings. Provide the necessary vault equipment for the new circuit.

D. Update the Existing RGLS programming unit and existing modem to support LED fixture programming and communication.

E. Any changes to RGL fixture quantities as a result of the construction shall include the reconfiguration as required of the RGLS and ALRCS. Any affected programming or configuration files shall be updated and provided to HAS.

F. Upon installation the RGLS shall be complete and functional. This system shall include the functionality to support operations at the airport during low visibility conditions, below 1200 feet and above 600 feet RVR. The quantities of components, location and installation details are per contract drawings

G. Provide an additional Series Circuit Modem for programming for the new RGL Fixtures and existing Light Monitor and Switch units, with all software and electronic files cables and hardware required for programming of all L852G (L) fixtures with integral flashing and flash monitoring, Light Monitor and Switch units, and Series Circuit Modems, at IAH

1.02 UNIT PRICES

A. Refer to Section 01 29 00, Payment Procedures for unit price procedures.

1.03 RELATED SECTIONS

A. Section 26 05 10 - Work in Existing Building

B. Section 26 05 53 - Electrical Identification

C. Section 26 08 20 - Airfield Electrical Installation Testing

D. Section 26 35 53 - Vault Equipment

E. Section 26 55 90 - Airport Lighting Systems

F. Section 26 55 95 - Airfield Lighting Remote Control System

1.04 RELATED DOCUMENTS

A. Drawings, Standard Contract Requirements, General Provisions, Special Provisions and other sections of Division II apply to this section.

B. FAA AC-120-57A Surface Movement Guidance and Control System.

C. FAA AC-150-5340-30 Design and Installation Details for Airport Visual Aids

D. FAA AC 150-5345-46 Specification for Runway and Taxiway Lighting Fixtures.

1.05 SUBMITTAL

A. Prior to start of project construction and within 30 days of Notice-to-Proceed, the supplier shall submit to the Airport for approval submittal containing complete dimensional and performance characteristics, system block diagram, theory of operation, wiring schematic diagrams and installation and operation instructions. The block diagram shall reflect the total integration of all new devices into the system. The diagram shall reference all interconnecting cabling requirements for digital components of the system including any data communications links.

B. 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.

C. The submittal shall include a description, by specification paragraph number, of how each of the requirements in the RGLS specification will be met.

D. Arrange, identify and bind all submittals complete with suitable index.

E. Software submittals shall provide a complete description of the system on a functional level.

F. The loading calculation for IPRGL fixtures, including all losses from the transformer secondary, cabling with the transformer sizing requirements and margins shall be submitted with the shop drawings. This analysis shall indicate RMS as well as peak loading requirements of the isolation transformer, to account for any wattage and peak demands on the transformer and series circuit, flashing of the fixture in the field. It is the responsibility of the system supplier to ensure proper operational conditions, accounting for all secondary losses and fixture loading.

G. Circuit or equipment modifications required by the IPRGL control system supplier to ensure specified level of performance shall be identified and detailed in the submittal. The costs of material and all labor shall be borne by the contractor.

H. Any requirement by the supplier of other equipment such as filters or other devices shall be completely described in the submittal, as to the functionality, location and how the a fault in the item is diagnosed, located and replaced.

I. The IPRGL system supplier shall identify in the submittal the minimum series circuit ground fault resistance the system can operate in, and meet all performance and functional requirements specified herein.

J. All submittal items shall be subject to approval of the Engineer-of-Record. 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.

K. Operations and Maintenance Manuals shall be submitted 2-weeks prior to any formal training.

1.06 GENERAL FUNCTIONAL DESCRIPTION

A. The RGLS shall support in pavement runway guard lights control and monitoring functionality. The system will be operated 24 hours a day/ 7 days a week in all visibility conditions. The lights designated for the RGLS require individual fixture monitoring to determine the operational state of the lighting at each hold point. In addition, the RGLS shall support precise and reliable RGL flashing functionality as specified in AC 150-5340-30. This control, monitoring and flashing functionality, requires the system controls to be addressable. Individual fixture status must be monitored by the system to determine the operability of the lighting system at the holding position. In addition, for in pavement RGLs in a specific hold bar, the evenly numbered

fixtures as a group must flash in synchronism and opposite in state from odd numbered fixtures in the same bar as another group.

B. When the RGLS circuits are energized, the IPRGL fixtures shall commence the flashing functionality as specified. No additional action from the ALRCS shall be required.

C. The RGLS shall report the operational status of each designated fixture in each hold bar individually and as a group to the ALRCS.

D. RGLS maintenance screens on the ALRCS shall provide the functionality to display the system status, isolate and clear system faults, and view and manage system log files. It also can provide any system control functions required to operate the system for fault isolation and maintainability purposes. The RGLS shall provide the functionality to perform trouble shooting fault isolation and system monitoring.

E. Location of equipment (refer to drawings for location specifics).

F. Each hold bar includes the required number of in pavement RGL fixtures, as few as approximately 7 and shall support as many as approximately 32. The system shall meet functional and operational requirements with as many fixtures with stop bar/ hold bars requiring in excess of 50 fixtures.

G. Each new LED In Pavement RGL fixture includes addressable control and monitoring integral to the fixture. The monitoring shall include the monitoring of the fixture, so the in pavement RGL system detects and corrects any flashing synchronization that is not compliant to AC 150/5340-30

H. The RGLS shall include the necessary series circuit communications equipment in the airfield lighting vaults to control, collect status, and otherwise operate the RGLS system components in the airfield.

1.07 HOLD BAR OPERATIONAL CRITERIA

A. The RGLS shall determine and maintain the status of the RGLS designated lights at each holding position so equipped. The operational criteria of all lighting groups shall be easily programmable either from the maintenance workstation, or the RGLS vault computer, or through easy to understand plain text editing of a configuration file stored on the RGLS vault computer. The operational status of RGLS designated lights and components at each holding position is defined below. Failures shall be detected if the light is on off or flashing, while the circuit power is on. This is to provide an indication to the RGLS of a component failure, and in some cases may avoid a repair operation just at the time the system changes state.

B. Since the normal operation of the RGL bar as defined in 150/ 5340-30, includes fixture failure state and flash performance timing. The RGLS shall detect the operational status of each RGL bar, by fixture operational status and also by detecting the flashing timing of all lights in each bar. The RGLS communications equipment in the vault shall monitor the flash performance timing of the bar. If the RGLS detects flash timing errors of the devices in an RGL bar, and is not able to bring the flashing back to the normal operational criteria of flash rate, duty cycle, same set and opposite set group error, as defined in this specification, the RGL bar is therefore out of compliance, and the RGLS shall declare the RGL bar non-operational with an appropriate indication on the tower screen, and maintenance system.

C. Operational. All fixtures on the in pavement RGL fixtures are operating properly.

D. Caution. Any of the following items is not operational:

1. One in pavement RGL fixture/ or flashing function.
2. Two non-adjacent in pavement RGL fixture flashing function.

E. Failed: Any of the following items is not operational:

1. Two adjacent in pavement RGL fixtures or flashing function.
2. Any three (or more) in pavement RGLs or flashing function.
3. The RGL bar does not meet flashing operational criteria

1.08 MAINTENANCE MODE

A. Provide maintenance mode functionality compliant with the existing RGLS:

1.09 LED IN-PAVEMENT RGL PERFORMANCE

A. Flash rate. The flash rate for In-pavement RGLs is defined as 30 to 32 flash cycles per minute. The flash cycle is defined as the period in which the light output is on and then an equal period of time that the light output is off during the flash cycle. The sequence of light on and light off, repeats between 30 and 32 times per minute.

B. Stability of flash rates. The flash rates shall be considered allowable static settings, not a limit of instability. Once selected, the flash rate must remain set.

C. Duty Cycle. During a flashing cycle, the length of time the light output of a given fixture is on must be equal to the length of time the light output is off, with a tolerance of +/- 0.5%. of the total cycle. At 30 flash cycles per minute, this is one second on followed by one second off. The allowable on or off time in this case is from 0.990 seconds to 1.010 seconds.

D. Stability of Duty Cycle. The duty cycle shall be considered allowable static settings, not a limit of instability. Once selected, the duty cycle must remain set.

E. Same set group error. During the normal flash functioning, when a group of in pavement RGL fixtures that operates in unison, change state (a group of odd numbered or a group of even numbered fixtures), it is required for all the lights in the group to change state simultaneously. Same set group error is defined as the time light output turns on(or turns off) the first fixture in the group, until the light output turns on (or turns off) the last fixture in the same group. Under normal operating conditions no same set group error is allowed.

F. Even to odd group error. During the normal flash functioning, a group of in pavement RGL fixtures that operates in unison, change state, and as they extinguish, the opposing unison group change to the opposite state, it is required that these state changes occur simultaneously. Even to odd group error is measured from the time the light output turns on (or turns off) on the first fixture to change state in either unison group, until the time the light output turns on (or turns off) on the last fixture in the either group. Under normal operating conditions no even to odd group error is allowed.

G. SMGCS mode Change of state performance. When the RGLS changes state from above 1200 feet RVR to below 1200 feet RVR, or the reverse, in cases where the lights are not flashing all the time, the In pavement RGL lights shall commence (or stop) flashing. The maximum time for the all RGLS lights to switch (pushing the button the tower, to light output turning on or off in the fixture) shall not exceed 5 seconds. The maximum time for all back indications of status on the ALRCS shall not exceed 7 seconds.

H. RGLS Modes of failure

1. Any fixture failures shall not affect the functions or performance of any other elements in the system.
2. If an RLG fixture fails, it shall fail in the off state. If this results in any effects to the series circuit communications that prevent communications, loss of communications requirements shall apply in this specification.

I. RGLS Loss of communication behavior

1. Since changing series circuit conditions can impact communications, a loss in communication is defined as any communications related condition that impacts flashing or status reporting, to be unable to meet the performance requirements for normal operation. This loss of communication shall be considered an isolated, non-operational state and shall in no case be the normal operational mode.

2. If a fixture experiences a loss of communication, the flash functionality shall continue to operate normally.
3. Eight hours following a communications loss, the lights within a unison group shall continue to flash simultaneously with a maximum same set group error of 0.05 seconds. Even to odd set group error shall not exceed 0.13 seconds.

J. Light output failure or flashing related non operational behavior. In the event of the light output fails to meet its operational criteria, or if the fixture flash functions becomes non operational, the remaining lights in the bar shall continue to pulse normally. If a failure occurs in the fixture electronics, it becomes non operational, its light shall be turned off.

K. Fixture failure ALRCS reporting response time. If an RGLS fixture or interface is not operational, or is replaced and becomes operational, the resulting operational state of the holding position shall appear on the ALRCS within a maximum of 60 seconds.

L. Fixture failure maintenance screen response time. Individual fixture failure response times shall be correctly reported by fixture and location on the maintenance screen within 60 seconds.

M. Fixture communications failure reporting. A failure of communications to a fixture shall be a discrete reporting state on the maintenance screen and vault control panel.

N. Communications failure to the fixture ALRCS reporting response time. If an RGLS fixture loses communications on the circuit, the resulting operational state of the holding position shall appear on the ALRCS within a maximum of 60 seconds. If an RGLS fixture is replaced or restored to an operational state, the resulting status of the holding position shall be reflected on the ALRCS within 60 seconds, excluding any in circuit parametric downloading as a result of a replacement.

O. Flash Function monitoring (synchronization). The RGL functionality of each bar shall be monitored. The system shall be capable of determining if there is a loss of synchronization, and attempt to restore normal functionality. If the system cannot restore synchronization functionality the hold bar shall report a non operational condition. Addressable device failure reporting response times shall apply.

P. Programmability of flash behavior. The in pavement RGL components in the RGLS system shall be programmable to flash in the even and odd fashion as defined in FAA AC 150-5340-30, and also all fixtures in a bar, in unison, at the same rate.

Q. Above ground enclosures. The use of above ground enclosures on the airfield shall not be permitted.

R. Use of repeaters. Since a repeater represents a single point of failure, repeater devices are not permitted for series circuit communications on the RGLS.

S. Emissions. The RGLS system shall not create conducted or radiated noise in excess of FAA or FCC requirements for this type of equipment. Furthermore the RGLS shall not interfere with or be affected by emissions of existing equipment.

T. Flashing. The In Pavement RGL fixture flashing functions shall be programmatically capable of simulating the ramp up and ramp down photomectric behavior of a quartz in pavement RGL fixture. This capability shall be a parameter that canbe configured as part of programming on site or as shipped.

U. Maintainability

1. The RGLS shall include the capability to diagnose and locate system faults from the maintenance workstation and the vault control panel of the ALRCS. All system software on system computers that resides on hard disks 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 hard disk image to the current system revision level, shall be accomplished by system restore CDs, and shall start an autorun or with a single restore command shall restore the entire system image. The system then shall be ready to operate.
2. Replacement of a although it is not recommended to access a fixture without turning the circuit off, RGLS fixture shall not require re-powering of the circuit to resume operation of flashing and monitoring of the fixture. The maintenance personnel shall be able to observe on the field without vault intervention that the fixture replacement resulted in proper observed operation.

V. Programming of Spares.

1. The RGLS shall be supplied with all tools, hardware and software necessary to configure spare addressable field devices and vault communications devices (if required for spare replacement).
2. “Plug and play” (in circuit, post replacement, component is downloaded its parameters) capability is also acceptable, as an alternative, as long as it meets the same maintainability requirements.

3. All operational and communications parameters shall be programmable so that spare components can be completely interchangeable with a like component. Programming shall provide the spare device with application and location specific parameters.
4. A spare replacement shall only require the use of a fixture number, or other single component identifier to be entered on the programming device. The maintenance personnel shall not be required to enter individual parameters.
5. Manufacturer updates to parameters shall be accommodated by simply replacing the appropriate file in the system or programming tools with the updated parameter file.
6. The RGLS device parametric programming functionality shall also include a confirmation capability. The system shall support a function to test a device's installed parameter set against the parameter set maintained by the programming function of the system, to both ensure a proper parameter download, and also to ensure any given device has the proper parameters.

PART 2 PRODUCTS

2.01 MAJOR SYSTEM COMPONENTS

A. The main components of the RGLS to be supplied under this contract are as follows:

1. LED In pavement RGL fixture with Integral control and monitoring.
2. Update the Series circuit communication equipment for the 8R-26L Circuits
3. Add additional series circuit modem, filter isolation transformer and all cabling power and enclosure modifiacations for the series circuit modem.
4. Update the In Pavement RGL programming system and existing modem to be compatible with the new LED fixtures and compatible with the existing in pavement RGL components with all software configuration file updates.
5. Provide an additional Series Circuit Modem for the In Pavement RGL programming, that is compatible with the LED In Pavement RGL fixtures and the existing In Pavement RGL components

2.02 SYSTEM FUNCTIONS

A. Each designated fixture is includes an integral addressable control and monitoring function that causes the fixture to flash, according to the requirements in this specification. The fixture is connected to each transformer using the 2-pole L823 plug. No other connections to the series circuit are permissible.

B. The integral addressable control also shall provide monitoring capability for the state of the fixture.

C. The integral addressable control shall communicate to associate interface equipment in the airfield lighting vault. The communications means shall be through the series circuit through the secondary of the isolation transformer.

2.03 VAULT EQUIPMENT

A. Series Circuit Communication Equipment

1. The series circuit communication equipment shall be 19” rack mountable and shall be capable of, but not limited to the following functions, and specifications:
2. Communications between the ALRCS and any number of addressable control and monitoring devices providing control and status of addressable control and monitoring devices or other addressable field components shall have lightning protection equal to that on the output of the CCR. The series circuit communications interface shall be provided with dual redundant Ethernet ports. These ports are interfaced to the Vault network and communicate with the ALRCS PLC’s supporting a redundant failover communications function.
   a. Operating temperature range -0°C to +55°C ambient.
   b. Relative Humidity, 10% to 90% non-condensing.
   c. Series circuit power (real or apparent) consumption not to exceed 200 watts.
   d. Shall provide indicators for determination of the status of the equipment and to facilitate maintenance.

2.04 AIRFIELD EQUIPMENT

A. In-Pavement RGL Fixture Integral Control and Monitor Requirement. The integral control and monitoring elements of the fixture shall be capable of, but not limited to the following control and monitoring functions and specifications:

1. Communication between fixture and series circuit communication equipment on the secondary side of the isolation transformer.
2. On/Off switching and flashing of the fixture.
3. Monitoring of status of the fixture.
4. Detect failed fixtures.
5. Short-circuit the isolation transformer in case of a failed fixture.
6. Shall be waterproof and impervious to deicing fluids, IP 68 rating.
7. Operating temperature range -40°C to +65°C ambient.

B. Field equipment installation requirements.

1. Secondary cables with L-823 connectors as required to suit field conditions.
2. Current 2.8 to 6.6 amps, 60 Hz, crest factor max 2.9.
3. Lighting and surge protection compliant with FAA requirements for field equipment.

C. Meets controllable and non-controllable stop bar, in pavement RGL requirements, and failure behavior specified in FAA AC 150-5340-30, and this specification.

2.05 VAULT EQUIPMENT FUNCTIONS

A. Interface Details. The interface between the RGL system and the ALRCS shall consist of dual Ethernet ports on the series circuit communications equipment. This interface shall support all of the specified functions and performance requirements and shall be provided with the necessary functionality to switch from a failed Ethernet connection to the other operational Ethernet connection seamlessly and automatically.

1. RGLS State Definition.
   a. Operational. This state is valid when a hold bar group meets operational criteria.
   b. Caution. This state is valid when a hold bar group meets caution criteria.
   c. Failed. This state is valid when a hold bar group meets failed criteria.
   d. Maintenance. This state is valid when a hold bar group is placed of service for maintenance.
   e. Unknown. This state is valid when the operational of the components in the RGLS cannot be determined by the RGLS. Such would be the case if the RGLS was in the process of initialization of the addressable devices at start up, or the series circuit interface device. The purpose of this discreet state is to distinguish between a failed state of the components that the RGLS has determined are actually failed and a state where the system is unable to provide meaningful information to the ALRCS.

B. RGLS Health check signal. In addition to the items listed on a per-bar basis, RGLS shall provide health check support to the ALRCS, in the vault. The ALRCS will monitor the health check indication from the series circuit communications equipment, and if communications is lost, the ALRCS will declare the RGLS having failed. When the RGLS resumes the health check status, the ALRCS shall restore the normal RGLS processing.

2.06 SPARES

A. The RGLS shall include the following spare components:

1. 10% spares of the new RGL Fixtures.
2. One each of all other new replaceable components.

PART 3 EXECUTION

3.01 INSTALLATION

A. Calibration and update of the in pavement runway guard light system will follow contract drawings and details.

B. Cable routing and circuit design and labeling shall follow schematics in contract drawings

C. Return the removed existing flasher modules, to Airport Electrical Shop.

3.02 TESTING

A. See section 26 08 20 for acceptance testing requirements.

3.03 TRAINING

A. Provide a qualified factory-trained service engineer to conduct on-site familiarization, operation, and maintenance training program for the RGL system. Training will be for the Airport's Maintenance personnel shall be conducted after the system is fully commissioned.

B. Provide 8 hours of on-site training for maintenance personnel covering operational, maintenance and troubleshooting procedures.

C. If some of the topics of training for the RGL control system are provided by the ALRCS training, duplication is not required.

D. As a minimum, training shall include the following:

1. Familiarization with the Operation and Maintenance Manuals.
2. Review of schematic drawings - how to read them and how to use them to troubleshoot system function and control problems.
3. Review of software documentation.
4. Physical check-over of equipment, noting device locations and relationships to schematics.
5. Equipment functional tests and checks.
6. Equipment operating instructions.
7. Equipment routine service requirements.

8. Equipment troubleshooting instructions and procedures - review equipment self-diagnostic features and indications, define most likely problems, symptoms and corrective actions.
9. Training shall be provided with specific emphasis and hands on training of the use and operation of the programming unit, components, and support software used to prepare a spare light monitor and switch device and series circuit modem. The programming of spares is one of the most critical items to be covered, and it is essential that all maintenance personnel are adequately trained to program spares. Programming files for all RGLS components at IAH shall be provided.
10. Trouble shooting shall include causing simulated faults throughout the system so that they can be diagnosed by maintenance personnel.

3.04 OPERATION AND MAINTENANCE MANUALS

A. Provide 7 copies of Operations and Maintenance Manuals.

B. Provide a detailed description of the RGL system operation principles and information on troubleshooting, servicing, and maintenance of the equipment, the actions required in the event of faults.

C. Manuals shall be in full color filly describing all equipment at site.

D. Provide a typical step-by-step procedure describing use and systematic troubleshooting of the system. Maintenance manuals shall describe in detail specifically how RGL system symptoms are diagnosed, isolated and repaired.

E. Provide individual manuals for specific equipment as appropriate. Provide identified tabs and sections in master manuals for individual equipment data/manuals.

F. Include schematics and detailed power and control/monitoring diagrams for all equipment supplied.

G. Include detailed material lists with parts numbers.

3.05 GUARANTEE

A. The complete system shall be guaranteed to meet or exceed the design and performance requirements stated in the project specification.

B. Installed equipment, software, and materials, which in the opinion of the Engineer do not meet the design requirements shall be replaced or modified by the supplier.

C. All equipment shall be warranted against defects in workmanship, hardware and software for a period of 1 year after system acceptance.

D. The RGLS consists of controls for in pavement runway guard lights fixtures, maintenance functionality on the ALRCS workstation in the maintenance office, and computer control panel in the vaults, and computer system with maintenance functionality.

E. The RGLS provides enhanced conspicuity at the entrances to runway 9-27 and at other designated locations on the airport. It is essential that the system be reliable and that the system be simple to maintain by airport personnel.

PART 4 MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. Calibration and update of the In pavement RGL system shall include all work and materials required by this specification, plans and details, including communication and programming of new fixtures, supply of all required vault equipment, equipment components and software upgrades and support for an additional RGL circuit, preparation and modification to configuration files, site acceptance testing support, tuning of components and circuit related elements, training documentation, coordination. Removing of existing flashing modules and returning to the Electrical Shop, and supply of new fixtures, shall be measured in another section.

4.02 BASIS OF PAYMENT

A. Payment for the calibration and update of the RGLS 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:

26 55 92 - 1 Calibrate and update Runway Guard Light Monitoring and Control System - Per Lump Sum

END OF SECTION

SECTION 26 55 95

AIRFIELD LIGHTING REMOTE CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. It is the intention of this Section to describe the upgrade to the Airfield Lighting Remote Control System (ALRCS) that is required as a result of the changes for the project in airfield circuitry and reconfiguration of constant current regulators. This may include changing the CCR rating, step configuration from 3 to 5 step or vice versa, and the addition of an In Pavement Runway Guard Light circuit.

B. 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 ALRCS, unless it is specifically mentioned that the work or a portion thereof shall not be included or shall be by others.

C. Supply ALRCS components as shown on contract drawings including, but not limited to, cables, networking components, miscellaneous hardware, cabinets, and materials.

D. Supervise the installation of all components of the described above. Provide final connection of all communication cables to the ALRCS shown on drawing.

E. Work directly with Control Tower personnel to upgrade the existing operator control interface that is acceptable to the ATCT personnel.

F. Commission the upgrades to the ALRCS including systematic electrical and mechanical checkout and proving the systems under actual or simulated VFR and appropriate CAT I/II/III, 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.

G. Provide training for personnel in the operation and maintenance of the upgraded ALRCS system including the provision of complete documentation, classroom instruction, and field training.

1.02 SECTION INCLUDES

A. Upgrades of the Airfield Lighting Remote Control System (ALRCS) for the North Vault.

B. Upgrades of the existing touchscreen at tower cab.

C. Training of maintenance operations and tower personnel in the operation and maintenance of the modified equipment.

1.03 RELATED SECTIONS

A. 26 08 20 - Airfield Electrical Installation Testing

B. 26 05 53 - Electrical Identification

C. 26 05 10 - Work in Existing Building – Electrical Demolition

D. 26 35 53 – Installation of Vault Equipment

E. 26 55 92 – Runway Guard Lights Control System

1.04 RELATED DOCUMENTS

A. AC 150/5340-30, Design and Installation Details for Airport Visual Aids

B. AC 150/5345-53, latest edition, Airport Lighting Equipment Certification Program.

C. AC 150/5345-56, latest edition, L-890 Airfield Lighting Control and Monitoring System

D. National Fire Protection Association (NFPA), NFPA 70, National Electrical Code.

E. National Electrical Manufacturer's Association (NEMA), ICS-1-Industrial Control and Systems General Requirements.

1.05 DEFINITIONS

A. The following words and abbreviations have particular meaning and relevance to the work of this Section:

1. ALPC Airfield Lighting Power Center/Vault
2. ALRCS Airfield Lighting Remote Control System
3. APP Approach lighting
4. APU Automatic power units
5. ATC Air traffic control
6. ATCT Air traffic control tower
7. ATS Automatic Transfer System
8. CAT Category
9. CC Current Contactor
10. CCR Constant current regulator

11.	CPU	Central processing unit
12.	CRT	Cathode ray tube
13.	EEPROM	Electrical Erasable Programmable Read-Only Memory
14.	FAA	Federal Aviation Administration
15.	HAS	Houston Airport Systems, Owner
16.	I/O	Input/output
17.	PCI	PCI Expansion Slot on CPU
18.	MTBF	Mean Time between Failure
19.	NEMA	National Electrical Manufacturer's Association
20.	NFPA	National Fire Protection Association
21.	PC	Personal computer, commercial grade computer
22.	PLC	Programmable logic controller
23.	RAM	Random access memory
24.	RVR	Runway visual range indicator
25.	RWY	Runway edge lighting
26.	SAW	Surface acoustic wave
27.	TAXI	Taxiway lighting
28.	TFT	Transition Film Technology
29.	UPS	Uninterruptible power supplies
30.	VFR	Visual flight regulator
31.	VRAM	Video rapid access memory

1.06 UPGRADES TO THE ALRCS

A. The ALRCS shall be upgraded to support the functionality associated with airfield lighting circuit reconfiguration identified on the contract drawings and specifications. All displays, preset functions, maintenance functions and CCR functions that are impacted by the reconfiguration shall comply with the specification performance and operational requirements. Any changes in circuitry from load rebalancing shall also include modifications to the remote control switches and legends on the ALRCS PLC cabinets.

1.07 EXISTING ALRCS SYSTEM DESCRIPTION

A. The ALRCS shall meet the requirements of FAA AC 150-5345-56, Specification for L-890, Airfield Lighting Control and Monitoring System. Type D and failsafe types A and B.

B. The requirements for L-890 shall be considered as general minimum requirements to be met. The ALRCS shall also fully comply with the requirements in this specification 26 55 95, which includes the specific requirements of this airport.

C. Existing ALRCS System Overview

1. The ALRCS architecture is specified to include a fully redundant design of critical system components. Refer to the drawings sheets to view the overall topology of the system. The primary function of the ALRCS is to provide the remote control and monitoring capability of the equipment in the airfield lighting vaults. 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 each lighting vault and the tower equipment room.
2. The ALRCS is a state-of-the-art system, microprocessor based and software-controlled, able to operate as a stand-alone system and to be expandable to be connected as a subsystem to an integrated workstation. 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.
3. The ALRCS includes the functionality to fully support the addressable lighting control and monitoring system required for In Pavement Runway Guard Lights. The ALRCS system as supplied shall include the performance capability to support additional addressable lighting control monitoring applications including controllable stop bars, sectionalized taxiway routing control, and single lamp monitoring, without requiring system architectural changes
4. The system shall be configured and installed in such a manner as to facilitate and minimize impact to a future upgrade process. The ALRCS PLC Control engines are to be supplied with the processing capacity, memory and other resources to support the potential growth indicated in this specification.

1.08 EXISTING SYSTEM REQUIREMENTS

A. The ALRCS design criteria to meet the minimum general, operational, and equipment functional requirements are as follows.

B. General Requirements

1. The ALRCS shall provide remote control and monitoring of the designated airfield lighting equipment in the vault under VFR, and CAT I / II / III operating conditions, as applicable.
2. The ALRCS 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 MTBF ratings.
3. Customized system and graphics software for control and maintenance operations.
4. The ALCRS supplier shall coordinate software and programming development with the control tower operations personnel and operations and

maintenance personnel 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 ALRCS. Functionality requirements from the RGLS and CCRs shall be integrated into the ALRCS, 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.

C. Control Software

1. All upgraded 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 shall be off-the-shelf, non-proprietary and become the property of the owner.
2. All interlocking, monitoring and control logic shall be programmed in electrical ladder logic format and shall reside in the PLCs provided. A failure of a tower, vault or maintenance computer that displays the airfield graphics shall not affect the PLC operation and the operation of the rest of the system.
3. The software contained in the graphics computers shall consist solely of graphic generation, touch-screen operator input, configuration utilities and remote access software. All logic shall be performed in the ALRCS control engines.
4. System functions and display information shall be completely configurable on-line by maintenance personnel without the need to power down any device. This provides the ability to change the operation 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 control tower, equipment room and vault.
   b. Independently enable or disable circuits to allow monitoring and control of the circuit.
   c. Independently enable or disable each monitoring feature for each circuit.
   d. Independently set the on-delay time, soft-start increment times for each circuit.
   e. Independently set the warning and alarm thresholds for each individual circuit and for each brightness level. It is acceptable to make these settings from the CCR keypad.
   f. Independently enable or disable alarming of each monitoring function for viewing by tower, vault, and maintenance personnel. This allows the site to specify which alarms are viewable at each different location.
   g. Enter or modify the circuit description / regulator information for each circuit.

h. Calibrate monitoring functions to match site true-RMS meters. It is acceptable to make these settings from the CCR keypad.
i. Configure all custom pushbuttons allowing the site to easily change how the system functions.
j. 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.
k. Swap spare regulators into service by simply changing field cables and specifying the new regulator number.

5. Airport personnel shall be able to make most site adaptation change as may be required in the future without the need to contact the original manufacturer of the Airfield Lighting Control and Monitoring System. All original program files and source code necessary to make any changes must be provided as part of this contract.
6. Access to all software shall be provided with suitable security measures to prevent inadvertent access to advanced 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, calibration).
   b. Remote access protected by passwords and data encryption.
   c. Desktop lock feature prevents users from accessing any Windows programs, functions, or preset keys.

1.09 MAINTENANCE REQUIREMENTS

A. The upgraded ALRCS shall include the capability to diagnose and locate system faults including all ALRCS network components, and connections to vault equipment, from any maintenance workstation, authorized PC and the vault PC of the ALRCS. All system software on system computers that resides on the SSD disk 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 SSD disk image to the current system revision level, shall be accomplished by system restore CDs, and shall start an autorun or with a single restore command shall restore the entire system image. The system then shall be ready to operate.

B. It shall be possible for failed replaceable components to be diagnosed by maintenance personnel using the software tools training supplied

1.10 OPERATIONAL REQUIREMENTS

A. The following operational requirements 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 the owner and FAA tower personnel. Any additions or changes shall be part of the scope of this contract.

B. Brightness Control

1. 3/5-step brightness level control.
2. Separate control for each system as required.
3. Provide individual brightness level pushbuttons.

C. Send Pushbutton

1. Must be pressed before any commands are sent to the control engine.
2. Allows entire airfield to be configured prior to initiating changes.

D. Cancel Pushbutton

1. Pressing this button will cancel the user's inputs and revert all buttons to the current status of the airfield.
2. This allows the user to change their mind, as long as the SEND push-button has not been pressed.
3. The Cancel feature (if enabled) will also cancel any user inputs after a pre-determined time of inactivity without the SEND push-button being pressed.

E. Operating Mode Selection Pushbuttons

1. Provide one for each runway direction or Operating Mode.
2. Pre-programmed default settings for VFR, and CAT I, II, III Conditions.
3. Allows quick switching of runway direction or modes.
4. Lighting patterns to be maintained when switching direction.
5. Interlocking to be provided to prevent lights of opposite of runway directions from being energized. Other interlocking to be provided as necessary for safe operations or regulator loading restrictions.

F. Runway and Taxiway Menus

1. Pop-up menus
2. SEND or CANCEL to automatically close menus
3. Provision to manually close menu

G. Runway Visual Range (RVR) Menu

1. Pop-up menu or permanent display
2. SEND or CANCEL to automatically close menu

3. Provision to manually close menu
4. Provision for Day / Night Operation
5. Provision for up to 5 visibility settings
6. SMGCS (less than 1200, above 600 feet RVR)
7. less than 1 mile
8. 1 to 2 miles
9. 2 to 3 miles
10. 3 to 5 miles
11. Greater than 5 miles

H. Runway Edge Lighting

1. Separate ON/OFF control for each runway
2. 5-step or 3-step brightness level control

I. Runway Centerline Lighting

1. Separate ON/OFF control for each runway
2. 5-step brightness level control

J. Touch Down Zone

1. Separate ON/OFF control for each runway
2. 5-step or 3-step brightness level control

K. Taxiway Lighting

1. Separate ON/OFF control
2. 3-step or 1-step brightness level control for edge lights
3. 5-step brightness level control for centerline lights

L. Runway Guard Lights

1. Separate ON/OFF control for in-pavement RGLs
2. 5-step brightness level control for in-pavement RGLs

M. Land and Hold Short Controls (LAHSO)

1. Separate ON/OFF control for LAHSOs
2. Monitor available status and display as required

1.11 ALRCS FUNCTIONAL REQUIREMENTS

A. Operator Control Panel

1. Each operator control panel shall be capable of independently controlling and displaying the entire airfield lighting installation or any predefined portion.
2. Operator Control panel functions shall include:
   a. Control and monitoring of runway lighting
   b. Control and monitoring of taxiway lighting
   c. Control and monitoring of the runway Guard Light System
   d. Control and monitoring of the generator, transfer switch, power
   e. Alarm indication of critical element failures including all battery low indications, loss of power, generator fail, fiber optic, radio modem communication fail.
   f. ALRCS or network failure
   g. Alarm indication of regulator or other circuit failures.
   h. Alarm of SMGCS lighting components
   i. Control and monitoring of the guidance sign circuits
   j. Control panels shall display a graphic representation of the airfield lighting installation.
   k. Only circuits that are actually “ON” (current is flowing in circuit) shall be indicated as being “ON” on the display.
3. Indication shall be as follows:
   a. Runways Edge- white bar
   b. Runway Centerlines – Green bar
   c. Taxiways Edge- blue bar
   d. Taxiway Centerlines – Green bar
   e. Touchdown zones – red bar
   f. In pavement RGLs Yellow Bar
   g. Signs (to be agreed upon)
4. Circuits that are currently not under ATC control from the tower shall be indicated on the mimic display as “LOCAL”
5. Airfield lighting control commands shall be entered at the touch-screen monitors using touch-buttons on the displayed pages.
6. Separate control touch-buttons shall be provided for each controllable lighting element as detailed in Operational Requirements above.
7. Push-buttons shall change color according to the following status indications:
   a. Gray to indicate push-button is not selected and lighting circuit is OFF.
   b. Yellow to indicate push-button has been pressed to turn on the lighting but no commands have been sent to the PLC.
   c. Green to indicate the command was initiated and acknowledged by the PLC at the Vault.
   d. Dark green to indicate push-button has been pressed to turn off the lighting but no commands have been sent to the PLC.
   e. Flashing red to indicate that the corresponding airfield circuit is not operating as requested by the pushbutton.
   f. Each display page shall have touch-buttons for command selection, SEND (acknowledge) and navigation to other display pages.

g. Provision shall be made to allow the tower personnel to calibrate the touch-screen simply by pressing a push-button on the screen.
h. Develop the displays and system/graphics software and coordinate this phase of the work with the ATC, maintenance and operations Personnel.

B. Air Traffic Control Tower (ATCT) Panels

1. The LCD panels shall include an embedded graphics engine that supports all of the required display and communications functions. This panel shall include an Ethernet interface to be connected to the network switch in the ATCT Equipment room. The ATCT panel shall perform the following functions:
   a. Generation of LCD graphics display.
   b. Receiving command signals from the touch-screen to control the airfield lighting.
   c. Decoding and acknowledging receipt of command signals.
   d. Transmitting control command signals to the Tower PLC that are sent via the dual Ethernet connection onto the fiber optic cable to the Vault PLC for execution.
   e. Reception of data from the ALRCS network regarding the status of the airfield lighting and associated equipment. The Tower panels shall display only that information, which is has operational necessity for control and monitoring and situational awareness of the airfield lighting components and electrical power sources.
   f. Provide real time status of the airfield lighting.
   g. Program for calibration of the touch-screen.

C. Remote Access

1. The software shall provide remote access capability to the Tower Computer using a dialup modem connection as follows:
   a. Maintenance electricians and other personnel as determined by the Airport Authority shall have the ability to remotely connect to the tower computer using a dialup V.92 modem, which is part of the maintenance workstation.
   b. Remote access shall be password protected and available only to those authorized by the Airport Authority.
   c. All graphic screens, displays and information that are locally available shall also be available from the remote location.
   d. Ability to view, control, maintain and troubleshoot the system shall be provided remotely, provided proper security passwords are provided.
   e. Ability to perform file transfers and product updates from the manufacturer via modem shall be provided.

D. Tower Equipment

1. The equipment room under the tower cab shall include an interface to control and monitor the local I/O points as indicated, if required. This interface shall include redundant Ethernet network support. The network connection shall be interfaced to the ALRCS network switch in the equipment room.

E. Vault PLC. All vault I/O shall be via the dual vault Ethernet network and switches. The PLC Control engines shall be redundant including failover mechanism. The functions below are entirely supported on the network. These functions include but are not limited to:

1. Provide output signals to control the regulators:
   a. Regulator On (CC)
   b. Regulator Brightness Level B1
   c. Regulator Brightness Level B2
   d. Regulator Brightness Level B3
   e. Regulator Brightness Level B4
   f. Regulator Brightness Level B5
2. Provide regulator monitoring input signals:
   a. Analog output current
   b. Analog output voltage
   c. Regulator status
   d. Control Switch not in remote
   e. Input voltage present
   f. Output current sensor when necessary
   g. Analog Insulation Resistance
   h. CCR alarm Status
3. Provide monitoring input signals for the following:
   a. Generator ON
   b. Generator Low Fuel
   c. Automatic Transfer Switch-- Commercial power on line
   d. Automatic Transfer Switch--Generator Transfer
   e. ALRCS Equipment- 120VAC power failure
   f. Low PLC battery
   g. Low 24VDC UPS Battery
4. Provide Control output signals for the following:
   a. Generator Start
   b. Generator Stop
5. The PLC shall be provided with an EEPROM module providing non-volatile program backup. The program shall be reloaded directly from EEPROM simply by cycling the PLC power supply switch off and then on.

F. Communications Network

1. The ALRCS network shall use standard TCP/IP between the each location to pass data between all ALRCS elements..
2. Communication between locations shall be via a redundant fiber optic network using 2 strands each of single mode cable indicated in the drawings that connect between each of the locations. A backup radio modem connecting the locations where ALRCS equipment is present shall be supplied and shall switch on line in the event that fiber paths is failed
3. Communication shall automatically switch between the main and backup (redundant) fibers and backup radio modem as follows:
   a. Failure of one fiber optic transmit or receive line shall cause communication to switch to the alternate transmit or receive fiber.
   b. Failure of both the transmit lines or the receive lines shall cause automatic switch over to the backup radio modem.
   c. Repair or recovery of the fiber optic lines shall cause communication to automatically switch back to the fiber optic cable.
   d. Communication switching shall be transparent to the control tower personnel. All systems shall remain fully operational regardless of the mode of operation. Any failure shall be alarmed at the tower and all user panels and PC's.
   e. A watchdog timer shall be provided for both the copper Ethernet links and fiber optic lines and the backup radio link to ensure that both communication networks and the backup radio link are fully operational.

G. Runway Guard Light System Functionality

1. The ALRCS shall support all functions of the existing Runway Guard Lights System (RGL). The ARLCS shall support RGL system by providing status to airfield status screens that reflect the operational state of each RGL bar. For tower or overall situational awareness, only the state of the RGL bar is displayed. Alarms are conveyed based on those bar states. The performance requirements for the existing RGL system and the time of reporting status shall apply.
2. For Maintenance screens displayed anywhere in the ALRCS, the status of the bar as defined in the RGL specification, as well as individual fixture status shall be displayed in all modes of visibility. The existing performance requirements for the RGL system regarding reporting status shall apply.
3. The status of the series circuit communications interface shall also be reported as a component.
4. During a power up of the circuit, the status of the RGL controls is unknown, until they initialize and report. Subject to the reporting timing requirements, the ALRCS shall not report any failed components or states during power up or power down of the RGL circuits until it has been determined that an actual failure has occurred.

H. Failsafe Functions:

1. In the event of communication/control system failure, the CCRs shall enter the failsafe state. This function shall be present in the CCR, and is included here for clarity of the system functionality
   a. Each regulator failsafe function shall be independently programmable such that upon communication or system failure, the regulator shall automatically revert to either remain in the last state or switch to OFF, Brightness B1, B2, B3, B4 or B5.
   b. If failsafe mode occurs, all regulators and circuits will set to their failsafe settings.
   c. The failsafe settings shall be determined by the airport operations and maintenance staff and shall be field adjustable without changing the software.
   d. A watchdog timer shall be installed to check the status of the control system and communications and the failsafe mode shall be entered if malfunction occurs.
2. When the control system returns to normal, control shall automatically be transferred back to the tower.

1.12 MAINTENANCE DISPLAY

A. Maintenance displays with, printer, and software in the vault shall provide real time and historical information on the status of the ALRCS.

B. In the vault the maintenance display is installed in the PC equipment rack and visible through the door.

C. Airfield lighting systems status information shall be presented on display screens and accessed by means of graphical icons located at the bottom of each page.

D. Various screens shall be provided to display sections of the single line diagram for the airfield lighting power distribution. Single lines shall show the incoming power sources generators, regulators, circuit selectors and feeder circuits as seen physically in the ALRCS.

E. Single Line Diagrams

1. Regulators shown on the single line diagrams shall indicate the following conditions. Selecting the single line will bring up the corresponding regulator status screen.

Regulator Status	**Graphical Representation**
Input voltage present	Breaker - green
Input voltage not present	Breaker - Flashes red

Regulator Status	**Graphical Representation**
Regulator off / not required	Regulator single line - black
Regulator energized and current is present	Regulator single line - green
Regulator energized and current is not present	Regulator single line - yellow
Regulator is in alarm	Regulator single line -flashing red

2. The PLCs shown on the single line diagram shall indicate their operational state.

F. Regulator Status Displays. One Regulator Status Screen shall be provided for each regulator and shall include the following information:

1. Pictorial representation of the regulator
2. Regulator Cell Number
3. Field Circuit Number and Description
4. Local (manual) selection
5. Input voltage loss
6. Over-current, over-voltage or door inter-lock shut-down
7. CCR alarm
8. Selected brightness level (by ATCT)
9. Actual brightness level/series circuit output current
10. Output voltage
11. Output Current
12. Output KVA
13. Output KW
14. Elapsed time on each brightness level
15. Number of regulator operations
16. Insulation Resistance of field circuit
17. Current Sensor Status
18. Elapsed time on each brightness level
19. Number of operations
20. Selecting the regulator description shall automatically bring up the corresponding regulator status screen.
21. Selecting a different circuit selector on the pictorial shall automatically bring up the corresponding status .screen.
22. Reset capability shall be provided to reset the Elapsed Time meters and operations counters.

G. Communications Status Displays. A communication Status Screen shall be provided and shall include:

1. Pictorial representation of the communication system

2. PLC Battery Status
3. 24VDC Battery Status at both Tower and vault
4. 120VAC Power Supply Status at both Tower and vault
5. Current Mode of Communication
6. Status of all network switches on the ALRCS network
7. Status of all network switches on the Vault networks
8. Status of all network links (between all switches and all devices)
9. Fiber Optic Channel A Receive Error (for each location)
10. Fiber Optic Channel B Receive Error (for each location)
11. Fiber Optic Channel A Impending Fault (for each location)
12. Fiber Optic Channel B Impending Fault (for each location)
13. Fiber Optic Watchdog Timer
14. Radio Modem Watchdog Timer
15. Push-buttons shall be provided for enhanced diagnostics and troubleshooting by automatically forcing failures on any of the fiber optic lines and forcing the fiber optic modules to trap and hold intermittent errors.

H. Alarm Summary. Alarm Status Screen shall display a list of all current malfunctions and provide:

1. Date and time of the malfunction
2. Type of Failure or Alarm
3. Lighting system, CCR, circuit selector
4. Computer or PLC fault
5. Communications fault
6. Location, e.g. Control Tower, vault
7. Description of malfunction

I. Event Summary

1. Event Status Screen shall display a list of all events and provide:
   a. Date and time of the event
   b. Operator circuit switching / brightness changes
   c. Security information
   d. System event information provided by hardware
   e. Description of the event

J. Historical Reports

1. Menu selected screens shall be provided to display all the activities and malfunctions which occurred during a defined time period including. The reports shall have the capability of being sorted by any field listed for ease of maintenance.
   a. All lighting system operations
   b. All control system malfunctions (computers, PLCs, communication systems, power supplies)

c. Elapsed time on each brightness level for each CCR/series lighting circuits
d. CCR activity, number of operations for each regulator, and malfunctions
e. Generator operations and malfunctions
f. Coordinate with and develop software, screen displays, and menus in cooperation with Airport maintenance personnel, to fully incorporate user requirements.

K. Trending

1. The software shall provide simultaneous real-time trending, history logging and history replay of control system data.
   a. Trending shall be available in real-time, in the background, or from historical data.
   b. The software shall be capable of displaying real time data and historical data on the same trend, allowing full comparison of current and historical data.
   c. The software shall be capable of trending any point or parameter of the control system that is either monitored or controlled.
   d. Trending shall be configurable by the site maintenance electricians to aid in troubleshooting and analysis of airfield lighting circuit or equipment problems.
   e. Coordinate with and develop software, screen displays, and menus in cooperation with Airport Authority engineering / maintenance personnel, to fully incorporate user requirements.

L. Control from Vault Computer

1. In normal operation, control of the airfield lighting shall not be permitted from the vault computer. Control shall be solely assigned from the control tower for maintenance of the system.

M. Remote Access

1. The software shall provide remote access capability to the Maintenance Computer using a dialup modem connection.
   a. Maintenance electricians and other personnel as determined by the airport shall have the ability to remotely connect to the maintenance computer using a dialup V.92 modem.
   b. Remote access shall be password protected and available only to the ALRCS system supplier or those authorized by the Airport.
   c. All graphic screens, displays and information that are locally available shall also be available from the remote location.
   d. The ability to view, control, maintain and troubleshoot the system shall be provided remotely, provided proper security passwords are provided.

e. The ability to perform file transfers and product updates from the manufacturer via modem shall be provided.

N. Event Data Related

1. The ALRCS shall include support for archiving log events, reports and other pertinent system events for the purposes of off line storage.
2. Archiving shall be supported to any storage volume connected to any workstation in the ALRCS. Events shall be stored for a predefined amount of time. Storage time shall be defined by the airport and shall be configurable from 1 day to 1 year
3. This includes but is not limited to CD R/W drives, removable flash storage devices and network storage appliances
4. Viewing events, including warnings and alarms, shall be able to be viewed via a user HMI interface.
5. Subset Viewing - Subset of events, including warnings and alarms, shall be able to be viewed via a subset HMI interface that allows the user to specify a date and time range to view. In addition, subsets of events shall be viewable based on configurable criteria, such as events involving a particular component, failure type, or any other searchable elements or combinations of elements, allowing the user to see the history of events with common characteristics.
6. Logging – All active and cleared events shall be stored to a database designed for optimal retrieval performance. These events shall be viewable as defined in d and e above.
7. Date/Time Stamp – Stored events shall be stamped with the date and time of occurrence.
8. Purging – The ALRCS shall provide a method (automatic or manual) for erasing the events database to allow for SSD disk space recovery

1.13 RESPONSE TIME PERFORMANCE REQUIREMENTS

A. Tower command on touch screen to CCR changing state, and actual back indication shall be less than two seconds

B. Vault or tower equipment room selection of any status screen until status of all elements is displayed shall be less than two seconds

C. Equipment on the any network fails until appropriate alarm or status is displayed shall be less than 30 seconds

D. Equipment on the any network is restored until appropriate alarm or status displayed is cleared shall be less than 30 seconds

E. Any event resulting in an automatic network failover shall be completed in less than 30 seconds. Any temporary loss of status or control beyond the failover

delay is not permitted. No control or status change of state as a result of a failover event is permitted.

F. Any event resulting in a restoration of an automatic network failover shall be completed in less than 30 seconds. Any temporary loss of status or control beyond the failover delay is not permitted. No control or status change of state as a result of a failover event is permitted

G. The PLC control engines shall keep system status synchronized between each other in order to meet the failover performance requirements

H. No false status or nuisance alarms are permitted.

1.14 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. For any new or modified wiring, provide drawings showing mounting details of Control Tower touch-screen video display monitors, 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. For any modifications provide detailed power schematics of computer or PLC control cubicles, showing incoming power supplies, circuit breakers, cooling fan and control, battery charger and control.

3. For any modifications, provide detailed control schematic and wiring diagrams including all control, monitoring, and communications interconnections and terminations between PLC I/O and airfield lighting control and monitoring points and terminals; PLC and computer interconnections, fiber optic communication connections, computer to touch-screen video display monitor interconnections. Provide control and monitoring schematic diagrams in electrical ladder format.
4. Provide preliminary and final touch-screen video 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 or PLC 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 updates to the Operations and Maintenance Manuals.

1.15 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.

1.16 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 five (5) years.

1.17 QUALIFICATIONS

A. Manufacturers must have a minimum of ten redundant PLC based airfield lighting control systems installed and fully operational.

B. The existing ALRCS software and system shall be upgraded, not replaced. Minimal changes to the existing system only are acceptable.

C. 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.

1.18 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Perform all work in conformance with guidelines established by the FAA for an ALRCS.

1.19 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of Section 26 05 00 – General Provisions - Electrical.

B. Accept products on site in factory containers. Inspect for damage.

1.20 WARRANTY

A. Provide written warranty that the ALRCS software upgrades and new equipment and components supplied and installed are warranted against defects and malfunction for a period of 12 months from date of completion of commissioning.

1.21 SPARE PARTS

A. If new hardware is required, provide a recommended spares kit for the ALRCS.

PART 2 PRODUCTS

2.01 UPGRADED COMPONENTS

A. Any new components required for the ALRCS upgrade shall exactly match existing ALRCS components, unless submitted and approved by the engineer.

B. All functionality and capability identified in this specification shall be included

C. Include and install any new components as required by this specification.

2.02 WIRING METHODS AND PRACTICES

A. All Ethernet cables shall be stranded, factory terminated Category 6 patchcords. No Horizontal cables are permitted.

B. Conductors: install copper conductors not smaller than #12 AWG for 120 V power circuits and #20 AWG for control wiring. Insulation: rated 600 V, 90ºC.

C. 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

D. 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.

E. 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 ALRCS 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 ALRCS for wiring at that location.

F. 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.

G. 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.

2.03 SOURCE QUALITY CONTROL

A. Tests of all equipment covered by these specifications shall be witnessed by a representative of the owner. The contractor shall provide advance notice of a minimum of two weeks prior to the schedule of factory testing. All costs associated with this testing shall be the contractor's expense for two (2) personnel to attend all testing.

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 and backup communication systems using cables of reduced length.

E. Perform any additional tests that the owner representative may require to satisfy themselves of the adequacy and satisfactory operation of the system.

PART 3 EXECUTION

3.01 INSTALLATION

A. The Upgrades to the ALRCS shall be coordinated with the Air Traffic Control personnel and the owner maintenance personnel as follows:

1. Existing control system shall remain operational until the modifications have been made and verified for correct operation. The changeover period shall be coordinated with the FAA and the owner 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 ALRCS work.
4. Install and wire all regulator, circuit selector, and other monitoring kits.

5. Install and connect all control and monitoring wiring as required between the regulators and the computer or PLC controls cabinet.
6. Make grounding connections as previously outlined in this section.

3.02 TESTING AND COMMISSIONING

A. Prepare and submit a proposed testing and commissioning procedure for the ALRCS. Prepare documents listing the testing and commissioning procedures and expected test results. If applicable for new components, tests shall include the following:

1. Point-to-point wiring continuity tests for new components.
2. Insulation and grounding tests.
3. Fiber-optic network 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.
6. Maintenance Center computer tests.

B. Acceptance testing

1. Following final installation and calibration of the ALRCS, 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, and shall bear all associated costs including the cost of performing the test again, and associated costs for additional time required by the engineer. Any changes to the system as submitted shall be subject to the approval of the engineer.

3.03 TRAINING

A. Provide a qualified factory-trained service engineer to conduct on-site familiarization, operation, and maintenance training program for the ALRCS. 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 2 sets of 1 hour of on-site training for Air Traffic Control personnel covering operational procedures including allowance for shift work periods.
2. Provide 2 sets of 1 hours of on-site training for maintenance personnel covering operational, maintenance and troubleshooting procedures.

3. The training shall include a review of changes to the ALRCS and any hardware or functionality that has changed for the project :

PART 4 MEASUREMENT AND PAYMENT

4.01 METHOD OF MEASUREMENT

A. Measurement for the upgrades to the ALRCS System shall be per lump sum, and shall include modification of the configuration of the ALRCS for the vault equipment, modifications to support any circuit reconfiguration or additional circuits, modifications of the remote control switches and legends on the ALRCS cabinets in the north vault, modifications of the maintenance PCs and tower panels, all labor, equipment, training manual updates software, testing, commissioning as required by the specification and all incidentals to provide a complete and working system.

4.02 METHOD OF PAYMENT

A. Payment for items covered in this section and subsidiary items shall be paid for per lump sum as shown below and shall be full compensation for furnishing all products and for preparation, assembly installation and testing of this item, and for all labor, equipment, tools, and incidentals necessary to complete the ALRCS System upgrade in accordance with the provisions and intent of the plans and specifications.

Payment will be made under:

26 55 95 - 1 ALRCS System Upgrades - Per Lump Sum.

END OF SECTION

Section 31 32 13.26

LIME / FLY ASH TREATED SUBGRADE

PART 1 GENERAL

1.01 DESCRIPTION. This item shall consist of constructing one or more courses of a mixture of soil, lime, fly ash, and water in accordance with this specification, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans.

PART 2 PRODUCTS

2.01 MATERIALS

A. HYDRATED LIME. All lime shall be manufactured high-calcium quicklime, low calcium quicklime, or hydrated lime, as defined by ASTM C 51, and conform to the requirements of ASTM C 977. By product lime or any form of calcium oxide (CaO), calcium hydroxide (Ca(OH)2), magnesium oxide (MgO) or magnesium hydroxide (Mg(OH)2), alone or in combination, that are not directly produced from quicklime produced from calcining limestone, shall not be permitted.

B. 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 to be 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.

1. Chemical Composition. The "solids content" of the lime slurry shall consist of a minimum of 70%, by weight, of calcium and magnesium oxides.

2. Residue. The percent by weight of residue retained in the "solids content" of lime slurry shall conform to the following requirements:

   Residue retained on a No.6 sieve - Max. 0.0%
   Residue retained on a No. 10 sieve - Max. 1.0%
   Residue retained on a No. 30 sieve - Max. 2.5%

3. Grade. Commercial lime slurry shall conform to one of the following two grades:

   Grade 1. The" dry solids content" shall be at least 31% by weight, of the

slurry.
Grade 2. The "dry solids content" shall be at least 35%, by weight, of the slurry.

C QUICKLIME. ASTM C 618, Class C and the applicable testing procedures modified as follows:

1. Loss by ignition shall not be more than 3.0 percent

2. Combined content of silica oxide (Si02), ferric oxide (Fe203), and aluminum oxide (AI20 3) shall be not less than 50 percent.

3. Lime pozzolan strength, minimum compressive strength shall be 600 psi at 7 days, 130+3 degrees F.

D. FLYASH. Fly Ash produced from sub-bituminous coal shall be used. Fly ash from lignite will not be permitted.

E. PROHIBITED. Lime containing magnesium hydroxide is prohibited.

2.02 WATER. Water used for mixing or curing shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water shall be tested in accordance with and shall meet the suggested requirements of AASHTO T 26. Water known to be of potable quality may be used without test.

2.03 SOIL. The soil for this work shall consist of materials on the site or selected materials from other sources and shall be 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.

PART 3 EXECUTION

3.01 COMPOSITION

A. LIME. Lime shall be applied at the rate ~~specified on the plans (7% Lime –Dry Weight)~~ of 4 percent by dry weight for the depth of subgrade treatment shown on the drawings.

B. FLY ASH. Fly ash shall be applied at rate of ~~8~~ 10 percent by dry weight for the depth of subgrade treatment shown on drawings.

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

Lime +0.5%
Fly Ash +0.5%

Water + 2%, -0%

3.02 WEATHER LIMITATIONS. The lime/fly ash-treated subgrade shall not be mixed while the atmospheric temperature is below 40 F or when conditions indicate that temperatures may fall below 40 F within 24 hours, when it is foggy or rainy, or when soil or subgrade is frozen.

3.03 EQUIPMENT. The equipment required shall include all equipment necessary to complete this item such as: grading and scarifying equipment, a spreader for the lime slurry or fly ash slurry, mixing or pulverizing equipment, sheepsfoot and pneumatic or vibrating rollers, sprinkling equipment, and trucks. The equipment for lime slurry and fly ash slurry is to be capable of producing a homogenous and uniform mixture of water and lime or fly ash as applicable.

3.04 CONSTRUCTION METHODS

A. GENERAL. It is the primary requirement of this specification to secure a completed subgrade containing a uniform lime/fly ash mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth, and with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of his/her work, to use the proper amount of water, lime, and fly ash, maintain the work, and rework the courses as necessary to meet the above requirements.

B. Prior to beginning any lime treatment, the subgrade shall be constructed and brought to grade as specified in Item P-152 "Excavation and Embankment" and shall be shaped to conform to the typical sections, lines, and grades as shown on the plans. The material to be treated shall then be excavated to the secondary grade (proposed bottom of lime treatment) and removed or windrowed to expose the secondary grade. Any wet or unstable materials below the secondary grade shall be corrected, as directed by the Engineer, by scarifying, adding lime, and compacting until it is of uniform stability. The excavated material shall then be spread to the desired cross section.

C. 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. However, the Contractor shall be required to roll the subgrade, as directed by the Engineer, and correct any soft areas that this rolling may reveal before using the pulverizing machine. This method will be permitted only where a machine is provided which will ensure that the material is cut uniformly to the proper depth and which has cutters that will plane the secondary grade to a smooth surface over the entire width of the cut. The machine must give visible indication at all times that it is cutting to the proper depth.

3.05 APPLICATION.

A. Lime and fly ash shall be spread only on that area where the first mixing operations can be completed during the same working day. The application and mixing of lime and fly ash with the soil shall be accomplished by the methods hereinafter described as "Slurry Placing." Dry placing of lime and fly ash will not be permitted.

B. Slurry Placing. The lime or fly ash 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 and fly ash percentage not less than that applicable for the grade used. The distribution of lime or fly ash shall be attained by successive passes over a measured section of subgrade until the proper amount of lime or fly ash has been spread. The amount of lime or fly ash spread shall be the amount required for mixing to the specified depth that will result in the percentage determined in the job mix formula. The distributor truck shall continually agitate the slurry to keep the mixture uniform.

C. Lime slurry shall be placed first ~~following~~ followed by mixing. Fly ash slurry shall be placed following the first mixing.

3.06 MIXING. The mixing procedure shall be the same for "Dry Placing" or "Slurry Placing" as hereinafter described:

A. First 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 6 hours. The mixing machine shall make two coverages. Water shall be added to the subgrade during mixing to provide a moisture content 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. During the interval of time between application and mixing, lime that has been exposed to the open air for 6 hours or more, or to excessive loss due to washing or blowing will not be accepted for payment.

B Second Mixing. The fly ash slurry shall be applied prior to the second mixing. The full depth of the treated subgrade shall be mixed with an approved mixing machine. Fly ash shall not be left exposed for more than 6 hours. The mixing machine shall make two coverages. Water shall be added to the subgrade during mixing to provide moisture content above the optimum moisture of the material. During the interval of time between application and mixing, fly ash that has been exposed to the open air for 6 hours or more, or to excessive loss due to washing or blowing will not be accepted for payment.

C. Final Mixing. If the mixture contains clods after the second mixing, 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:

Minimum of clods passing 1 inch sieve	100%
Minimum of clods passing No.4 sieve	60%

3.07 COMPACTION.

A. Compaction of the mixture shall begin immediately after final mixing. The material shall be aerated or sprinkled as necessary to provide optimum moisture. The field density of the compacted mixture shall be at least 93 percent 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 D 1557. The in-place field density shall be determined in accordance with ASTM D 1557 or ASTM D 2922. Any mixture that has not been compacted shall not be left undisturbed for more than 30 minutes. The moisture content of the mixture at the start of compaction shall not be below nor more than 2 percentage points above the optimum moisture content. The optimum moisture content shall be determined in accordance with ASTM D 1557 and shall be less than that amount which will cause the mixture to become unstable during compaction and finishing.

B. 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 by sprinkling and rolling. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

C. In addition to the requirements specified for density, the full depth of the material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After each section is completed, tests will be made by the Engineer. If the material fails to meet the density requirements, it shall be reworked to meet these requirements. Throughout this entire operation, the shape of the course shall be maintained by blading, and the surface upon completion shall be smooth and shall conform with the typical section shown on the plans and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density, and finish before the next course is placed or the work is accepted, it shall be recompacted and refinished at the sole expense of the Contractor.

3.08 FINISHING AND CURING.

A. After the final layer or course of lime/fly ash 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, with a pneumatic or other suitable roller sufficiently light to prevent hair cracking. The finished surface shall not vary more than 3/8 inch when tested with a 16- foot 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, at his/her own expense, in a manner satisfactory to the Engineer. The completed section shall be moist-cured for a minimum of 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/fly ash-treated subgrade is cured.

B. If, for any approved reason, any portion of the lime-fly ash ~~stabilized Subbase~~ treated subgrade ~~top~~ layer cannot be overlaid in 7 days, the lime-fly ash-~~stabilized Subbase~~ treated subgrade will be sealed with an approved bituminous material at a rate between 0.10 and 0.15 gallons per square yard.

3.09 THICKNESS. The thickness of the lime/fly ash-treated subgrade shall be determined by depth tests or cores taken at intervals so that each test shall represent no more than 300 square yards. When the base deficiency is more than 1/2 inch, the Contractor shall correct such areas in a manner satisfactory to the Engineer. The Contractor shall replace, at his/her expense, the base material where borings are taken for test purposes.

3.10 MAINTENANCE. The Contractor shall maintain, at his/her own expense, the entire lime/fly ash-treated subgrade in good condition from the start of work until all the work has been completed, cured, and accepted by the Engineer.

PART 4 MEASURE AND PAYMENT

4.01 MEASUREMENT

A. The yardage of lime-fly ash treated subgrade to be paid for shall be the number of square yards completed and accepted.

B. The amount of lime to be paid for shall be the number of tons of dry lime contained in the lime slurry used as authorized.

C. The amount of fly ash to be paid for shall be the number of tons of dry fly ash contained in the fly ash slurry used as authorized.

4.02 PAYMENT

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

B. ~~Lime will be paid for under section 02715.~~ Payment shall be made at the contract unit price per ton of lime. This price shall be full compensation for furnishing this material; for all delivery, placing and incorporation of this material; and for all labor, equipment, tool, and incidentals necessary to complete this item.

C. Payment shall be made at the contract unit price per ton of fly ash. This price shall be full compensation for furnishing this material; for all delivery, placing and incorporation of this material; and for all labor, equipment, tool, and incidentals necessary to complete this item.

TESTING REQUIREMENTS

ASTM D 698 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. Rammer and 12-in. Drop

ASTM D 1556 Density of Soil in Place by the Sand-Cone Method

ASTM D 2922 Density of Soil in Place by the Nuclear Density Method

AASHTO T 26 Quality of Water to be used in Concrete

MATERIAL REQUIREMENTS

ASTM C 977 Quicklime and Hydrated lime for Soil Stabilization

END OF DOCUMENT

Section 32 01 90.34

REMOVAL OF MARKINGS

DESCRIPTION

1.01 General. This item shall consist of furnishing all labor, materials and equipment required for the obliteration (complete removal) of existing pavement markings (paint and rubber) from asphalt and concrete surfaces, which are identified to be removed, including the obliteration of temporary painted pavement markings installed under this contract, as shown in the plans.

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

This item also includes the cleanup and disposal of the markings and other materials used in the obliteration of the pavement markings. Areas of pavement marking obliteration have been estimated for bidding purposes. The actual locations of pavement marking obliteration will be as shown on the plans.

EQUIPMENT

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

2.02 General. The allowable methods for marking obliteration may include grinding and / or water blasting or a combination of multiple methods. The combination of equipment used may be different for asphalt vs. concrete surfaces and must not damage the pavement surface. The Contractor shall submit a description of the types and quantity of equipment proposed for this project. The Contractor shall submit a qualification statement indicating length of time the company has been performing marking obliteration on airfields and references from airports that a similar method was used. No pavement marking removal shall be started until the work has been laid out by the Contractor and approved by the Construction Manager.

2.03 Water Blasting. The water blasting equipment shall be truck-mounted and shall be capable of water pressures of 2,000 to 40,000 psi. Operating pressures during

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

2.04 Grinding. The grinding equipment may be hand operated or mounted on a skid steer or other motorized vehicle. Adjustable skids or other means to control the depth of the grinding shall be used to prevent excessive grinding depths. Grinding equipment shall be subject to approval of the Engineer. Grinding equipment to be used on concrete pavements shall be used to remove the top most layers of paint, with clean up by water blasting methods. Grinding may be acceptable for complete obliteration of pavement markings should a light grind texture be left behind. Test sections shall be performed by the Contractor to verify that such equipment can consistently produce results as specified herein.

PERFORMANCE

3.01 Test Strip. The Contractor shall perform a test strip for each different pavement type and removal process used to demonstrate the ability of the equipment to do the work, ability of the operator to run the equipment, and the degree of marking obliteration.

3.02 Cleanup and Restoration. Immediately upon completion of each work period's removal operations, or more frequently if required by Airport Operations, the Contractor shall completely clean the work area of all debris, such as excess marking remnants, resulting from the pavement marking obliteration. Dust control is imperative during removal and cleanup operations. Methods to prevent dust generation will need to be employed.

Subsequent to water blasting, the pavement surface shall be flushed with high-pressure water (via water truck or similar) to remove the debris from the surface to be repainted. Subsequent to grinding, the surface shall be vacuumed, swept and blown with compressed air to adequately remove all dust particles left on the pavement surface. Cleaning with water may be required to remove residual grit if the compressed air cannot clean the surface adequately. Vacuum trucks alone are not sufficient means to remove all the debris and dust left after the removal process, however should be used to reduce the amount of dust generated.

All debris shall be disposed of off the airport property by the Contractor in a licensed landfill offsite in accordance with local laws and regulations, unless otherwise noted. No material shall be wasted on the airport site unless approved by the owner. This shall be considered subsidiary to the various bid items of the project. The Contractor shall not violate any local, state, or federal law or regulation in the disposal of the debris.

3.03 The Contractor shall furnish all equipment, water trucks and labor for delivery of water to the job site. The Contractor shall obtain all permits, pay all fees and provide to the Engineer the written approval of the authority having jurisdiction over the water source that all requirements for its use have been met.

3.04 The removal method applied to the surface shall not be damaging to concrete or asphalt surfaces, joint sealant material, or light fixtures. The Contractor shall prevent damage to existing joint sealant when removing pavement markings when the joint sealant is to remain in place. If it is deemed by the Engineer that damage to any existing facility is caused by an operational error, such as permitting a pressure water jet to dwell in one location for an extensive time, the Contractor shall repair said damage at no additional expense to the Owner. The Contractor shall cover or protect light fixtures within the removal area. Any damage to light fixtures or lenses shall be repaired at no additional expense to the Owner. The Contractor shall replace all damaged joints at no additional expense to the Owner.

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

The Contractor shall take precautions to protect the public from any damage due to his operations. Accumulation of sand, water, dust, or other residue resulting from the removal operation shall be removed as the work progresses and legally disposed of off airport property.

3.05 Pavement markings removal shall be defined as the removal of the existing markings at the degree specified in the table below.

Type of Marking Removal	Degree of Removal
Markings not to be Remarked	90% to 100%
Markings to be remarked in same location	85% to 95%

METHOD OF MEASUREMENT

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

BASIS OF PAYMENT

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

Payment will be made under:

Item 32 01 90.34-5.1 Pavement Marking Obliteration - Per Square Foot

End of Section 32 01 90.34

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 GENERAL.

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

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

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

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

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

101-3.2 REMOVAL OF EXISTING PAVEMENT.

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

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

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

All materials removed shall be disposed of as designated in the project demolition plans.

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 (1) foot (30 cm) inside the perimeter of the final removal limits or outside the dowels, whichever is greater when the limits of removal are located on the joints. The pavement between the perimeter of the pavement removal and the saw cut shall be carefully broken up and removed using hand-held jackhammers, weighing 30 pounds (14 kg) or less, or other light-duty equipment which will not cause distress in the pavement which is to remain in place. The Contractor shall ~~have the option of sawing through the dowels at the joint, removing the pavement~~ saw through the existing dowels and install~~ing~~ new dowels. The pavement shall be removed so the joint for each layer of pavement replacement is offset two (2) feet from the joint in the preceding layer.

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

Where the perimeter of the removal limits is not located on a joint and there are no dowels present, then the perimeter shall be saw cut the full depth of the pavement, including all underlying base and / or subbase layers also designated for removal. The pavement inside the saw cut shall be removed by methods suitable to the Engineer which will not cause distress in the pavement which is to remain in place. ~~If the material is to be wasted on the airport site, it shall be reduced to a maximum size designated by the Engineer.~~

The Contractor's removal operation shall not cause damage to cables, utility ducts, pipelines, or drainage structures under the pavement. Concrete slabs that are damaged by under breaking shall be removed. Any damage shall be repaired at the Contractor's expense.

b. Asphalt concrete pavement. Asphalt concrete pavement to be removed shall be sawcut 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 one (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 inches (mm).] [meet the following gradation:]~~

101-3.3 ~~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.~~

~~[Cracks and joints may be filled with a mixture of emulsified asphalt and aggregate. The aggregate shall consist of limestone, volcanic ash, sand, or other material that will cure to form a hard substance. The combined gradation shall be as shown in the following table.~~

~~Gradation~~

~~Sieve Size~~	~~Percent Passing~~
~~No. 4~~	~~100~~
~~No. 8~~	~~90-100~~
~~No. 16~~	~~65-90~~
~~No. 30~~	~~40-60~~
~~No. 50~~	~~25-42~~
~~No. 100~~	~~15-30~~
~~No. 200~~	~~10-20~~

~~Up to 3% cement can be added to accelerate the set time. The mixture shall not contain more than 20% natural sand without approval in writing from the Engineer.~~

~~The proportions of asphalt emulsion and aggregate shall be determined in the field and may be varied to facilitate construction requirements. Normally, these proportions will be approximately one part asphalt emulsion to five parts aggregate by volume. The material shall be poured or placed into the joints or cracks and compacted to form a voidless mass. The joint or crack shall be filled within 0 to 1/8 inches (0-3 mm) of the surface. Any material spilled outside the width of the joint shall be removed from the pavement surface prior to constructing the overlay. Where concrete overlays are to be constructed, only the excess joint material on the pavement surface and vegetation in the joints need to be removed.]~~

101-3.4 REMOVAL OF PAINT AND RUBBER.

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

Removal of paint and rubber shall be performed in accordance with Section 32 01 90.34, Removal of Markings.

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

a. Repair of concrete spalls in areas to be overlaid with asphalt. ~~The Contractors shall repair all spalled concrete as shown on the plans or as directed by the Engineer. The perimeter of the repair shall be saw cut a minimum of 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.~~

101-3.6 ~~COLD MILLING.~~

~~Milling shall be performed with a power-operated milling machine or grinder, capable of producing a finished surface that provides a good bond to the new overlay. The milling machine or grinder shall operate without tearing or gouging the under laying surface. The milling machine or grinder shall be equipped with automatic grade and slope controls. All millings shall be removed and disposed 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 [windrow the millings or cuttings] [remove the millings or cuttings from the pavement and load them into a truck].~~

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

101-3.7 ~~PREPARATION OF ASPHALT 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.

101-3.8 MAINTENANCE.

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

101-3.9 PREPARATION OF JOINTS IN RIGID PAVEMENT.

101-3.8.1 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.

101-3.10 PREPARATION OF CRACKS IN FLEXIBLE PAVEMENT.

101-3.9.1 Preparation of Crack. Widen crack with [router] [random crack saw] 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] [random crack saw]. Following [routing] [sawing] 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 of each layer of pavement material 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.

Payment will be made under:

Item P 101-5.1	Surface Reinforced Concrete Pavement Removal (Taxiway) – per square yard
Item P 101-5.2	Asphalt Bond Breaker Removal (Taxiway) – per square yard
Item P 101-5.3	Sublayer Reinforced Concrete Pavement Removal (Taxiway) – per square yard
Item P-101-5.4	Asphalt Shoulder Pavement Removal (Shoulder) – per square yard
Item P-101-5.5	Crushed Concrete Base Removal (Shoulder) – per square yard
~~Item P-101-5.6~~	~~Cement Stabilized Sand Removal (Shoulder) – per square yard~~
Item P-101-5.7	Pavement Transition (Between Phases) 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 Subgrade Excavation~~, Subgrade,~~ and Embankment

DESCRIPTION

152-1.1 This item covers subgrade excavation, ~~disposal, placement~~embankment, and ~~compaction~~disposal ~~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~~off airport property or as directed by the Engineer. ~~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~~off of airport property or as directed by the Engineer.

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 of off airport property or 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. Not used.

b. Undercutting. Not used.

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. Proof rolling. ~~After compaction is completed, the subgrade area~~After excavation, the subgrade under areas to be paved 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 one coverage, or as specified by the Engineer~~, to all paved areas~~. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be reworked to conform to the moisture content and compaction requirements in accordance with these specifications; treated with lime-fly ash as directed by the Engineer in accordance with Specification Section 31 32 13.26, "LIME/FLY ASH TREATED SUBGRADE"; or removed and replaced with suitable material as authorized by the Engineer.

f. Compaction requirements. ~~The subgrade under areas to be paved~~ Reworked subgrade beneath areas to be paved and replacement suitable material beneath areas to be paved shall be compacted to a depth of 8-inches and to a density of not less than 95 percent of the maximum density as determined by ASTM D698. 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). Material treated with lime/fly ash as authorized by the Engineer shall be compacted in accordance with Section 31 32 13.26 "LIME FLY-ASH TREATED SUBGRADE".

The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6

inches (150 mm) of the subgrade. The finished grading operations, conforming to the typical cross-section, shall be completed and maintained at least 1,000 feet (300 m) ahead of the paving operations or as directed by the Engineer.

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

Blasting shall not be allowed.

152-2.3 Borrow excavation. Not used.

152-2.4 Drainage excavation. Not used.

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 1000 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 698. Under all areas to be paved, the embankments shall be compacted to a depth of 8 inches and to a density of not less than 95 percent of the maximum density as determined by ASTM 698.

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.

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 [___] feet of runway pavement or [___] feet of taxiway pavement~~ Stockpiles shall placed in accordance with the Construction Safety and Phasing Plan or as directed by the Engineer 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 shall be the number of cubic yards (cubic meters) measured in its original position. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

152-3.2 The quantity of soft subgrade removed and replaced with suitable material shall be the number of cubic yards (cubic meters) measured in its original position. Measurement shall not include any quantity of materials excavated beyond the limits authorized by the Engineer.

152-3.3 For payment specified by the cubic yard (cubic meter), measurement for all excavation shall be computed by the average end area method. The end area is that bound by the original ground line and final ground line as established by field survey~~cross-sections and the final theoretical pay line established by excavation cross-sections shown on the plans~~, subject to verification by the Engineer. After completion of all excavation operations and prior to the placing of base or subbase material, the final excavation shall be verified by the Engineer by means of field cross-sections taken randomly at intervals not exceeding 500 linear feet (150 m).

BASIS OF PAYMENT

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

152-4.2 "Soft Subgrade Removal and Replacement with Suitable Material" payment shall be made at the contract unit price per cubic yard (cubic meter) for each identified type of soft subgrade removal and replacement with suitable material. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

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-156 TEMPORARY AIR AND WATER POLLUTION, SOIL EROSION, AND SILTATION CONTROL

DESCRIPTION

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

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

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

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

156-1.2 The Contractor shall develop a Pollution Prevention Plan to supplement the Owner's Stormwater Pollution Prevention Plan (SWPPP) as contained in the drawings. The plan shall be in strict compliance with the National Pollutant Discharge Elimination System (NPDES) permit issued or approved by the U.S. Environmental Protection Agency (EPA) pursuant to 40 CFR Part 122.6 and / or the Texas Pollutant Discharge Elimination System (TPDES) permit issued by the Texas Commission on Environmental Quality (TCEQ). The Plan shall address all measures to dispose of, control, or prevent the discharge of solid, hazardous and sanitary wastes to the waters of the U.S. The plan shall include procedures to control offsite tracking of soil by vehicles and construction equipment and procedures for cleanup and reporting of non-storm water discharges such as contaminated groundwater or accidental spills.

See Specification 01410 – TPDES Requirements for additional information.

156-1.3 Any permits that the Owner has obtained for any purpose such as NPDES, TPDES, SPCC, etc., does not include nor cover the Contractor's haul routes, equipment access points, staging areas, office compounds, materials stockpiles, blending and batch plant areas and operations or other project related activity areas outside the project limits or off site.

156-1.4 The Contractor shall prepare all required documentation, pay all fees and perform all services and work necessary to obtain all permits and approvals from any and all local, state and federal regulatory agencies for the Contractor's staging, stockpile, blending and batch plant areas and operations. The cost of all permitting shall be subsidiary to other items of work.

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

MATERIALS

~~**156-2.1 GRASS.**~~

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

~~**156-2.2 MULCHES.**~~

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

~~**156-2.3 FERTILIZER.**~~

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

~~**156-2.4 SLOPE DRAINS.**~~

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

156-2.5 ~~SILT FENCE~~ FILTER FABRIC BARRIERS.

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

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

156-2.6 INLET PROTECTION BARRIERS.

The inlet protection barriers shall consist of grate inlet protection, hay bales, bagged gravel, and filter fabric barriers, as applicable.

Filter fabric barriers shall be installed as described in Section 2.5.

Hay bales shall be standard-baled agricultural hay bound by wire, nylon, or polypropylene rope. Jute and cotton binding shall not be used.

Bagged gravel shall have a minimum unit weight of four (4) ounces per square yard, grab strength exceeding 100 psi in any principal direction (ASTM D4632), Mullen burst strength exceeding 300 psi (ASTM D3786), and ultraviolet stability exceeding 70 percent after 500 hours of exposure (ASTM D4355). Bagged gravel shall have approximate dimensions of 18 to 24 inches in length, 12 to 18 inches in width, 6 to 8 inches in thickness, and shall weigh approximately 40 to 50 pounds but not exceeding 75 pounds.

156-2.7 OTHER.

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

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

CONSTRUCTION REQUIREMENTS

156-3.1 GENERAL.

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

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

156-3.2 SCHEDULE.

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

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

156-3.3 CONSTRUCTION DETAILS.

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

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

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

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

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

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

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

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

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

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

156-3.5 INSTALLATION, MAINTENANCE AND REMOVAL OF INLET PROTECTION BARRIER 1.

Install filter fabric to lay inside the inlet grate, overlapping the frame by a minimum of two (2) inches.

Install bagged gravel and filter fabric barriers around inlets adjacent to earthwork disturbing activities and as shown in the plans.

Install inlet protection barriers to retain and accumulate sediment, but maintain inlet protection barriers to allow minimal inlet inflow restrictions and blockage during storm events. Maintain inlet protection barriers to remain in proper position and configuration at all times.

156-3.6 INSTALLATION, MAINTENANCE AND REMOVAL OF INLET PROTECTION BARRIER 2.

Install filter fabric to lay inside the inlet grate, overlapping the frame by a minimum of two (2) inches.

Install hay bales around inlets adjacent to earthwork disturbing activities and as shown in the plans. Install hay bales tightly abutting adjacent hay bales, embedded in soil a minimum of four (4) inches, and with bindings parallel to ground surface. Securely anchor hay bales in place with wood stakes, two (2) per hay bale, driven a minimum of eight (8) inches in to ground. Angle first stake in each hay bale toward previously laid hay bale to force hay bales together. Fill gaps between hay bales to prevent water from channeling between them. Replace hay bales every two (2) months, or as required by the Owner's representative.

Install inlet protection barriers to retain and accumulate sediment, but maintain inlet protection barriers to allow minimal inlet inflow restrictions and blockage during storm events. Maintain inlet protection barriers to remain in proper position and configuration at all times.

156-3.7 MAINTENANCE, INSPECTION, AND REPAIR.

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

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

Repair or replace damaged sections immediately.

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

156-3.8 EQUIPMENT MAINTENANCE AND REPAIR.

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

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

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

156-3.9 VEHICLE / EQUIPMENT WASHING AREAS.

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

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

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

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

METHOD OF MEASUREMENT

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

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

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

156-4.2 Control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured and paid for directly but shall be considered as a subsidiary obligation of the Contractor.

BASIS OF PAYMENT

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

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

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

Payment will be made under:

Item P-156-5.1	Installation and Removal of Filter Fabric Barriers - per linear feet
Item P-156-5.2	Installation and Removal of Inlet Protection Barrier 1 - per each
Item P-156-5.3	Installation and Removal of Inlet Protection Barrier 2 - per each

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
ASTM D3786	Standard Test Method for Hydraulic Bursting Strength for Knitted Goods and Nonwoven Fabrics
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
AC 150/5200-33	Hazardous Wildlife Attractants

END OF ITEM P-156

Item P-209 Crushed Aggregate Base Course and Subbase Course

DESCRIPTION

209-1.1 This item consists of ~~a~~ base and subbase courses composed of crushed aggregate ~~base~~ constructed on a prepared course in accordance with these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

MATERIALS

209-2.1 Crushed aggregate ~~base~~. Crushed aggregate shall consist of clean, sound, durable particles of crushed stone or crushed gravel, and shall be free from coatings of clay, silt, organic material, or other objectionable materials. Aggregates shall contain no clay lumps or balls. Fine aggregate passing the No. 4 (4.75 mm) sieve shall consist of fines from the coarse aggregate crushing operation. If necessary, fine aggregate may be added to produce the correct gradation. The fine aggregate shall be produced by crushing stone or gravel, that meet the coarse aggregate requirements for wear and soundness.

The coarse aggregate portion, defined as the material retained on the No. 4 (4.75 mm) sieve, shall not have a loss of greater than 45% when tested per 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. The aggregate shall contain no more than 15%, by weight, of flat, elongated, or flat and elongated particles per ASTM D4791. A flat particle is one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than three (3). The aggregate shall have at least 90% by weight of particles with at least two fractured faces and 100% with at least one fractured face per ASTM D5821. The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

a. Sampling and testing for initial aggregate ~~base~~ requirements. Samples shall be taken by the Contractor in the presence of the Engineer. Material shall meet the requirements in paragraph 209-2.1 and 209-2.2. This sampling and testing will be the basis for approval of the aggregate ~~base~~ quality requirements.

209-2.2 Gradation requirements. The gradation of the aggregate ~~base~~ material shall meet the requirements of the gradation given in the following table when tested per ASTM C117 and ASTM C136. The gradation shall be well graded from coarse to fine as defined by ASTM D2487 and shall not vary from the lower limit on one sieve to the high limit on an adjacent sieve or vice versa. The fraction of material passing the No. 200 (0.075 mm) sieve shall not exceed one-half the fraction passing the No. 40 (0.45 mm) sieve.

Requirements For Gradation Of Aggregate ~~Base~~

Sieve Size	Design Range Percentage by Weight	Contractor's Final Gradation	Job Control Grading Band Tolerances for Contractor's Final Gradation Percent
2 inch (50 mm)	100		0
1-1/2 inch (38 mm)	95-100		±5
1 inch (25 mm)	70-95		±8
3/4 inch (19 mm)	55-85		±8
No. 4 (4.75 mm)	30-60		±8
No. 40 (0.45 mm)	10-30		±5
No. 200 (0.075 mm)	0-8		±3

The "Job Control Grading Band Tolerances for Contractor's Final Gradation" in the table shall be applied to "Contractor's Final Gradation" to establish a job control grading band. The full tolerance still applies if application of the tolerances results in a job control grading band outside the design range.

a. Sampling and testing for gradation. Gradation tests shall be performed by the Contractor per ASTM C136 and sieve analysis on material passing the No. 200 sieve (75 mm) per ASTM C117. The Contractor shall take at least two aggregate ~~base~~ samples per lot to check the final gradation. Sampling shall be per ASTM D75. The lot will be consistent with the lot size used for density. The samples shall be taken from the in-place, un-compacted material in the presence of the Engineer. Sampling points and intervals will be designated by the Engineer.

CONSTRUCTION METHODS

209-3.1 Preparing underlying subgrade ~~and/or subbase~~. ~~The underlying subgrade and/or subbase shall be checked and accepted by the Engineer before base course placing and spreading operations begin. Re-proof rolling of the subgrade or proof rolling of the subbase in accordance with P-152, at the Contractor's expense, may be required by the Engineer if the Contractor fails to ensure proper drainage or protect the subgrade and/or subbase. Any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, shall be corrected before the base course is placed.~~The underlying subgrade shall be proof rolled in the presence of the Engineer 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). Apply a minimum of one coverage, or as specified by the Engineer. A coverage is defined as the application of one tire print over the designated area. Soft areas of material that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be reworked to conform to the moisture content and compaction requirements in accordance with Item P-152, "EXCAVATION, SUBGRADE, AND EMBANKMENT". If authorized by the Engineer; soft areas may be treated with lime/fly ash in accordance with Section 31 32 13.26 "LIME FLY-ASH TREATED SUBGRADE" or removed and replaced with suitable material in accordance with Item P-152, "EXCAVATION, SUBGRADE, AND EMBANKMENT". To ensure proper drainage, the spreading of the ~~base~~aggregates shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

209-3.2 Production. The aggregate shall be uniformly blended and, when at a satisfactory moisture content per paragraph 209-3.4, the approved material may be transported directly to the spreading equipment.

209-3.3 Placing. The aggregate ~~base material~~ shall be placed on the prepared underlying subgrade ~~and/or subbase~~ and compacted in layers to the thickness shown on the plans. Work shall progress without interruption. The material shall be deposited and spread in lanes in a uniform layer without segregation to such loose depth that, when compacted, the layer shall have the specified thickness. The aggregate ~~base~~ course shall be constructed in layers of uniform thickness of not less than 3 inches (75 mm) nor more than 6 inches (150 mm) of compacted thickness. The aggregate as spread shall be of uniform grading with no pockets of fine or coarse materials. The aggregate, unless otherwise permitted by the Engineer, shall not be spread more than 2,000 square yards (1700 sq m) in advance of the rolling. Any necessary sprinkling shall be kept within these limits. Care shall be taken to prevent cutting into the underlying layer during spreading. No material shall be placed in snow or on a soft, muddy, or frozen course. The aggregate ~~base material~~ shall be spread by spreader boxes or other approved devices. This equipment shall have positive thickness controls that spread the aggregate in the required amount to avoid or minimize the need for hand manipulation. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted ~~base~~ course shall not be permitted.

When more than one layer is required, the construction procedure described herein shall apply similarly to each layer.

209-3.4 Compaction. Immediately after completion of the spreading operations, compact each layer of the ~~base~~ course, as specified, with approved compaction equipment. The number, type, and weight of rollers shall be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade. The moisture content of the material during placing operations shall be within ±2 percentage points of the optimum moisture content as determined by ASTM D6938 using Procedure A, the direct transmission method. ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated per ASTM D6938.

209-3.5 Acceptance sampling and testing for density. Aggregate ~~base~~ course shall be accepted for density on a lot basis. A lot will consist of one day's production if it does not exceed 2,400 square yards (2000 sq m). A lot will consist of one-half day's production if a day's production consists of between 2,400 and 4,800 square yards (2000 and 4000 sq m). The Engineer shall perform all density tests**.**

Each lot shall be divided into two equal sublots. One test shall be made for each sublot and shall consist of the average of two random locations for density determination. Sampling locations will be determined by the Engineer on a random basis per ASTM D3665.

Each lot will be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens. The specimens shall be compacted and tested per ASTM 1557. The in-place field density shall be determined per ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the entire lot shall be reworked and/or recompacted and two additional random tests made at the Contractor's expense. This procedure shall be followed until the specified density is reached.

209-3.6 Surface tolerances. After the course has been compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and recompacted to grade. until the required smoothness and accuracy are obtained and approved by the Engineer. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's

expense. The smoothness and accuracy requirements specified here apply only to the top layer when ~~base~~ course is constructed in more than one layer.

a. Smoothness. The finished surface shall not vary more than 3/8 inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

b. Accuracy. The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +0 and -1/2 inch (12 mm) of the specified grade.

209-3.7 Thickness control. The thickness of the ~~base~~ course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the Engineer. Tests shall be taken at intervals representing no more than 300 square yards (250 sq m) per test. Sampling locations will be determined by the Engineer per ASTM D3665. Where the thickness is deficient by more than 1/2 inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. Additional test holes may be required to identify the limits of deficient areas. The Contractor shall replace, at his expense, ~~base~~ material where depth tests have been taken.

209-3.8 Protection. Perform construction when the atmospheric temperature is above 35°F (2°C). When the temperature falls below 35°F (2°C), protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements. When the aggregates contain frozen materials or when the underlying course is frozen or wet, the construction shall be stopped. Hauling equipment may be routed over completed portions of the ~~base~~ course, provided no damage results. Equipment shall be routed over the full width of the ~~base~~ course to avoid rutting or uneven compaction. The Engineer will stop all hauling over completed or partially completed ~~base~~ course when, in the Engineer's opinion, such hauling is causing damage. Any damage to the ~~base~~ course shall be repaired by the Contractor at the Contractor's expense.

209-3.9 Maintenance. The Contractor shall maintain the ~~base~~ course in a satisfactory condition until the full pavement section is completed and accepted by the Engineer. The surface shall be kept clean and free from foreign material and properly drained at all times. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any ~~base~~ course that is not paved over prior to the onset of winter shall be retested to verify that it still complies with the requirements of this specification. Any area of ~~base~~ course that is damaged shall be reworked or replaced as necessary to comply with this specification.

Equipment used in the construction of an adjoining section may be routed over completed ~~base~~ course, if no damage results and the equipment is routed over the full width of the ~~base~~ course to avoid rutting or uneven compaction.

The Contractor shall remove all survey and grade hubs from the ~~base~~ courses prior to placing any bituminous surface course.

METHOD OF MEASUREMENT

209-4.1 The quantity of crushed aggregate base course and subbase course will be determined by measurement of the number of square yards (square meters) of material actually constructed and accepted by the Engineer as complying with the plans and specifications. ~~Base~~ Materials shall not be included in any other excavation quantities.

BASIS OF PAYMENT

209-5.1 Payment shall be made at the contract unit price per square yard (square meter) for each identified thickness of aggregate base course and subbase course. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

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 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 D75	Standard Practice for Sampling Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN -m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2700 kN-m/m^3))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4718	Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

END OF ITEM P-209

Intentionally Left Blank

Item P-219 Recycled Concrete Aggregate Base Course and Subbase Course

DESCRIPTION

219-1.1 This item consists of a base course and subbase course composed of recycled concrete aggregate, crushed to meet a particular gradation, constructed on a prepared course per these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

MATERIALS

219-2.1 Aggregate. Recycled concrete aggregate shall consist of portland cement concrete (PCC) or other concrete containing pozzolanic binder material. The recycled concrete material shall be free of reinforcing steel and expansion material. Asphalt concrete overlays shall be removed from the PCC surface prior to pavement removal and crushing. Any full-slab asphalt concrete panels (used as a replacement for a removed PCC slab) shall also be removed. An incidental amount of recycled asphalt concrete pavement may be present in the recycled concrete aggregate.

Concrete that exhibits deterioration from alkali-silica reaction (ASR), in the opinion of the Engineer, shall not be used for recycled concrete aggregate.

Recycled concrete aggregate ~~base~~ course shall consist of at least 90%, by weight, Portland cement concrete, with the remaining ~~10% consisting of the following materials:~~percentage consisting of incidental asphalt concrete:

~~Wood~~	~~0.1% maximum~~
~~Brick, mica, schist, or other friable materials~~	~~4% maximum~~
~~Asphalt concrete~~	~~10% maximum~~

Virgin aggregates may be added to meet the 90% minimum PCC requirement.

The percentage of ~~wood, brick, mica, schist, other friable materials, and~~ asphalt concrete shall be determined by weighing that material retained on the No. 4 sieve, and dividing by the total weight of recycled concrete aggregate material retained on the No. 4 sieve.

The fine aggregate shall be produced by crushing stone, gravel, slag, or recycled concrete that meet the requirements for wear and soundness specified for coarse aggregate. Fine aggregate may be added to produce the correct gradation.

The amount of flat and elongated particles in recycled concrete aggregate shall not exceed 20% for the fraction retained on the 1/2 inch (12 mm) sieve nor 20% for the fraction passing the 1/2 inch (12 mm) sieve when tested per ASTM D4791. A flat particle is one having a f width to thickness ratio greater than 3; an elongated particle is one having a length to width ratio greater than 3.

The percentage of wear shall not be greater than 45% when tested per ASTM C131. The sodium sulfate soundness test (ASTM C88) requirement is waived for recycled concrete aggregate.

The fraction passing the No. 40 (0.42-mm) sieve shall have a liquid limit no greater than 25 and a plasticity index of not more than four (4) when tested per ASTM D4318. The fine aggregate shall have a minimum sand equivalent value of 35 when tested per ASTM D2419.

a. Sampling and testing. Recycled concrete aggregate samples for preliminary testing shall be furnished by the Contractor prior to the start of base or subbase construction. All tests for initial aggregate submittals necessary to determine compliance with the specification requirements will be made by the Engineer at no expense to the Contractor.

Samples of recycled concrete aggregate shall be furnished by the Contractor at the start of production and at intervals during production. The sampling points and intervals will be designated by the Engineer. The samples will be the basis of approval of specific lots of recycled concrete aggregate for the quality requirements.

Samples of recycled concrete aggregate to check gradation shall be taken at least once daily. Sampling shall be per ASTM D75, and testing shall be per ASTM C136 and ASTM C117.

b. Gradation requirements. The gradation (job mix) of the final mixture shall fall within the design range indicated in the following table, when tested per ASTM C117 and ASTM C136. The final gradation shall be continuously graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on an adjacent sieve or vice versa.

Requirements for Gradation Of Recycled Concrete Aggregate ~~Base~~

Sieve Size	Percentage by Weight Passing Sieves	Job Mix Tolerances Percent
2 inch (50 mm)	100	--
1-1/2 inch (38 mm)	95 - 100	±5
1 inch (25 mm)	70 - 95	±8
3/4 inch (19 mm)	55 - 85	±8
No. 4 (4.75 mm)	30 - 60	±8
No. 30 (0.60 mm)	12 - 30	±5
No. 200 (0.075 mm)	0 - 5	±3

The job mix tolerances in the table shall be applied to the job mix gradation to establish a job control gradation band. The full tolerance still will apply if application of the tolerances results in a job control gradation band outside the design range.

EQUIPMENT

219-3.1 General. All equipment necessary to mix, transport, place, compact, and finish the recycled concrete aggregate ~~base~~ course shall be furnished by the Contractor. The Contractor shall provide written certification to the Engineer that all equipment meets the requirements for this section. The equipment shall be inspected by the Engineer at the job site prior to the start of construction operations.

219-3.2 Mixing equipment. ~~Base~~ Course shall be thoroughly mixed in a plant suitable for recycled concrete aggregate. The mixer shall be a batch or continuous-flow type equipped with a calibrated metering and feeding device that introduce the aggregate and water into the mixer in specified quantities. If necessary, a screening device shall be installed to remove oversized material greater than 2 inches (50 mm) from the recycled concrete aggregate feed.

The Engineer shall have access to the plant at all times for inspection of the plant's equipment and operation and for sampling the mixed recycled concrete aggregate materials.

219-3.3 Hauling equipment. The mixed recycled concrete aggregate ~~base~~ course shall be transported from the plant to the job site in hauling equipment having beds that are smooth, clean, and tight. Truck bed covers shall be provided and used to protect the mixed recycled concrete aggregate ~~base~~ course from rain during transport.

219-3.4 Placing equipment. Recycled concrete aggregate shall be placed using a mechanical spreader or machine capable of receiving, spreading, and shaping the material into a uniform layer or lift without segregation. The placing equipment shall be equipped with a strike off plate that can be adjusted to the layer thickness.

219-3.5 Compaction equipment. Recycled concrete aggregate ~~base~~ course shall be compacted using one or a combination of the following pieces of equipment: steel-wheeled roller; vibratory roller; pneumatic-tire roller; and/or hand-operated power tampers (for areas inaccessible to rollers).

219-3.6 Finishing equipment. Trimming of the compacted recycled concrete aggregate to meet surface requirements shall be accomplished using a self-propelled grader or trimming machine, with a mold board cutting edge of 12 feet (3.7 m) minimum width automatically controlled by sensors in conjunction with an independent grade control from a taut stringline. Stringline will be required on both sides of the sensor controls for all lanes.

CONSTRUCTION METHODS

219-4.1 Weather limitations. Construction is allowed only when the atmospheric temperature is at or above 35°F (2°C). When the temperature falls below 35°F (2°C), the Contractor shall protect all completed areas against detrimental effects of freezing. The Contractor shall repair any areas damaged by freezing, rainfall, or other weather conditions.

219-4.2 Preparing underlying ~~course~~subgrade. ~~The underlying course shall be checked by the Engineer before placing and spreading operations are started. Any ruts or soft yielding places caused by improper drainage conditions, hauling, or any other cause shall be corrected at the Contractor's expense before the base course is placed there.~~The underlying subgrade shall be proof rolled in the presence of the Engineer 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). Apply a minimum of one coverage, or as specified by the Engineer. A coverage is defined as the application of one tire print over the designated area. Soft areas of material that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be reworked to conform to the moisture content and compaction requirements in accordance with Item P-152, "EXCAVATION, SUBGRADE, AND EMBANKMENT". If authorized by the Engineer; soft areas may be treated with lime/fly ash in accordance with Section 31 32 13.26 "LIME FLY-ASH TREATED SUBGRADE" or removed and replaced with suitable material in accordance with Item P-152, "EXCAVATION, SUBGRADE, AND EMBANKMENT". Material shall not be placed on frozen material.

To protect the existing layers and to ensure proper drainage, the spreading of the recycled concrete aggregate ~~base~~ course shall begin along the centerline of the pavement on a crowned section or on the greatest contour elevation of a pavement with a variable uniform cross slope.

219-4.3 Grade control. Grade control between the edges of the recycled concrete aggregate ~~base~~ course lanes shall be accomplished by grade stakes, steel pins, or forms placed in lanes parallel to the centerline and at intervals of 50 feet (15 m) or less on the longitudinal grade and 25 feet (7.5 m) or less on the transverse grade.

219-4.4 Mixing. The recycled concrete shall be uniformly blended during crushing operations and mixed with water in a mixing plant suitable for recycled concrete aggregate. The plant shall blend and mix the materials to meet the specifications and to secure the proper moisture content for compaction.

219-4.5 Placing. The recycled concrete aggregate ~~base~~ material shall be placed on the moistened subgrade ~~or base~~ in layers of uniform thickness with an approved mechanical spreader.

The maximum depth of a compacted layer shall be 6 inches (150 mm). If the total depth of the compacted material is more than 6 inches (150 mm), it shall be constructed in two or more layers. In multi-layer construction, the material shall be placed in approximately equal-depth layers.

The previously constructed layer shall be cleaned of loose and foreign material prior to placing the next layer. The surface of the compacted material shall be kept moist until covered with the next layer.

Adjustments in placing procedures or equipment shall be made to obtain grades, to minimize segregation grading, to adjust the water content, and to ensure an acceptable recycled concrete aggregate ~~base~~ course.

219-4.6 Compaction. Immediately after completion of the spreading operations, the recycled concrete aggregate shall be compacted. The number, type, and weight of rollers shall be sufficient to compact the material to the required density.

Each layer of the recycled concrete aggregate ~~base~~ course shall be compacted to the required density using the compaction equipment. The moisture content of the material during placing operations shall be within ±1-1/2 percentage points of the optimum moisture content as determined by ASTM D1557.

The compaction shall continue until each layer has reached compaction that is at least 100% of the laboratory maximum density through the full depth of the layer. The Contractor shall make adjustments in compacting or finishing techniques to obtain true grades, to minimize segregation and degradation, to reduce or increase water content and to ensure a satisfactory ~~base~~ course. Any unsatisfactory materials shall be removed and replaced with satisfactory material or reworked, to meet the requirements of this specification.

219-4.7 Acceptance sampling and testing for density. The Engineer shall perform all density tests. Recycled concrete aggregate shall be accepted for density on a lot basis. A lot will consist of one day's production where it does not exceed 2,400 square yards (2000 sq m) per lift. A lot will consist of one-half day's production, where a day's production is between 2,400 and 4,800 square yards (2000 and 4000 sq m) per lift.

Each lot shall be divided into two equal sublots. One density test shall be made for each sublot and shall consist of the average of two random locations for density determination. Sampling locations will be determined by the Engineer on a random basis per ASTM D3665.

Each lot will be accepted for gradation when it falls within the limits and tolerances shown in the table above when tested per ASTM C117 and ASTM ~~C131~~C136. If the proper gradation is not attained the gradation test will be repeated. If the re-test does not indicate gradations within the limits of the table above, the entire lot shall be rejected and replaced by the Contractor at the Contractor's expense.

Each lot will be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens prepared from samples of the ~~base~~ course material. The specimens shall be compacted and tested per ASTM D1557. The in-place field density shall be determined per ASTM D6938. The field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method and the machines shall be calibrated in accordance with per ASTM D6938. When using the nuclear method, ASTM D4643 shall be used to determine the moisture content of the material. If the specified density is not attained, the entire lot shall be reworked and two additional random tests made. This procedure shall be followed until the specified density is reached.

219-4.8 Finishing. The surface of the recycled concrete aggregate ~~base~~ course shall be finished by equipment designed for this purpose.

Adding a thin layer of material to the top of the ~~base~~ course to meet grade shall not be allowed. If the elevation of the layer is 1/2 inch (12 mm) or more below grade, the layer shall be scarified to a depth of at least 3 inches (75 mm), new material added, and the layer shall be recompacted. If the finished surface is above plan grade, it shall be cut back to grade and rerolled. The grade shall be measured on a maximum 25-foot (7.5-m) grid (longitudinal and transverse). Thickness results shall be furnished to the Engineer daily for acceptance determination.

Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, and recompacted or replaced at the Contractor's expense.

219-4.9 Surface tolerances. The finished surface shall not vary more than 3/8 inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with or at right angles to the centerline. The Contractor shall correct any deviation in excess of this amount, at the Contractor's expense.

219-4.10 Thickness control. The completed thickness of the ~~base~~ course shall be within 1/2 inch (12 mm) of the design thickness. Four thickness determinations shall be made for each lot of material placed. Each lot shall be divided into four equal sublots and one test shall be made for each sublot. Sampling locations will be determined per ASTM D3665. Where the thickness is more than 1/2 inch (12 mm) deficient, the Contractor, at his or her expense, shall correct the areas by excavating to the required depth and replacing with new material. Additional test holes may be required to identify the limits of deficient areas.

219-4.11 Traffic. Equipment used in construction may be routed over completed portions of the ~~base~~ course, provided there is no damage to the ~~base~~ course. The equipment shall be routed evenly over the full width of the ~~base~~ course to avoid rutting or uneven compaction.

219-4.12 Maintenance. The ~~base~~ course shall be maintained until the ~~base~~ course is completed and accepted. Maintenance will include immediate repairs to any defects and shall be repeated as often as necessary to keep the completed work intact. The Contractor, at his or her expense, will rework any area of the recycled concrete aggregate ~~base~~ course that is damaged.

METHOD OF MEASUREMENT

219-5.1 The quantity of recycled concrete aggregate base course and subbase course shall be measured by the number of square yards (square meters) of material actually constructed and accepted as complying with the plans and specifications.

BASIS OF PAYMENT

219-6.1 Payment shall be made at the contract unit price per square yard (square meter) for each indicated thickness of aggregate base course and subbase course. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

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 D75	Standard Practice for Sampling Aggregates
ASTM C117	Standard Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregate
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN -m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2700 kN-m/m^3))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber-Balloon Method
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating
ASTM D4718	Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

END OF ITEM P-219

Item P-304 Cement-Treated Base Course

DESCRIPTION

304-1.1 This item shall consist of a cement-treated base (CTB) course composed of mineral aggregate and cement, uniformly blended and mixed with water. The mixed material shall be spread and shaped with a mechanical spreader, and compacted with rollers in accordance with these specifications and in conformance to the lines, grades, dimensions, and cross-sections shown on the plans.

MATERIALS

304-2.1 Aggregate. The aggregate shall be select granular materials, comprised of crushed or uncrushed gravel and/or stone, or recycled crushed and graded portland cement concrete (PCC). The material shall be free of roots, sod, and weeds. The crushed or uncrushed aggregate shall consist of hard, durable particles of accepted quality, free from an excess of soft, flat, elongated, or disintegrated pieces, and objectionable matter. The method used to produce the aggregate shall ensure the finished product is as consistent as practicable. All inferior quality stones and rocks shall be wasted. If recycled PCC is used as the aggregate, it must meet the requirements for virgin aggregate.

The percentage of wear of the crushed aggregate retained on the No. 4 (4.75-mm) sieve shall not be greater than 40% when tested in accordance with ASTM C131. The sodium sulfate soundness loss shall not exceed 10%, or the magnesium sulfate soundness loss shall not exceed 15%, after five cycles, when tested in accordance with ASTM C88.

When tested in accordance with ASTM C136, the aggregate shall conform to the gradation(s) shown in the table below (titled Aggregate Gradation for CTB Material). An aggregate blend that meets the requirements of the table shall be selected by the Contractor and used in the final mix design. The final aggregate blend shall be well graded from coarse to fine within the limits designated in the table and shall not vary from the low limit on one sieve to the high limit on adjacent sieves, or vice versa. The portion of final aggregate blend passing the No. 40 (425 μm) sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than six (6) when tested in accordance with ASTM D4318.

Aggregate Gradation for CTB Material

Sieve Size	Percentage by Weight Passing Sieves	
	Gradation A	Gradation B
2 inch (50 mm)	100 [1]	100 [1]
No. 4 (4.75 mm)	45 - 100	55 - 100
No. 10 (1.80 mm)	37 - 80	45 - 100
No. 40 (450 μm)	15 - 50	25 - 80
No. 80 (210 μm)	0 - 25	10 - 35

[1] Maximum nominal size of aggregate is 1 inch (25 mm).

All aggregate samples required for testing shall be furnished by the Contractor at the expense of the Contractor. Sampling shall be performed by the Contractor in accordance with ASTM D75.

304-2.2 Cement. Cement shall conform to the requirements of ASTM C150 Type I or II.

304-2.3 Cementitious additives. Pozzolanic and slag cement may be added to the CTB mix. If used, each material must meet the following requirements:

a. Pozzolan. Pozzolanic materials must meet the requirements of ASTM C618, Class F, or N with the exception of loss of ignition, where the maximum shall be less than 6%.

b. Slag Cement. Slag shall conform to ASTM C989, Grade 80, 100, or 120.

304-2.4 Water. Water used in mixing or curing shall be potable, clean and free of oil, salt, acid, alkali, sugar, vegetable, or other deleterious substances injurious to the finished product.

304-2.5 Curing materials. For curing CTB placed under PCC pavement, use white-pigmented, liquid membrane-forming compound conforming to ASTM C309, Type 2, Class A or Class B (wax-based).

COMPOSITION OF MIXTURE

304-3.1 General. The CTB material shall be composed of a mixture of aggregate, cementitious material, and water. Fly ash or slag cement may be used as a partial replacement for Portland cement.

304-3.2 Mix design. The mix design shall use a cement content that, when tested in the laboratory per ASTM D1633, produces a 7-day compressive strength between 400 pounds per square inch (2758 kPa) minimum and 800 pounds per square inch (5516 kPa) maximum. The 28-day strength shall not exceed ~~1000~~1500 pounds per square inch (6895 kPa).

The mix design shall include a complete list of materials, including type, brand, source, and amount of cement, fine aggregate, coarse aggregate, water, and cementitious additives.

Should a change be made in aggregate sources or type of cement, or if cementitious additives are added or deleted from the mix, production of the CTB mix shall be stopped and a new mix design shall be submitted.

304-3.3 Submittals. At least 30 days prior to the placement of the CTB, the Contractor shall submit certified test reports to the Engineer for those materials proposed for use during construction, as well as the mix design information for the CTB material. Tests older than six (6) months shall not be used. The certification shall show the ASTM or AASHTO specifications or tests for the material, the name of the company performing the tests, the date of the tests, the test results, and a statement that the material did or did not comply with the applicable specifications. The submittal package shall include the following:

a. Source(s) of materials, including aggregate, cement, cementitious additives, curing, and bond-breaking materials.

b. Physical properties of the aggregates, cement, cementitious additives, curing, and bond-breaking materials.

c. Mix design:

- Mix identification number
- Aggregate gradation
- Cement content
- Water content
- Cementitious materials content

d. Laboratory test results:

- Compaction and strength test procedures
- Laboratory compaction characteristics (maximum dry density and optimum moisture content)
- Compressive strength at seven (7) days
- Wet-dry and/or freeze-thaw weight loss, if applicable

No CTB material shall be placed until the submittal is accepted in writing by the Engineer.

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

EQUIPMENT

All equipment necessary to mix, transport, place, compact, and finish the CTB material shall be furnished by the Contractor. The equipment shall be inspected and approved by the Engineer at the job site prior to the start of construction operations.

304-4.1 Mixing. The mixer shall be a batch or continuous-flow type stationary mixer. The mixer shall be equipped with calibrated metering and feeding devices that introduce the aggregate, cement, water, and cementitious additives (if used) into the mixer in the specified quantities. If necessary, a screening device shall be used to remove oversized material greater than 2 inches (50 mm) from the raw aggregate feed prior to mixing.

The Engineer shall have free access to the plant at all times for inspection of the plant's equipment and operation and for sampling the CTB mixture and its components.

304-4.2 Hauling. The mixed CTB material shall be transported from the plant to the job site in trucks or other hauling equipment having beds that are smooth, clean, and tight. Truck bed covers shall be provided and used to protect the CTB from rain. CTB material that becomes wet during transport shall be rejected.

304-4.3 Placing. CTB material shall be placed using a mechanical spreader or a machine capable of receiving, spreading, and shaping the mixture without segregation into a uniform layer or lift. The equipment shall be equipped with a strike-off plate capable of being adjusted to the specified layer thickness. It shall also be equipped with two end gates or cut off plates, so that the CTB may be spread in widths varying up to lane width.

304-4.4 Compaction. Compaction of the CTB layer shall be accomplished using one or a combination of the following pieces of equipment: tamping or grid roller; steel-wheeled roller; vibratory roller; pneumatic-tire roller, and/or vibrating plate compactor (for areas inaccessible to rollers). The number, type, and weight of rollers and/or compactors shall be sufficient to compact the mixture to the required density.

304-4.5 Finishing. Final trimming of the compacted CTB to meet surface requirements shall be accomplished using a self-propelled grader or trimming machine, with a mold board cutting edge, which is at least 12 feet (3.7 m) wide and is automatically controlled by sensors in conjunction with an independent grade control from a taut stringline. Stringline will be required on both sides of the sensor controls for the pilot lane. For all other lanes, a single stringline on the outside and grade matching with previously completed adjacent lanes is permissible.

CONSTRUCTION METHODS

304-5.1 Weather limitations.

304-5.1.1 Cold weather. Do not construct base when weather conditions will detrimentally affect quality of the finished course. Apply cement when the ambient temperature is a minimum of 40°F (4°C) and rising. Do not apply cement to aggregate materials that are frozen or contain frost. If ambient temperature falls below 40°F (4°C), protect completed cement-treated areas against freezing. Reprocess, reshape, and recompact damaged material. The CTB shall not be placed on frozen surfaces. Provide drainage to prevent water from collecting or standing on stabilized areas, and on the pulverized, mixed, or partially mixed materials.

304-5.1.2 Rain. The CTB may not be placed when it is raining. If unexpected rain occurs during placement, the layer should be quickly compacted. CTB material that becomes wet by rain during transport or placement shall be evaluated by the Engineer, and may be rejected.

304-5.2 Preparation of underlying course. The underlying course shall be checked by the Engineer before placing and spreading operations are started, to ensure that it is free of any ruts, depressions, or bumps and is finished to the correct grade. Any ruts or soft yielding places shall be corrected before the CTB mixture is placed. The underlying course shall be wetted in advance of placing the CTB layer. The final prepared grade prior to placing the CTB should be in a firm and moist condition free of frost. Use of chemicals to eliminate frost will not be permitted.

To ensure proper drainage, placement of the base shall begin along the centerline of the pavement on a crowned section or on the highest elevation contour of a pavement with variable cross slope.

304-5.3 Grade control. Grade control between the edges of the CTB shall be accomplished at intervals of 50 feet (15 m) or less on the longitudinal grade and at 25 feet (7.5 m) or less on the transverse grade.

304-5.4 Handling, measuring, and batching. The continuous flow central plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Aggregate stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials. Aggregates that are segregated or mixed with earth or foreign material will not be accepted.

Continuous flow plants shall be equipped with feeders to automatically and accurately proportion aggregates and bulk cement, by weight. When bulk cement is used, the Contractor shall use a suitable method of handling the cement such as a chute, boot or other device, to prevent loss of cement between the weigh hopper and mixer. The device shall provide positive assurance that the specified cement content is present in each batch.

304-5.5 Mixing. Aggregate and cement may be proportioned either by weight or volume, and shall be mixed sufficiently to prevent the forming of cement balls when water is added. The mixing time shall be that required to secure a well-blended, uniform mixture of aggregate, cement, water, and pozzolan (if used). The minimum mixing time will be based on the uniformity and consistency of the mixture.

304-5.6 Placing. The CTB mixture shall be deposited on the moistened subgrade or subbase and spread into a uniform layer of specified width and thickness that, when compacted and trimmed, conforms to the required line, grade, and cross-section. The Contractor may install the CTB layer in single or multiple compacted lifts; however, each compacted lift must be no greater than 6 inches (150 mm) thick. In multi-lift construction, the surface of the compacted lift shall be kept moist until covered with the next lift. Successive lifts shall be placed and compacted so that the required total depth of the CTB layer is completed within 12 hours.

A single spreader may be used, provided it is capable of placing a uniform, full-depth layer of material across the full width of the base in one pass. Otherwise, two or more spreaders will be required, and shall be operated so that spreading progresses along the full width of the base in a uniform manner.

304-5.7 Compaction. Immediately upon completion of the spreading operations, the CTB material shall be thoroughly compacted using approved compaction equipment. At the start of compaction, the moisture content shall be within ±2 percentage points of the specified optimum moisture.

304-5.8 Finishing. After completing compaction, the surface of the CTB layer shall be shaped to the specified lines, grades, and cross-section. During the finishing process, the surface shall be kept moist by means of fog-type sprayers. Compaction and finishing shall produce a smooth, dense surface, free of ruts, cracks, ridges, and loose material. All placement, compaction, and finishing operations shall be completed within two (2) hours from the start of mixing. Material not completed within the 2-hour time limit shall be removed and replaced at the Contractor's expense.

CTB layer limits that extend beyond the edges of the new PCC surface course shall be rolled down or shaped to ensure the drainage is away from the new PCC surface course edge.

304-5.9 Construction joints. At the end of each day's construction, a transverse construction joint shall be formed that is a true vertical face (perpendicular to the centerline) and is free of loose material.

Longitudinal construction joints (parallel to the centerline) shall be formed to a consistent, well-defined vertical edge that is free of loose material. The longitudinal joints shall be located so there is a 2-foot (0.6-m) minimum offset from planned joints in any overlying layer.

While forming construction joints, the Contractor shall make sure the material in the joint area is adequately compacted and that the joints are finished level and even with the remainder of the CTB layer.

304-5.10 Curing. The compacted and finished CTB shall be cured with the approved curing agents as soon as possible and in no case later than two (2) hours after completion of the finishing operations. The layer shall be kept moist using a moisture-retaining cover or a light application of water until the curing material is applied.

~~When a liquid membrane-forming curing compound is used as the curing agent, t~~The surface of the CTB layer shall be uniformly sprayed with the liquid membrane-forming curing compound at the rate of one gallon (3.8 liters) to not more than 200 square feet (18.6 m^2) to obtain a uniform cover over the surface. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. The curing compound shall be thoroughly and uniformly mixed with the pigment in the storage tank. During application, the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and CTB surfaces exposed by the removal of forms is permitted.

The curing seal shall be maintained and protected until the pavement is placed. If the surface of the finished CTB and/or the curing seal becomes damaged, additional curing material shall be applied at the time it is damaged or when the damage is first observed.

304-5.11 Protection. Completed portions of the cement-stabilized area may be opened to local traffic provided the curing process is not impaired and to other traffic after the curing period has elapsed, provided that the cement-stabilized course has hardened sufficiently to prevent surface marring or distortion by equipment or traffic. Do not permit construction equipment on the area during protection and curing periods. Necessary cement and water may be hauled over the area with pneumatic-tired equipment on approval of the Engineer. Protect finished portions of cement stabilized base from traffic of equipment used in constructing adjoining sections in a manner to prevent marring or damaging completed work. The CTB shall also be protected from freezing at all times.

304-5.12 Bond-breaker. When the CTB is to be placed directly beneath PCC, the entire surface of the CTB shall be coated with a de-bonding compound applied in a ~~quality~~quantity sufficient to prevent bonding of the PCC pavement to the base course. ~~If an impervious membrane or asphalt emulsion is used as a curing material~~If the liquid membrane forming curing compound is used as the bond breaker, additional applications of curing materials may be required. The Contractor shall be responsible for selecting the de-bonding compound and determining the necessary application rate. The de-bonding compound shall be approved by the Engineer, applied to a test section of approved area, and the test section accepted by the Owner prior to being incorporated into the remaining work. The Contractor shall provide for a representative of the de-bonding compound manufacturer to be present during application of the material to the test section. The manufacturer's representative shall confirm in writing to the Owner that the de-bonding compound has been applied in accordance with the manufacturer's requirements.

MATERIAL ACCEPTANCE

304-6.1 Acceptance sampling and testing. All acceptance sampling and testing, with the exception of thickness determination, necessary to determine conformance with the requirements specified in this section will be performed by the Engineer. The Contractor shall provide the required CTB samples during construction for acceptance testing purposes. The samples shall be taken in the presence of the Engineer.

Testing organizations performing these tests shall meet the requirements of ASTM D3666. All test equipment in Contractor-furnished laboratories shall be calibrated by the testing organization prior to the start of operations.

The CTB layer shall be tested for density, thickness, grade, and surface tolerance on a lot basis, with a lot consisting of either (1) one day's production not to exceed 2,000 square yards (1700 sq m), or (2) a half day's production, where a day's production consists of 2,000 to 4,000 square yards (1675 to 3350 m^2).

Each lot shall be divided into four equal sublots. Within each sublot, one density test, one thickness measurement, and continuous surface straightedge tests (surface tolerance testing) shall be performed, as described below. Sampling locations shall be determined by the Engineer per ASTM D3665.

If only three sublots are produced, the three sublots shall constitute a complete lot. If one or two sublots are produced for the same reason, they shall be incorporated into the next or previous lot, and the total number of sublots shall be used in the acceptance criteria calculation.

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

304-6.1.1 Density testing. CTB samples shall be taken from each sublot and used to create laboratory test specimens representing the various sublots. The specimens shall be compacted and tested for density and moisture content per ASTM D558. The density for each sublot comprising a lot, shall be used to determine an average density for the lot, which will serve as the basis for acceptance of the lot for density.

Within each sublot in the field, one in-place density test shall be performed in accordance with ASTM D6938. The location of the test shall be randomly selected per ASTM D3665. The in-place density for each sublot comprising the lot shall be averaged and compared with the corresponding average lot density. Acceptance criteria for CTB density are provided in paragraph 304-6.2.1. All testing shall be done by the Engineer.

304-6.1.2 Thickness testing. The CTB shall be tested for thickness using the same lot and sublots established for density testing. After three (3) days of curing, one 3-inch (75 mm) diameter core per sublot shall be obtained from a random location, per ASTM D3665. The thickness of each sampled core shall be determined using the caliper measurement procedures provided in ASTM C174. The average thickness for the lot shall be determined using the individual sublot core thicknesses. Acceptance criteria for CTB thickness are provided in paragraph 304-6.2.2. At all locations where cores have been drilled, the resulting core holes shall be filled by the Contractor with CTB or non-shrink grout.

304-6.1.3 Grade testing. The elevations of the finished CTB shall be surveyed every 25 feet (7.5 m) on both sides of the CTB lane as soon as it has hardened sufficiently. Acceptance criteria for CTB grade are provided in paragraph 306-6.2.3.

304-6.1.4 Surface tolerance testing. After the CTB has hardened sufficiently, it shall be tested for surface tolerance with a 12-foot (3.7-m) straightedge or other approved measuring device for tolerances outlined in paragraph 304-6.2.

304-6.2 Acceptance criteria. Acceptance of CTB will be based on density, thickness, grade, and surface tolerance, as described in the paragraphs below.

304-6.2.1 Density requirements. For density, each lot of compacted material will be accepted without adjustment if the average in-place density of the lot is equal to or greater than 98% of the average laboratory density determined for the lot. Each lot of compacted CTB shall be accepted and payment adjusted in accordance with the table below.

Sliding Pay Scale Factors For Density

Average Dry Density (%)	Payment (%)
98.0 and greater	100
97.0 - 97.9	95
96.0 - 96.9	90
95.0 - 95.9	75
Less than 95.0	Reject

If the average density is below 95%, the lot will be rejected and shall be removed and replaced at the Contractor's expense. In multi-layer construction, density shall be tested for each lift, and all lifts within a rejected lot shall be removed and replaced. No payment shall be made for removed lifts. Replacement lifts shall be paid in accordance with this section.

304-6.2.2 Thickness requirements. The completed thickness shall be as shown on the plans. When the average lot thickness is not deficient by more than 1/2 inch (12 mm) from the plan thickness, full payment shall be made. If the average lot thickness is deficient by more than one inch (25 mm), it shall be removed and replaced at the Contractor's expense. When such measurement is deficient by more than 1/2 inch (12 mm) but less than one inch (25 mm) from the plan thickness, one additional core shall be taken at random from each sublot within the lot. The thickness of these additional cores shall be determined as indicated in paragraph 304-6.1.2. A new average lot thickness shall be recomputed based on these additional cores and the original cores taken from each sublot. If the recomputed average lot thickness is not deficient by more than 1/2 inch (12 mm) from the plan thickness, full payment shall be made. If the average lot thickness is deficient by more than 1/2 inch (12 mm) from the plan thickness, the entire lot shall be removed and replaced at the Contractor's expense or shall be permitted to remain in-place at an adjusted payment of 75% of the contract unit price.

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

304-6.2.3 Grade requirements. When the completed surface is higher than 1/2 inch (12 mm) above the grade shown in the plans, the surface shall be trimmed, at the Contractor's expense, with an approved grinding machine to an elevation that falls within a tolerance of 1/4 inch (6 mm) or less.

304-6.2.4 Surface tolerance requirements. The finished surface shall not vary more than 3/8 inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with, or at right angles to, the centerline of the CTB area. Areas in the CTB showing high spots greater than 3/8 inch (9 mm) over 12 feet (3.7 m) shall be marked and immediately trimmed with an approved grinding machine. Such trimming shall be at the Contractor's expense.

METHOD OF MEASUREMENT

304-7.1 Cement-treated base course. The quantity of cement-treated base course will be determined by measurement of the number of square yards (m^2) of CTB actually constructed and accepted by the Engineer as complying with the plans and specifications.

BASIS OF PAYMENT

304-8.1 Cement-treated base course. Payment shall be made at the contract unit price per square yard (m^2) for each indicated thickness of cement-treated base course. This price shall be full compensation for furnishing all materials, including cement; for all preparation, manipulation, placing, and curing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Each lot of CTB material will be accepted for density at the full contract price adjusted in accordance with paragraph 304-6.2.1.

TESTING REQUIREMENTS

ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregate
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D558	Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1633	Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders

ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
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
AASHTO T135	Standard Method of Test for Wetting-and-Drying Test of Compacted Soil-Cement Mixtures
AASHTO T136	Standard Method of Test for Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures

MATERIAL REQUIREMENTS

ASTM C150	Standard Specification for Portland Cement
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D2397	Standard Specification for Cationic Emulsified Asphalt

END OF ITEM P-304

Intentionally Left Blank

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 90 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 10% 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) 64-16. A certificate of compliance from the manufacturer shall be included with the mix design submittal.

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

401-2.4 Preliminary material acceptance. Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

a. Coarse aggregate:

(1) Percent of wear
(2) Soundness
(3) Clay lumps and friable particles
(4) Percent fractured faces
(5) Flat and elongated particles
(6) Unit weight of slag

b. Fine aggregate:

(1) Liquid limit and Plasticity index
(2) Soundness
(3) Clay lumps and friable particles
(4) Percent natural sand
(5) Sand equivalent

c. Mineral filler.

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

The certifications shall show the appropriate ASTM tests for each material, the test results, and a statement that the material meets the specification requirement.

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

401-2.5 Anti-stripping agent. Any anti-stripping agent or additive if required shall be heat stable, shall not change the asphalt cement viscosity beyond specifications, shall contain no harmful ingredients, shall be added in recommended proportion by approved method, and shall be a material approved by the Department of Transportation of the State in which the project is located.

COMPOSITION

401-3.1 Composition of mixture. The HMA mix shall be composed of a mixture of well-graded aggregate, filler and anti-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. ASTM D6926 shall be used for preparation of specimens using the manually held and operated hammer for the mix design procedure. ASTM D6927 shall be used for testing for Marshall stability and flow.

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

The design criteria in Table 1 are target values necessary to meet the acceptance requirements contained in paragraph 401-5.2b. The criteria is based on a production process which has a material variability with the following standard deviations: Stability = 270 lbs (1200 N); Flow (0.01 inch (0.25 mm)) = 0.015 inches (.38 mm); Air Voids = 0.65%.

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

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

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

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

b. Percent of asphalt cement.

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

d. Number of blows per side of molded specimen.

e. Laboratory mixing temperature.

f. Laboratory compaction temperature.

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

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

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

j. Specific Gravity and absorption of each aggregate.

k. Percent natural sand.

l. Percent fractured faces.

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

n. Tensile Strength Ratio (TSR).

o. Anti-strip agent (if required).

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

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, including a new test strip when required by the engineer, will be borne by the Contractor. There will be no time extension given or considerations for extra costs associated with the stoppage of production paving or restart of production paving due to the time needed for the Engineer to approve the initial, new or modified JMF.

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

Table 1. Marshall Design Criteria

Test Property	Value
Number of blows	75
Stability, pounds (Newtons) minimum	2150 (9560)
Flow, 0.01 in. (0.25 mm)	10-16
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)	--
1/2 inch (12 mm)	100
3/8 inch (9 mm)	79-99
No. 4 (4.75 mm)	58-78
No. 8 (2.36 mm)	39-59
No. 16 (1.18 mm)	26-46
No. 30 (0.60 mm)	19-35
No. 50 (0.30 mm)	12-24
No. 100 (0.15 mm)	7-17
No. 200 (0.075 mm)	3-6
Asphalt Percent:	
Stone or gravel	5.5-8.0
Slag	7.0-10.5

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

401-3.3 Reclaimed asphalt pavement (RAP). RAP shall not be used.

401-3.4 Job mix formula (JMF) laboratory. The Contractor's laboratory used to develop the JMF shall be accredited in accordance with ASTM D3666. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the JMF must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

401-3.5 Test section. Prior to full production, the Contractor shall prepare and place a quantity of HMA according to the JMF. The amount of HMA shall be sufficient to construct a test section 100

feet long and 20-30 feet wide, placed in two lanes, with a longitudinal cold joint, and shall be of the same depth specified for the construction of the course which it represents. A cold joint for this test section is an exposed construction joint at least four (4) hours old or whose mat has cooled to less than 160°F (71°C). The cold joint must be cut back using the same procedure that will be used during production in accordance with 401-4.13. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

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

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

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

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

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

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 1 inches (50 mm) but less than 3 inches (7.5 cm)	45	7
1 in. (2.5 cm) or less	50	10

401-4.2 HMA plant. Plants used for the preparation of HMA shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 with the following changes:

Requirements for all plants include:

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

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

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

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

(1) Adequate artificial lighting.

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

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

(4) Work benches for testing.

(5) Desk with chairs and file cabinet.

(6) Sanitary facilities convenient to testing laboratory.

(7) Exhaust fan to outside air.

(8) Sink with running water.

Failure to provide the specified facilities shall be sufficient cause for disapproving HMA plant operations.

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

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

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

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

(2) Stored in insulated bins for a period of time not to exceed eight (8) hours.

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

401-4.3 Hauling equipment. Trucks used for hauling HMA shall have tight, clean, and smooth metal beds. To prevent the HMA from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the Engineer. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

401-4.3.1 Material transfer vehicle (MTV). Material transfer vehicles are not required.

401-4.4 HMA pavers. HMA pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of HMA that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

The paver shall 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.~~

c. 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. Additionally, "three wheel" (three-drum) steel rollers 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, if shown on the plans.

401-4.11 Laydown plan, transporting, placing, and finishing. Prior to the placement of the HMA, the Contractor shall prepare a laydown plan for approval by the Engineer. This is to minimize the number of cold joints in the pavement. The laydown plan shall include the sequence of paving laydown by stations, width of lanes, temporary ramp locations, and laydown temperature. The laydown plan shall also include estimated time of completion for each portion of the work (that is, milling, paving, rolling, cooling, etc.). Modifications to the laydown plan shall be approved by the Engineer.

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

The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose for the first lift of all runway and taxiway pavements. Successive lifts of HMA ~~surface course~~ may be placed using a ski, or laser control per paragraph 401-4.4.1, 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 15 feet (5 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~~HMA, 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, except that three wheel steel drum rollers are not to be used. 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.

e. 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, stability, and flow on a lot basis. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. Samples shall be taken in accordance with ASTM D979.

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

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

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

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

(2) Testing. Sample specimens shall be tested for stability and flow in accordance with ASTM D6927. Air voids will be determined by the Engineer in accordance with ASTM D3203. One set of laboratory compacted specimens will be prepared for each sublot in accordance with ASTM D6926 at the number of blows required by paragraph 401-3.2, Table 1. Each set of laboratory compacted specimens will consist of three test specimens prepared from the same sample. The manual hammer in ASTM D6926 shall be used.

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

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

The stability and flow for each sublot shall be computed by averaging the results of all test specimens representing that sublot.

(3) Acceptance. Acceptance of plant produced HMA for stability, flow, and air voids shall be determined by the Engineer in accordance with the requirements of paragraph 401-5.2b.

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

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

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

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

(7) Stability

(8) Flow

Mat density and air voids will be evaluated for acceptance in accordance with paragraph 401-5.2b(1). Stability and flow will be evaluated for acceptance in accordance with paragraph 401-5.2b(2). Joint density will be evaluated for acceptance in accordance with paragraph 401-5.2b(3).

Thickness will be evaluated by the Engineer for compliance in accordance with paragraph 401-5.2b(4). Acceptance for smoothness will be based on the criteria contained in paragraph 401-5.2b(5). Acceptance for grade will be based on the criteria contained in paragraph 401-5.2b(7).

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

b. Acceptance criteria.

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

(2) Stability and flow. Acceptance of each lot of plant produced HMA for stability and flow shall be based on the PWL. If the PWL of the lot equals or exceeds 90%, the lot shall be acceptable. If the PWL is less than 90%, the Contractor shall determine the reason and take corrective action. If the PWL is below 80%, the Contractor must stop production until the reason for poor stability and/or flow has been determined and adjustments to the HMA are made.

(3) Joint density. Acceptance of each lot of plant produced HMA for joint density shall be based on the PWL. If the PWL of the lot is equal to or exceeds 90%, the lot shall be considered acceptable. If the PWL is less than 90%, the Contractor shall evaluate the reason and act accordingly. If the PWL is less than 80%, the Contractor shall cease operations and until the reason for poor compaction has been determined. If the PWL is less than 71%, the pay factor for the lot used to complete the joint shall be reduced by five (5) percentage points. This lot pay factor reduction shall be incorporated and evaluated in accordance with paragraph 401-8.1.

(4) Thickness. Thickness of each lift of ~~surface course~~HMA 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~~the final lift 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 the 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~~the final lift. 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~~the final lift. Each measurement shall be recorded and a copy of the data shall be furnished to the Engineer at the end of each days testing.

(b) Longitudinal measurements. Longitudinal measurements will be taken for each lot placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6m); and at the 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~~the final lift. 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.

(6) Grade. Grade shall be evaluated on the first day of placement and ~~then as a minimum, every [ ]~~each successive day of placement 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 (1,650 m^2). 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. Marshall acceptance limits for stability, flow, air voids, density

TEST PROPERTY		
Number of Blows	75	
	Specification Tolerance	
	L	**U**
Stability, minimum pounds	1800	--
Flow, 0.01 inch	8	18
Air Voids Total Mix %	2	5
~~**Surface Course Mat Density %**~~	~~96.3~~	--
Mat Density %	95.5	--
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.

(1) 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.

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

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

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

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. 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 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 (kg)~~square yards for each identified thickness of HMA used in the accepted work.~~ Recorded batch weights or truck scale weights will be used to determine the basis for the tonnage.~~

BASIS OF PAYMENT

401-8.1 Payment. Payment for a lot of HMA meeting all acceptance criteria as specified in paragraph 401-5.2 shall be made based on results of tests for mat density and air voids. Payment for acceptable lots shall be adjusted according to paragraph 401-8.1a for mat density and air voids, 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)~~square yards (square meters) 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.

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 D6927	Standard Test Method for Marshall Stability and Flow of Bituminous mixtures
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

Item P-501 Portland Cement Concrete (PCC) Pavement

DESCRIPTION

501-1.1 This work shall consist of pavement composed of portland cement concrete (PCC), with reinforcement**,** constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross-sections shown on the plans.

MATERIALS

501-2.1 Aggregates.

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

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

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

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

Listed below are sources that have been accepted (pre-qualified) as sources acceptable to the City of Houston for aggregates for this project. The pre-qualification does not relieve the requirement for Contractor submission of the applicable test results to ensure (and for Contractor assurance) that the aggregates delivered meet all of the requirements of this Section.

Fine Aggregate	Coarse Aggregate
Vulcan Materials, Knippa Pit, TX	Vulcan Materials, Knippa Pit, TX
Vulcan Materials **, Brownwood Plant, TX	Vulcan Materials, Brownwood Plant, TX
Texas Crushed Stone **, Georgetown, TX	Martin- Marietta, Chico Plant, TX

* Trap Rock. ** Limestone Fines

This list does not prohibit the Contractor from submitting other aggregate sources as long as the submitted documentation shows conclusively that the source produces aggregates in conformance with the requirements of this Section.

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

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

Limits for Deleterious Substances in Fine Aggregate for Concrete

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than 0.075mm (No. 200 sieve)	ASTM C117	3.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.4	0.5
Total of all deleterious Material		3.0

Fine aggregate shall be subjected to the sand equivalent test (Test Method Tex-203-F as outlined in the Texas Department of Transportation (TxDOT) "Manual of Testing Procedures", Volume 1. The sand equivalent shall not be less than 80.

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

Aggregates delivered to the mixer shall consist of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates should be free of ferrous sulfides, such as pyrite, that would cause “rust” staining that can bleed through pavement markings. Steel blast furnace slag shall not be permitted. The aggregate shall be composed of clean, hard, uncoated particles. Dust and other coating shall be removed from the aggregates by washing. The total of all deleterious substances shall not exceed 3.0% of the weight of aggregate, not counting material finer than the No. 200 sieve.

The percentage of wear shall be no more than 35 when tested in accordance with ASTM C131.

Loss by decantation shall not exceed 1% and shall be determined by Test Method Tex-406-A as outlined in TxDOT "Manual of Testing Procedures", Volume 2. In the case of aggregates made primarily from the crushing of stone. if the material finer than the 200 sieve Is definitely established to be the dust of fracture, essentially free from clay or shale, as established by Part 11/ of Test Method Tex-406-A, the percent may be increased to 1.5.

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

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

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

Limits for Deleterious Substances in Coarse Aggregate for Concrete

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (0.075mm)	ASTM C117	1.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	1.0
Total of all deleterious Material		3.0

The aggregates shall be furnished in two separate size groups as shown in Table 2. When aggregate blending is required to achieve specified gradation. The Contractor shall provide aggregate fractions with uniform specific gravities. i.e. specific gravities within a range of +/-0.05.

Table 1. Gradation For Coarse Aggregate

(ASTM C33)

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

The aggregate that is used shall produce a concrete meeting all requirements of the drawings and specifications. Only one job-mix gradation of coarse aggregate will be used for Portland Cement concrete pavement mixes unless otherwise approved in writing by the Engineer.

(1) Aggregate susceptibility to durability (D) cracking. Aggregates that have a history of D-cracking shall not be used.

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

(a) The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in d. below, the point thus determined shall fall within the parallelogram described therein.

(b) The CF shall be determined from the following equation:

CF = (cumulative percent retained on the 3/8 in. sieve)(100) / (cumulative percent retained on the No. 8 sieve)

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

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

Storage Facilities. Where the coarse aggregate is delivered on the Job in two or more sizes or types. Each type and/or size shall be batched and weighed separately.

All aggregates shall be handled and stored in such a manner as to prevent size segregation and contamination by foreign substances. When segregation is apparent, the aggregate shall be re-mixed before use in concrete. At the time of its use, the aggregate shall be free from frozen material, and aggregate containing foreign materials will be rejected. Coarse aggregate that contains more than 0.5% free moisture by weight shall be stockpiled for at least 24 hours prior to use.

Adequate storage facilities shall be provided for all approved materials. The intermixing of non-approved materials with approved materials either in stockpiles or in bins will not be permitted. Aggregates from different sources shall be stored in different stockpiles unless otherwise approved by the Engineer.

Aggregates shall be stockpiled in such a manner as to prevent segregation and maintain as nearly as possible a uniform condition of moisture.

Each aggregate stockpile shall be reworked with suitable equipment at such times as required by the Engineer to remix the material to provide uniformity of thestockpile.

Unless otherwise approved by the Engineer in writing, coarse aggregates will be dumped in traps and stockpiled with stacker conveyors. At no time shall the aggregate be pushed with a bulldozer or front-end loader.

501-2.2 Cement. Cement shall conform to the requirements of ASTM 150 Type I or II.

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

501-2.3 Cementitious materials.

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

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

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

501-2.4 Joint seal. The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-605 and shall be of the type specified in the plans.

501-2.5 Isolation joint filler. Premolded joint filler for isolation joints shall conform to the requirements of ASTM D1752, Type II or III and shall be where shown on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Engineer.

501-2.6 Steel reinforcement. Reinforcing shall consist of deformed steel bars conforming to the requirements of ASTM A615 or welded steel wire fabric conforming to the requirements of ASTM A1064.

The steel shall be properly stored to protect it from mechanical injury and rust. The steel shall be free from dirt, rust, scale or other deleterious materials at the time of placement.

501-2.7 Dowel and tie bars. Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete. ~~Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078.~~Each dowel bar shall be completely coated with red oxide paint. The painted dowels shall be coated upon installation with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

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

501-2.8 Water. Water used in mixing or curing shall be potable, clean, free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product, except that non-potable water, or water from concrete production operations, may be used if it meets the requirements of ASTM C1602.

501-2.9 Material for curing concrete. Curing materials shall conform to one of the following specifications:

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

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

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

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

501-2.10 Admixtures. Admixtures may only be used as approved by the Engineer. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

a. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

b. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

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

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

Constituent	Limit (Percent by Mass)
LiNO3 (Lithium Nitrate)	30 ±0.5
SO4 (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

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

501-2.11 Epoxy-resin. All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

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

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

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

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

501-2.12 Material acceptance. Prior to use of materials, the Contractor shall submit certified test reports to the Engineer for those materials proposed for use during construction. The certification shall show the appropriate ASTM test for each material, the test results, and a statement that the material passed or failed.

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

MIX DESIGN

501-3.1. General. No concrete shall be placed until the mix design has been submitted to the Engineer for review and the Engineer has taken appropriate action. The Engineer's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

501-3.2 Proportions. The laboratory preparing the mix design shall be accredited in accordance with ASTM C1077. The mix design for all Portland cement concrete placed under P-501 shall be stamped or sealed by the responsible professional Engineer of the laboratory. Concrete shall be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 501-5.2 for a flexural strength of 700 psi per ASTM C78. The mix shall be developed using the procedures contained in the Portland Cement Association's (PCA) publication, "Design and Control of Concrete Mixtures".

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash or slag cement) shall be 564 pounds per cubic yard (227 kg per cubic meter). The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall not be more than 0.45 by weight.

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

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

If a change in sources is made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Engineer for approval.

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

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

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

b. Reactivity Test Results.

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

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

e. Mill certificates for cement and supplemental cementitious materials.

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

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

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

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

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

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

501-3.3 Cementitious materials. Either fly ash or slag cement shall be used as a partial replacement for cement.

a. Fly ash. When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes at 20 to 25% by weight of total cementitious material.~~, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.~~

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

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

501-3.4 Admixtures.

a. Air-entraining admixtures. Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be 4.0%. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

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

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

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

501-3.5 Concrete mix design laboratory. The Contractor's laboratory used to develop the concrete mix design shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix design 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

CONSTRUCTION METHODS

501-4.1 Equipment. Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer, but does not relieve the Contractor of the responsibility for the proper operation of equipment and maintaining the equipment in good working condition. The equipment shall be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.

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

(1) General. The batching plant shall include bins, weighing hoppers, and scales for the fine aggregate and coarse aggregate. If bulk cement is used a bin, hopper and separate scale for cement shall be included. The weighing hoppers shall be properly sealed and vented to preclude dusting during operation.

(2) Bins and Hopper. Bins with adequate separate compartments for fine aggregate and coarse aggregate shall be provided in the batching plant. Each compartment shall discharge efficiently and freely into the weighing hopper. Means of control shall be provided so that as the quantity desired in the weighing hopper is approached the material may be added slowly and shut off with precision. A port or other opening for removing an overload of anyone of the several materials from the hopper shall be provided. Weighing hoppers shall be constructed to eliminate accumulations of materials and to discharge fully.

(3) Scales. The scales for weighing aggregates and cement shall be of either the beam or the springless dial type. They shall be accurate within 0.5 percent throughout their range of use. When beam-type scales are used, provisions such as a "telltale" dial shall be made for indicating to the operator that the required load in the weighing hopper is being approached. A device on the weighing beams shall clearly indicate critical position. Poises shall be designed to be locked in any position and to prevent unauthorized change. The weight beam and "telltale" device shall be in full view of the operator while charging the hopper and the operator shall have convenient access to all controls.

Scales shall be inspected and sealed as often as the Engineer may deem necessary to assure their continued accuracy. The Contractor shall have on hand not less than ten 50pound (23 kg) weights for testing of all scales when directed by the Engineer. Scales shall be equipped with an automatic recording device with printout capability to record the weight of each solid component of the batch. The device shall be sealed.

b. Mixers and transportation equipment.

(1) General. Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer’s nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

A device accurate within 3 percent and satisfactory to the Engineer shall be provided at the mixer for determining the amount of air-entraining agent or other admixture to be added to each batch requiring such admixtures.

Mixers shall be examined daily for the accumulation of hand concrete or mortar and the wear of blades.Accumulations greater than 1/8 inch shall be removed prior to resumption of concrete production.

Each mixer shall be equipped with a water measuring device so constructed that it will measure within one percent (1%) of the total amount required for each batch. Unless the Water is to be weighed, the water measuring equipment shall include an auxiliary tank with a capacity greater than that of the measuring tank, and from which the measuring tank will be filled by gravity flow. The measuring tank will be open to the atmosphere and shall be so placed and constructed that the water for a batch can be discharged into a calibrated tank or weighing device for checking the accuracy of water measurement without seriously delaying the paving operations. The Contractor shall have a calibrated tank or weighing device available at all times at a location satisfactory to the Engineer.

(2) Central plant mixer. Central plant mixers shall conform to the requirements of ASTM C94. Mixing shall be in an approved mixer capable of combining the aggregates, cementitious materials, and water into a thoroughly mixed and uniform mass within the specified mixing period and of discharging the mixture without segregation. Central plant mixers shall be equipped with an acceptable timing device that will not permit the batch to be discharged until the specified mixing time has elapsed. The water system for a central mixer shall be either a calibrated measuring tank or a meter and shall not necessarily be an integral part of the mixer.

The mixer shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch (19 mm) or more. The Contractor shall have a copy of the manufacturer’s design on hand showing dimensions and arrangement of blades in reference to original height and depth.

(3) Truck mixers and truck agitators. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall conform to the requirements of ASTM C94.

(4) Nonagitator trucks. Nonagitating hauling equipment shall conform to the requirements of ASTM C94.

(5) Transfer and spreading equipment. Equipment for transferring concrete from the transporting equipment to the paving lane in front of the paver shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will transfer and spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

c. Finishing equipment. The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The finishing machine shall be equipped with one or more oscillating-type transverse screed. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It shall weigh at least 2,200 lbs per foot (3274 kg/m) of paving lane width and powered by an engine having at least 6.0 horsepower per foot of lane width.

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

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

The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The Contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the Engineer.

Hand held vibrators may be used in irregular areas only, but shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

e. Concrete saws. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations. Early-entry saws may be used, subject to demonstration and approval of the Engineer.

f. Side forms. Straight side forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall have a depth equal to the pavement thickness at the edge, and a base width equal to or greater than the depth. Flexible or curved forms of proper radius shall be used for curves of 100-foot (31 m) radius or less. Flexible or curved forms shall be of a design acceptable to the Engineer. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Flange braces shall extend outward on the base not less than two-thirds the height of the form. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of

abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the Engineer.

g. Pavers. The paver shall be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement, true to grade, tolerances, and cross-section. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown in the plans, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. The paver shall be equipped with electronic or hydraulic horizontal and vertical control devices.

Prior to the start of paving operations, the manufacturer's representative is to certify that the paver to be used by the Contractor on this project is in good operating condition and is capable of performing the work required by the drawings and specifications. The paver shall be rechecked by the manufacturer's representative for proper operation and condition at least once every 90 days during its use on this project, and as requested by the Engineer. Cost of certification and rechecks shall be included in the Contract Unit Prices for work under this specification item. There will be no separate pay for certification and re-checks: costs to be subsidiary to the item(s) which it is a component.

501-4.2 Form setting. Forms shall be set sufficiently in advance of the concrete placement to ensure continuous paving operation. After the forms have been set to correct grade, the underlying surface shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place sufficiently to maintain the form in position for the method of placement.

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/8 inch (3 mm) at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the placing of concrete.

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete.

501-4.3 Conditioning of underlying surface. The compacted underlying surface on which the pavement will be placed shall be widened approximately 3 feet (1 m) to extend beyond the paving machine track to support the paver without any noticeable displacement. After the underlying surface has been placed and compacted to the required density, the areas that will support the paving machine and the area to be paved shall be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the underlying surface shall be controlled by a positive grade control system using lasers, stringlines, or guide wires. If the density of the underlying surface is disturbed by the trimming operations, it shall be corrected by additional compaction and retested at the option of the Engineer before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it shall be corrected full depth by the Contractor. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. The underlying surface shall be protected so that it will be entirely free of frost when concrete is placed.

501-4.4 Conditioning of underlying surface, side-form and fill-in lane construction. The prepared underlying surface shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from the concrete. Damage caused by hauling or usage of other equipment shall be corrected and retested at the option of the Engineers. If damage occurs to a stabilized subbase, it shall be corrected full depth by the Contractor. A multiple-pin template weighing

not less than 1.000 pounds per 20 feet or other approved template shall be provided and operated on the forms immediately in advance of the placing of all concrete. The template shall be propelled only by hand and not attached to a tractor or other power unit. Templates shall be adjustable so that they may be set and maintained at the correct contour of the underlying surface. The adjustment and operation of the templates shall be such as will provide an accurate retest of the grade before placing the concrete thereon. All excess material shall be removed and wasted. Low areas shall be filled and compacted to a condition similar to that of the surrounding grade. The underlying surface shall be protected so that it will be entirely free from frost when the concrete is placed. The use of chemicals to eliminate frost in the underlying surface shall not be permitted.

The template shall be maintained in accurate adjustment, at all times by the Contractor, and shall be checked daily.

501-4.5 Handling, measuring, and batching material. The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials. Stockpiles shall be built up in layers of not more than 3 feet (90 cm) in thickness. Each layer shall be completely in place before beginning the next layer and shall not be allowed to "cone" down over the next lower layer. Aggregates from different sources and of different grading shall not be stockpiled together. Improperly placed stockpiles will not be accepted by the Engineer. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant.

Aggregates shall be handled from stockpiles or other sources to the batching plant in such manner to secure the specified grading of the material. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage. The fine aggregate and coarse aggregate shall be separately weighed into hoppers in the respective amounts set by the Engineer in the job mix. Cement shall be measured by weight Separate scales and hopper, with a device to positively indicate the complete discharge of the batch of cement into the batch box or container, shall be used for weighing the cement.

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

Batches may be rejected unless mixed within 1-1/2 hours of initial contact of cement with the aggregates. Batching shall be conducted so that the results in the weights of each material required will be within a tolerance of 1 percent for cement and 2 percent for aggregates.

Water may be measured either by volume or by weight the accuracy of measuring the water shall be within plus or minus 1 percent of required amounts. Unless the water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. The measuring tank shall be equipped with an outside tap and valve to provide for checking the setting unless other means are provided for readily and accurately determining the amount of water in the tank. The volume of the auxiliary tank shall be at least equal to that of the measuring tank.

Methods and equipment for adding air-entraining agent or other admixtures to the batch, when required, shall be approved by the Engineer. All admixtures shall be measured into the mixer with an accuracy of plus or minus 3 percent.

501-4.6 Mixing concrete. The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are emptied into the drum. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94 except that the minimum required revolutions of mixing for transit mixed concrete may be reduced to not less than that recommended by the mixer manufacturer. The number of revolutions recommended by the mixer manufacturer shall be indicated on the manufacturer's serial plate attached to the mixer. The Contractor shall furnish test data acceptable to the Engineer verifying that the make and model of the mixer will produce uniform concrete conforming to the provisions of ASTM C 94 at the reduced number of revolutions shown on the serial plate.

When mixed at the work site or in a central mixing plant the mixing time shall not be less than 50 seconds nor more than 90 seconds. Mixing time ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

The mixer shall be operated at the drum speed as shown on the manufacturer's nameplate on the approved mixer. Any concrete mixed less than the specified time shall be discarded at the Contractor's expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic feet (cubic yards), as shown on the manufacturer's standard rating plate on the mixer. An overload up to 10 percent above the mixer's nominal capacity may be permitted provided concrete test data for segregation and uniform consistency are satisfactory and provided no spillage of concrete takes place. The batch shall be charged into the drum so that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform, and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is deposited in place at the work site shall not exceed ~~30~~45 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified in the approved mix design is not exceeded, and approved by the Engineer.

Computerized batch tickets shall be supplied for all concrete.

501-4.7 Limitations on mixing and placing. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

a. Cold weather. Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C) prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

b. Hot weather. During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions shall be taken.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The finished surfaces of the newly laid pavement shall be kept damp by applying a water-fog or mist with approved spraying equipment until the pavement is covered by the curing medium. When necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.2 psf (0.98 kg/m^2 per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. Such measures shall consist of wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

c. Temperature management program. Prior to the start of paving operation for each day of paving, the Contractor shall provide the Engineer with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. As a minimum the program shall address the following items:

(1) Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.

(2) Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 11-8, PCA, Design and Control of Concrete Mixtures.

(3) Anticipated timing of initial sawing of joint.

(4) Anticipated number and type of saws to be used.

501-4.8 Placing concrete. At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a flexural strength of 550 psi (3792 kPa), based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed. Also, subgrade and subbase planers, concrete pavers, and concrete finishing equipment may be permitted to ride upon the edges of previously constructed pavement when the concrete has attained a minimum flexural strength of 400 psi (2757 kPa).

The Contractor shall have available materials for the protection of the concrete during inclement weather. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

a. Slip-form construction. The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit shall not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes The spacing of internal units shall be uniform and shall not exceed 18 inches (0.5 m).

The term internal vibration means vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be within 8000 to 12000 cycles per minute and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or amplitude shall vary proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

Not more than 15% of the total free edge of each 500 foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches (0.5 m) from the edge. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor as directed by the Engineer.

b. Side-form construction. Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work. Metal side forms shall be used except at end closures and transverse construction joints where straight forms of other suitable material may be used.

Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such build-up is attached to the top of metal forms, the build-up shall also be metal.

Width of the base of all forms shall be equal to or greater than the specified pavement thickness.

Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the weight of subgrading and paving equipment or from the pressure of the concrete. The Contractor shall provide sufficient forms so that there will be no delay in placing concrete due to lack of forms.

It is the intent of the specification to produce a high quality, dense, long lasting and smooth pavement suitable for the high speed operations of roughness-sensitive heavy jet aircraft. This requires that all joints and particularly all longitudinal joints meet the specified tolerance throughout their length. The Engineer will designate the paving lanes in an apron, taxiway or the outer runway paving lanes to be used for the initial paving operations.

Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the finished pavement. They shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

Concrete shall be spread, screeded, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery.

Concrete for the full paving width shall be effectively consolidated by internal vibrators without causing segregation. Internal type vibrators' rate of vibration shall be not less than 7,000 cycles per minute. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than one foot (30 cm) from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete.

c. Consolidation. Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than inches (50 mm). Excessive vibration shall not be permitted. If the vibrators cause visible tracking in the paving lane, the paving operation shall be stopped and equipment and operations modified to prevent it. Concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment shall be vibrated with an approved

hand-operated immersion vibrator operated from a bridge spanning the area. Vibrators shall not be used to transport or spread the concrete. Hand-operated vibrators shall not be operated in the concrete at one location for more than 20 seconds. Insertion locations for hand-operated vibrators shall be between 6 to 15 inches (150 to 400 mm) on centers. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the Engineer.

If a lack of consolidation of the concrete is suspected by the Engineer, referee testing may be required. Referee testing of hardened concrete will be performed by the Engineer by cutting cores from the finished pavement after a minimum of 24 hours curing. Density determinations will be made by the Engineer based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m^2) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original mix design density, with no cores having a density of less than 96% of the original mix design density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete conforms to the above requirements.

501-4.9 Strike-off of concrete and placement of reinforcement. Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

501-4.10 Joints. Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2 inch (12 mm) from their designated position and shall be true to line with not more than 1/4 inch (6 mm) variation in 10 feet (3 m). The surface across the joints shall be tested with a 12 feet (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

a. Construction. Longitudinal construction joints shall be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

b. Contraction. Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

c. Isolation (expansion). Isolation joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface. A cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. All devices used for the installation of expansion joints shall be approved by the Engineer. They shall be easily removable without disturbing the concrete and held in proper transverse and vertical alignment. After the concrete has been placed and struck off, the cap shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint sealant reservoir. Before the pavement is opened to traffic, this space shall be swept clean and filled with approved joint sealing material.

d. Tie bars. Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab depth. When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.

e. Dowel bars. Dowel bars or other load-transfer units of an approved type shall be placed across joints as shown on the plans. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the Engineer.

f. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

g. Placing dowels and tie bars. The method used in installing and holding dowels in position shall ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after the pavement has been completed will not be greater than 1/8 inch per feet (3 mm per 0.3 m). Except as otherwise specified below, horizontal spacing of dowels shall be within a tolerance of ±5/8 inch (16 mm). The vertical location on the face of the slab shall be within a tolerance of ±1/2 inch (12 mm). The vertical alignment of the dowels shall be measured parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment

shall be checked perpendicular to the joint edge. The horizontal alignment shall be checked with a framing square. Dowels and tie bars shall not be placed closer than 0.6 times the ~~dowel~~ bar length to the planned joint line. If the last regularly spaced longitudinal dowel or tie bar is closer than that dimension, it shall be moved away from the joint to a location 0.6 times the ~~dowel~~ bar length, but not closer than 6 inches (150 mm) to its nearest neighbor. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels and tie bars shall be installed as specified in the following subparagraphs.

(1) Contraction joints. Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires. At the Contractor's option, in lieu of the above, dowels and tie bars in contraction joints shall be installed near the front of the paver by insertion into the plastic concrete using approved equipment and procedures. Approval will be based on the results of a preconstruction demonstration, showing that the dowels and tie bars are installed within specified tolerances.

(2) Construction joints. Install dowels and tie bars by the cast-in- place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. The spacing of dowels and tie bars in construction joints shall be as indicated.

(3) Dowels installed in isolation joints and other hardened concrete. Install dowels for isolation joints and in other hardened concrete by bonding the dowels into holes drilled into the hardened concrete. The concrete shall have cured for seven (7) days or reached a minimum flexural strength of 450 psi (3.1 MPa) before drilling commences. Holes 1/8 inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur to the concrete joint face. Modification of the equipment and operation shall be required if, in the Engineer's opinion, the equipment and/or operation is causing excessive damage. Depth of dowel hole shall be within a tolerance of ±1/2 inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel. Dowels required to be installed in any joints between new and existing concrete shall be grouted in holes drilled in the existing concrete, all as specified above.

h. Sawing of joints. Joints shall be cut as shown on the plans. Equipment shall be as described in paragraph 501-4.1. The circular cutter shall be capable of cutting a groove in a straight line and shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans. The top of the slot shall be widened by sawing to provide adequate space for joint sealers as shown on the plans. Sawing shall commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and shall continue without interruption until all joints have been sawn. The joints shall be sawn at the required spacing. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial sawcut and maintained for the remaining cure period.

501-4.11 Finishing. Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Any operations which produce more than 1/8 inch (3 mm) of mortar-rich surface (defined as deficient in plus U.S. No. 4 (4.75 mm) sieve size aggregate) shall be halted immediately and the equipment, mixture, or procedures modified as necessary. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

a. Machine finishing with slipform pavers. The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float shall be allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

b. Machine finishing with fixed forms. The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

c. Other types of finishing equipment. Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the Engineer’s approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

d. Hand finishing. Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Use hand finishing operations only as specified below.

(1) Equipment and screed. In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping screed and a longitudinal float for hand finishing. The screed shall be at least one foot (30 cm) longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, and shall be constructed of metal or other suitable material shod with metal. The longitudinal float shall be at least 10 feet (3 m) long, of approved design, and rigid and substantially braced, and shall maintain a plane surface on the bottom. Grate tampers (jitterbugs) shall not be used.

(2) Finishing and floating. As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross-section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, the entire surface shall be tamped with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed, consolidated and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces.

e. Straightedge testing and surface correction. After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a Contractor furnished 12-foot (3.7-m) straightedge swung from handles 3 feet (1 m) longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements of paragraph 501-5.2e(3). Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment. This straight-edging is not a replacement for the straightedge testing of paragraph 501-5.2e(3), Smoothness.

f. Stationing Stencil. Furnish stencils to impress centerline stationing at 100 foot intervals into the fresh concrete along each edge, with numerals approximately 2 in. high by 1 in. wide by 1/4 in. deep. There will be no separate payment for stenciling.

501-4.12 Surface texture. The surface of the pavement shall be finished with either a brush or broom, burlap drag, or artificial turf finish for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the Engineer.

a. Brush or broom finish. If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 inch (2 mm) in depth.

b. Burlap drag finish. If a burlap drag is used to texture the pavement surface, it shall be at least 15 ounces per square yard (555 grams per square meter). To obtain a textured surface, the transverse threads of the burlap shall be removed approximately one foot (30 cm) from the trailing edge. A heavy

buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the pavement surface. The corrugations shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth.

c. Artificial turf finish. If artificial turf is used to texture the surface, it shall be applied by dragging the surface of the pavement in the direction of concrete placement with an approved full-width drag made with artificial turf. The leading transverse edge of the artificial turf drag will be securely fastened to a lightweight pole on a traveling bridge. At least 2 feet (60 cm) of the artificial turf shall be in contact with the concrete surface during dragging operations. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated by the Contractor to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85 inch-long polyethylene turf blades per square foot. The corrugations shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth.

501-4.13 Curing. Immediately after finishing operations are completed and marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

Minimize surface drying of the pavement before application of the curing system. To this end, consider the use of evaporation retardant on the pavement surface. Apply evaporation retardant at the rate recommended by the manufacturer. Reapply the evaporation retardant as needed to maintain the concrete surface in a moist condition until curing system is applied. Do not use evaporation retardant as a finishing aid. Precautions to prevent surface drying of the pavement may be needed to prevent undesirable effects on pavement life.

When a two-sawcut method is used to construct the contraction joint, the curing compound shall be applied to the sawcut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

a. Impervious membrane method. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 sq ft (14 sq m). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the Engineer, a double application rate shall be used to ensure coverage. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface. Curing shall be applied immediately after the bleed water is gone from the surface.

b. White burlap-polyethylene sheets. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire

surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

c. Water method. The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

d. Concrete protection for cold weather. The concrete shall be maintained at an ambient temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the curing time. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor's expense.

e. Concrete protection for hot weather. Concrete should be continuous moisture cured for the entire curing period and shall commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the Engineer.

f. Curing Effectiveness Testing. Contractor shall cooperate with efforts to monitor the effectiveness of the curing operations by both surface relative and surface dielectric measurements to determine if the relative humidity and the free moisture levels in the surface of the concrete pavement are sufficient to sustain hydration and strength gain. These efforts are expected to have minimal impact on the contractors operations.

501-4.14 Removing forms. Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab shall be cured as per the methods indicated in paragraph 501-4.13. Major honeycombed areas shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-5.2(f).

501-4.15 Saw-cut grooving. If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.

501-4.16 Sealing joints. The joints in the pavement shall be sealed in accordance with Item P-605.

501-4.17 Protection of pavement. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents until accepted by the Engineer. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the Engineer.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days and the joints have been sealed or otherwise protected, and the concrete has attained a minimum field cured flexural strength of 550 psi (37928 kPa) and approved means are furnished to prevent damage to the slab edge.

All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean, and spillage of concrete or other materials shall be cleaned up immediately upon occurrence.

Damaged pavements shall be removed and replaced at the Contractor's expense. Slabs shall be removed to the full depth, width, and length of the slab.

501-4.18 Opening to construction traffic. The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural strength of 550 lb / square inch (3.8 kPa) when tested in accordance with ASTM C78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion.

501-4.19 Repair, removal, or replacement of slabs.

a. General. New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable shall be removed and replaced or repaired, as directed by the Engineer and as specified hereinafter at no cost to the Owner. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The Engineer will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be 4 inch (100 mm) diameter, shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. All epoxy resin used in this work shall conform to ASTM C881, Type V. Repair of cracks as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

b. Shrinkage cracks. Shrinkage cracks, which do not exceed 4 inches (100 mm) in depth, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved by the Engineer. Care shall be taken to assure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the Engineer. Shrinkage cracks, which exceed 4 inches (100 mm) in depth, shall be treated as full depth cracks in accordance with paragraphs 4.19b and 4.19c.

c. Slabs with cracks through interior areas. Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than 4 inches (100 mm) in depth, that extend into the interior area.

d. Cracks close to and parallel to joints. All cracks essentially parallel to original joints, extending full depth of the slab, and lying wholly within 6 inches (150 mm) either side of the joint shall be treated as specified here. Any crack extending more than 6 inches (150 mm) from the joint shall be treated as specified above in subparagraph c.

(1) Full depth cracks present, original joint not opened. When the original un-cracked joint has not opened, the crack shall be sawed and sealed, and the original joint filled with epoxy resin as specified below. The crack shall be sawed with equipment specially designed to follow random cracks. The reservoir for joint sealant in the crack shall be formed by sawing to a depth of 3/4 inches (19 mm), ±1/16 inch (2 mm), and to a width of 5/8 inch (16 mm), ±1/8 inch (3 mm). Any equipment or

procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent such raveling or spalling. The joint sealant shall be a liquid sealant as specified. Installation of joint seal shall be as specified for sealing joints or as directed. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler type material has been used to form a weakened plane in the transverse joint, it shall be completely sawed out and the saw cut pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

(2) Full depth cracks present, original joint also cracked. At a joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced for the full lane width and length.

e. Removal and replacement of full slabs. Where it is necessary to remove full slabs, unless there are dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If dowels, or tie bars are present along any edges, these edges shall be sawed full depth just beyond the end of the dowels or tie bars. These joints shall then be carefully sawed on the joint line to within one inch (25 mm) of the depth of the dowel or tie bar.

The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along doweled edges shall be carefully broken up and removed using light, hand-held jackhammers, 30 lb (14 kg) or less, or other approved similar equipment.

Care shall be taken to prevent damage to the dowels, tie bars, or to concrete to remain in place. The joint face below dowels shall be suitably trimmed so that there is not abrupt offset in any direction greater than 1/2 inch (12 mm) and no gradual offset greater than one inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4 inches (38 and 100 mm) deep occurs at any point along any edge, the area shall be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary.

If underbreak over 4 inches (100 mm) deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels or tie bars, or where they have been damaged, dowels or tie bars of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All four (4) edges of the new slab shall contain dowels or original tie bars.

Placement of concrete shall be as specified for original construction. Prior to placement of new concrete, the underlying material (unless it is stabilized) shall be re-compacted and shaped as specified in the appropriate section of these specifications. The surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab shall be prepared and sealed as specified for original construction.

f. Repairing spalls along joints. Where directed, spalls along joints of new slabs, and along parallel cracks used as replacement joints, shall be repaired by first making a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inch (50 mm). Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete. The cavity thus formed shall be thoroughly cleaned with high-pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat of epoxy resin, Type III, Grade I, shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Pooling of epoxy resin shall be avoided. The cavity shall be filled with low slump Portland cement concrete or mortar or with epoxy resin concrete or mortar. Concrete shall be used for larger spalls, generally those more than 1/2 cu. ft. (0.014 m^3) in size, and mortar shall be used for the smaller ones. Any spall less than 0.1 cu. ft. (0.003 m^3) shall be repaired only with epoxy resin mortar or a Grade III epoxy resin. Portland cement concrete and mortar mixtures shall be proportioned as directed and shall be mixed, placed, consolidated, and cured as directed. Epoxy resin mortars shall be made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved by the Engineer. The epoxy resin materials shall be placed in the cavity in layers not over 2 inches (50 mm) thick. The time interval between placement of additional layers shall be such that the temperature of the epoxy resin material does not exceed 140°F (60°C) at any time during hardening. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or mortar. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab shall be removed and replaced as previously specified If any spall would require over 25% of the length of any single joint to be repaired, the entire slab shall be removed and replaced. Repair of spalls as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of spalls shall be allowed in any panel that demonstrates segregated aggregate with a significant absence of coarse aggregate in the upper one-eight (1/8th) inch of the pavement surface.

g. Diamond grinding of PCC surfaces. Diamond grinding of the hardened concrete with an approved diamond grinding machine should not be performed until the concrete is 14 days or more old and concrete has reached full minimum strength. When required, diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive. The saw blades shall be assembled in a cutting head mounted on a machine designed specifically for diamond grinding that will produce the required texture and smoothness level without damage to the pavement. The saw blades shall be 1/8-inch (3-mm) wide and there shall be a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; the actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Each machine shall be capable of cutting a path at least 3 feet (0.9 m) wide. Equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The area corrected by diamond grinding the surface of the hardened concrete should not exceed 10% of the total area of any sublot. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. All pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above, may require removing and replacing in conformance with paragraph 501-4.19.

501-4.20 Existing concrete pavement removal and repair.

All operations shall be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts shall be made perpendicular to the slab surface.

a. Removal of existing pavement slab.

When it is necessary to remove existing concrete pavement and leave adjacent concrete in place, unless there are dowels present, the joint between the removal area and adjoining pavement to stay in place, including dowels or tie bars, shall first be cut full depth with a standard diamond-type concrete saw. If dowels are present at this joint, the saw cut shall be made full depth just beyond the end of dowels. The edge shall then be carefully sawed on the joint line to within one inch (25 mm) of the top of the dowel. Next, a full depth saw cut shall be made parallel to the joint at least 24 inches (600 mm) from the joint and at least 12 inches (300 mm) from the end of any dowels. All pavement between this last saw cut and the joint line shall be carefully broken up and removed using hand-held jackhammers, 30 lb (14 kg) or less, or the approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. Where dowels are present, care shall be taken to produce an even, vertical joint face below the dowels. If the Contractor is unable to produce such a joint face, or if underbreak or other distress occurs, the Contractor shall saw the dowels flush with the joint. The Contractor shall then install new dowels, of the size and spacing used for other similar joints, by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph 501-4.10g. All this shall be at no additional cost to the Owner. Dowels of the size and spacing indicated shall be installed as shown on the drawings by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph 501-4.10g. The joint face shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/2 inches (12 mm) and no gradual offset greater than one inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

b. Edge repair.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas that are damaged during construction shall be repaired at no cost to the Owner.

(1) Spall repair. Spalls shall be repaired where indicated and where directed by the Engineer. Repair materials and procedures shall be as previously specified in subparagraph 501-4.19f.

(2) Underbreak repair. All underbreak shall be repaired. First, all delaminated and loose material shall be carefully removed. Next, the underlying material shall be recompacted, without addition of any new material. Finally, the void shall be completely filled with paving concrete, thoroughly consolidated. Care shall be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material shall be thoroughly moistened. After placement, the exposed surface shall be heavily coated with curing compound.

(3) Underlying material. The underlying material adjacent to the edge and under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete, and shall be shaped as shown on the drawings or as directed. Sufficient material shall be kept in place outside the joint line to prevent disturbance (or sloughing) of material under the pavement that is to remain in place. Any material under the portion of the concrete pavement to remain in place, which is disturbed or loses its compaction shall be carefully removed and replaced with concrete as specified in paragraph 501-4.20b(2). The underlying material outside the joint line shall be thoroughly compacted and moist when new concrete is placed.

MATERIAL ACCEPTANCE

501-5.1 Acceptance sampling and testing. All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the Engineer at no cost to the Contractor. The Contractor shall bear the cost of providing curing facilities for the strength specimens, per paragraph 501-5.1a(3), and coring and filling operations, per paragraph 501-5.1b(1). Testing organizations performing these tests shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

Concrete shall be accepted for strength and thickness on a lot basis.

A lot shall consist of a day's production not to exceed 4,000 square yards (947 square meters)**.**

The in-place concrete shall be homogeneous without segregation and honeycombing. The Engineer reserves the right to take random cores to verify the quality of the in-place pavement. These cores are in addition to those required. If a core reveals segregations and/or honeycombing that is in the opinion of the Engineer detrimental to the pavement structure, additional cores will be taken to define the area of deficiency. Areas so defined as containing segregated concrete and/or honeycombing shall be rejected, removed, and replaced at the Contractor's expense. The Engineer will be the sole judge as to the acceptability of the quality of the pavement.

a. Flexural strength.

(1) Sampling. Each lot shall be divided into four equal sublots. One sample shall be taken for each sublot from the plastic concrete delivered to the job site. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D3665. The concrete shall be sampled in accordance with ASTM C172.

(2) Testing. Two (2) specimens shall be made from each sample. Specimens shall be made in accordance with ASTM C31 and the flexural strength of each specimen shall be determined in accordance with ASTM C78. The flexural strength for each sublot shall be computed by averaging the results of the two test specimens representing that sublot.

Immediately prior to testing for flexural strength, the beam shall be weighed and measured for determination of a sample unit weight. Measurements shall be made for each dimension; height, depth, and length, at the mid-point of the specimen and reported to the nearest 1/10 inch (3 mm). The weight of the specimen shall be reported to the nearest 0.1 pound (45 gm). The sample unit weight shall be calculated by dividing the sample weight by the calculated volume of the sample. This information shall be reported as companion information to the measured flexural strength for each specimen.

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method.

Slump, air content, and temperature tests will also be conducted by the quality assurance laboratory for each set of strength test samples, per ASTM C31.

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

closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

(4) Acceptance. Acceptance of pavement for flexural strength will be determined by the Engineer in accordance with paragraph 501-5.2b.

b. Pavement thickness.

(1) Sampling. Each lot shall be divided into four equal sublots and one core shall be taken by the Contractor for each sublot. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, shall be excluded from sample locations.

Cores shall be neatly cut with a core drill. The Contractor shall furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes shall be filled by the Contractor with a non-shrink grout approved by the Engineer within one day after sampling.

(2) Testing. The thickness of the cores shall be determined by the Engineer by the average caliper measurement in accordance with ASTM C174.

(3) Acceptance. Acceptance of pavement for thickness shall be determined by the Engineer in accordance with paragraph 501-5.2c.

c. Partial lots. When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot, or when the Contractor and Engineer agree in writing to allow overages or minor placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

Where three sublots have been produced, they shall constitute a lot. Where one or two sublots have been produced, they shall be incorporated into the next lot or the previous lot and the total number of sublots shall be used in the acceptance criteria calculation, that is, n=5 or n=6.

d. Outliers. All individual flexural strength tests within a lot shall be checked for an outlier (test criterion) in accordance with ASTM E178, at a significance level of 5%. Outliers shall be discarded, and the percentage of material within specification limits (PWL) shall be determined using the remaining test values.

501-5.2 Acceptance criteria.

a. General. Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-5.2e:

(1) Flexural strength

(2) Thickness

(3) Smoothness

(4) Grade

(5) Edge slump

Flexural strength and thickness shall be evaluated for acceptance on a lot basis using the method of estimating PWL. Acceptance using PWL considers the variability (standard deviation) of the material and the testing procedures, as well as the average (mean) value of the test results to calculate the percentage of material that is above the lower specification tolerance limit (L).

Acceptance for flexural strength will be based on the criteria contained in accordance with paragraph 501-5.2e(1). Acceptance for thickness will be based on the criteria contained in paragraph 501-5.2e(2). Acceptance for smoothness will be based on the criteria contained in paragraph 501-5.2e(3). Acceptance for grade will be based on the criteria contained in paragraph 501-5.2e(4).

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

b. Flexural strength. Acceptance of each lot of in-place pavement for flexural strength shall be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

c. Pavement thickness. Acceptance of each lot of in-place pavement shall be based on PWL. The Contractor shall target production quality to achieve 90 PWL or higher.

d. Percentage of material within limits (PWL). The PWL shall be determined in accordance with procedures specified in Section 110 of the General Provisions.

The lower specification tolerance limit (L) for flexural strength and thickness shall be:

Lower Specification Tolerance Limit (L)

Flexural Strength	0.93 × strength specified in paragraph 501-3.1
Thickness	Lot Plan Thickness in inches, - 0.50 in

e. Acceptance criteria.

(1) Flexural Strength. If the PWL of the lot equals or exceeds 90%, the lot shall be acceptable. Acceptance and payment for the lot shall be determined in accordance with paragraph 501-8.1.

(2) Thickness. If the PWL of the lot equals or exceeds 90%, the lot shall be acceptable. Acceptance and payment for the lot shall be determined in accordance with paragraph 501-8.1.

(3) Smoothness. As soon as the concrete has hardened sufficiently, but not later than 48 hours after placement, the surface of each lot shall be tested in both longitudinal and transverse directions for smoothness to reveal all surface irregularities exceeding the tolerances specified. ~~The Contractor shall furnish paving equipment and employ methods that produce a surface for each section of pavement having an average profile index meeting the requirements of paragraph 501-8.1c when evaluated with a profilograph; and t~~The finished surface of the pavement shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. When the surface smoothness exceeds specification tolerances which cannot be corrected by diamond grinding of the pavement, full depth removal and replacement of pavement shall be to the limit of the longitudinal placement. Corrections involving diamond grinding will be subject to the final pavement thickness tolerances specified.

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

(i) Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. Smoothness readings will not be made across grade changes or cross slope transitions; at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between

these two high points. Deviations on final pavement > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of pavement. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) The joint between lots shall be tested separately to facilitate smoothness between lots. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface, with half the straightedge on one side of the joint and the other half of the straightedge on the other side of the joint. Measure the maximum gap between the straightedge and the pavement surface in the area between these two high points. One measurement shall be taken at the joint every 50 feet (15m) or more often if directed by the Engineer. Maximum gap on final pavement surface > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Each measurement shall be recorded and a copy of the data shall be furnished to the Engineer at the end of each days testing.

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

(i) ~~Longitudinal Short Sections. Longitudinal Short Sections are when the longitudinal lot length is less than 200 feet (60m) and areas not requiring a profilograph. When approved by the Engineer, the first and last 15 feet (4.5m) of the lot can also be considered as short sections for smoothness.~~ The finished surface shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. Smoothness readings will not be made across grade changes or cross slope transitions, at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement surface > 1/4 inch (6mm) in longitudinal direction will be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(4) Grade. An evaluation of the surface grade shall be made by the Engineer for compliance to the tolerances contained below. The finish grade will be determined by running levels at intervals of 50 feet (15 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet (15 m)) to determine the elevation of the completed pavement. The Contractor shall pay the costs of surveying the level runs, and this work shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer.

(a) Lateral deviation. Lateral deviation from established alignment of the pavement edge shall not exceed ±0.10 feet (3 mm) in any lane.

(b) Vertical deviation. Vertical deviation from established grade shall not exceed ±0.04 feet (12 mm) at any point.

(5) Edge slump. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor as directed by the Engineer in accordance with paragraph 501-4.8a.

f. Removal and replacement of concrete. Any area or section of concrete that is removed and replaced shall be removed and replaced back to planned joints. The Contractor shall replace damaged dowels and the requirements for doweled longitudinal construction joints in paragraph 501-4.10 shall apply to all contraction joints exposed by concrete removal. Removal and replacement shall be in accordance with paragraph 501-4.20.

CONTRACTOR QUALITY CONTROL

501-6.1 Quality control program. The Contractor shall develop a Quality Control Program in accordance with Section 100 of the General Provisions. The program shall address all elements that affect the quality of the pavement including but not limited to:

a. Mix Design

b. Aggregate Gradation

c. Quality of Materials

d. Stockpile Management

e. Proportioning

f. Mixing and Transportation

g. Placing and Consolidation

h. Joints

i. Dowel Placement and Alignment

j. Flexural or Compressive Strength

k. Finishing and Curing

l. Surface Smoothness

501-6.2 Quality control testing. The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

a. Fine aggregate.

(1) Gradation. A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

b. Coarse Aggregate.

(1) Gradation. A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

c. Slump. Four slump tests shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each sublot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

d. Air content. Four air content tests, shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each sublot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

e. Four unit weight and yield tests shall be made in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

501-6.3 Control charts. The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, moisture content and air content.

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

a. Fine and coarse aggregate gradation. The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits contained in the Lower Specification Tolerance Limit (L) table above and the Control Chart Limits table below shall be superimposed on the Control Chart for job control.

b. Slump and air content. The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

Control Chart Limits

Control Parameter	Individual Measurements		Range Suspension Limit
	Action Limit	Suspension Limit	
Slip Form:			
Slump	+0 to -1 inch (0-25 mm)	+0.5 to -1.5 inch (13-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%
Side Form:			
Slump	+0.5 to -1 inch (13-25 mm)	+1 to -1.5 inch (25-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%

The individual measurement control charts shall use the mix design target values as indicators of central tendency.

501-6.4 Corrective action. The Contractor Quality Control Program shall indicate that appropriate action shall be taken when the process is believed to be out of control. The Contractor Quality Control Program shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

a. Fine and coarse aggregate gradation. When two consecutive averages of five tests are outside of the specification limits in paragraph 501-2.1, immediate steps, including a halt to production, shall be taken to correct the grading.

b. Fine and coarse aggregate moisture content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher shall be adjusted.

c. Slump. The Contractor shall halt production and make appropriate adjustments whenever:

(1) one point falls outside the Suspension Limit line for individual measurements or range

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

d. Air content. The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

(1) one point falls outside the Suspension Limit line for individual measurements or range

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

Whenever a point falls outside the Action Limits line, the air-entraining admixture dispenser shall be calibrated to ensure that it is operating correctly and with good reproducibility.

METHOD OF MEASUREMENT

501-7.1 Portland cement concrete pavement shall be measured by the number of square yards (square meters) of either plain or reinforced pavement as specified in-place, completed and accepted.

BASIS OF PAYMENT

501-8.1 Payment. Payment for concrete pavement meeting all acceptance criteria as specified in paragraph 501-5.2 Acceptance Criteria shall be based on results of strength and thickness tests. Payment for acceptable lots of concrete pavement shall be adjusted in accordance with paragraph 501-8.1a for strength and thickness and 501-8.1c for smoothness, subject to the limitation that:

The total project payment for concrete pavement shall not exceed 100 percent of the product of the contract unit price and the total number of square yards (square meters) of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment shall be full compensation for all labor, materials, tools, equipment, and incidentals required to complete the work as specified herein and on the drawings.

a. Basis of adjusted payment. The pay factor for each individual lot shall be calculated in accordance with the Price Adjustment Schedule table below. A pay factor shall be calculated for both flexural strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both flexural strength and thickness are 100% or higher. The lot pay factor shall be the product of the two values when only one of the calculations for either flexural strength or thickness is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both flexural strength and thickness are less than 100%.

Price Adjustment Schedule[1]

Percentage of Materials Within Specification Limits (PWL)	Lot Pay Factor (Percent of Contract Unit Price)
96 – 100	106
90 – 95	PWL + 10
75 – 90	0.5 PWL + 55
55 – 74	1.4 PWL – 12
Below 55	Reject[2]

[1] Although it is theoretically possible to achieve a pay factor of 106% for each lot, actual payment in excess of 100% shall be subject to the total project payment limitation specified in paragraph 501-8.1.

[2] The lot shall be removed and replaced. However, if the Engineer and the FAA have decided to allow the rejected lot to remain in accordance with Section 50-02 after 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 limitation shall be reduced by the amount withheld for the rejected lot.

For each lot accepted, the adjusted contract unit price shall be the product of the lot pay factor for the lot and the contract unit price. Payment shall be subject to the total project payment limitation specified in paragraph 501-8.1. Payment in excess of 100% for accepted lots of concrete pavement shall be used to offset payment for accepted lots of concrete pavement that achieve a lot pay factor less than 100%.

TESTING REQUIREMENTS

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C289	Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM 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 Aggregate (Accelerated Mortar-Bar Method)

ASTM C1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

ASTM D3665 Standard Practice for Random Sampling of Construction Materials

ASTM D4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM E178 Standard Practice for Dealing With Outlying Observations

~~ASTM E1274 Standard Test Method for Measuring Pavement Roughness Using a Profilograph~~

U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD) C662 Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

MATERIAL REQUIREMENTS

ASTM A184 Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A704 Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement

ASTM A706 Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM A714 Standard Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe

ASTM A775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars

ASTM A934 Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars

ASTM A996 Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

ASTM A1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM A1078 Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement

ASTM C33 Standard Specification for Concrete Aggregates

ASTM C94 Standard Specification for Ready-Mixed Concrete

ASTM C150 Standard Specification for Portland Cement

ASTM C171 Standard Specification for Sheet Materials for Curing Concrete

ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving And Structural Construction
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
AC 150/5320-6	Airport Pavement Design and Evaluation
PCA	Design and Control of Concrete Mixtures

END ITEM P-501

Intentionally Left Blank

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 of 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 (liter). 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 (liter) 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.

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

Intentionally Left Blank

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 (liter). 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 (liter) 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.

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

Intentionally Left Blank

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. Not used.

605-2.4 Bond breaking tapes. Not used.

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 sealant. 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 calendar 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. Not used.

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. Not used.

g. Two-component, cold-applied, machine mix sealing equipment. Not used.

h. Two-component, cold-applied, hand-mix sealing equipment. Not used.

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~~ 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~~ waterblasted clean. ~~Sandblasting~~Waterblasting 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. Backer rod. When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using backer rod to prevent the entrance of the sealant below the specified depth. Take care to ensure that the material is placed at the specified depth and is not stretched or twisted during installation.

d. Bond-breaking tape. Not used.

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 to 3/8 inch below

the pavement surface. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the ~~Contracting Officer~~ Owner's Authorized Representative. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

605-3.5 Inspection. The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

605-3.6 Clean-up. Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

METHOD OF MEASUREMENT

605-4.1 ~~Joint sealing material shall be measured by the [gallon (liter)] [pound (kg)] [linear foot (meter)] of sealant in place, completed, and accepted.~~ No direct measurement for joint sealant shall be made. All work under this item shall be subsidiary to the bid items for P-501, "Portland Cement Concrete Pavement".

BASIS OF PAYMENT

605-5.1 ~~Payment for joint sealing material shall be made at the contract unit price per [gallon (liter)] [pound (kg)] [linear foot (meter)]. The price shall be full compensation for furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.~~No separate payment will be made for joint sealant, including furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

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

Item P-610 Structural Portland Cement Concrete

DESCRIPTION

610-1.1 This item shall consist of plain and reinforced structural portland cement concrete (PCC), prepared and constructed in accordance with these specifications, at the locations and of the form and dimensions shown on the plans. This specification shall be used for all structural and miscellaneous concrete including signage bases.

MATERIALS

610-2.1 General. Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the Engineer before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

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

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

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

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

610-2.2 Coarse aggregate. The coarse aggregate for concrete shall meet the requirements of ASTM C33. ~~Crushed stone aggregate shall have a durability factor, as determined by ASTM C666, greater~~

~~than or equal to 95.~~ 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
	1 in. (25 mm)
No. 4 to 3/4 in. (4.75-19 mm)	100
No. 4 to 1 in. (4.75-25 mm)	90-100
No. 4 to 1-1/2 in. (4.75-38 mm)	

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 Supplementary 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. Not used.

e. Fly ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash for use in mitigating alkali-silica reactivity shall have a Calcium Oxide (CaO) content of less than 13%.

610-2.7 Premolded joint material. Premolded joint material for expansion joints shall meet the requirements of ASTM D1751**.**

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, ASTM A706, ASTM A775, or ASTM A934**.**

610-2.10 Materials for curing concrete. Curing materials shall conform to 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 3000 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 (32.2°C) when measured in accordance with ASTM C1064. Cooling of the mixing water and aggregates, or both, may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph 610-2.6 may be used to facilitate placing and finishing. Steel forms and reinforcement shall be cooled prior to concrete placement when steel temperatures are greater than 120°F (50°C). Conveying and placing equipment shall be cooled if necessary to maintain proper concrete-placing temperature. Submit the proposed materials and methods for review and approval by the Engineer, if concrete is to be placed under hot weather conditions.

610-3.22 Filling joints. All joints that require filling shall be thoroughly cleaned, and any excess mortar or concrete shall be cut out with proper tools. Joint filling shall not start until after final curing and shall be done only when the concrete is completely dry. The cleaning and filling shall be done with proper equipment to obtain a neat looking joint free from excess filler.

METHOD OF MEASUREMENT

610-4.1 ~~Portland cement concrete shall be measured by the number of cubic yards (cubic meters) of concrete complete in place and accepted. In computing the yardage of concrete for payment, the dimensions used shall be those shown on the plans or ordered by the Engineer. No measurements or other allowances shall be made for forms, falsework, cofferdams, pumping, bracing, expansion joints, or finishing of the concrete. No deductions in yardage shall be made for the volumes of reinforcing steel or embedded items.~~

610-4.2 ~~Reinforcing steel shall be measured by the calculated theoretical number of pounds (kg) placed, as shown on the plans, complete in place and accepted. The unit weight used for deformed bars shall be the weight of plain square or round bars of equal nominal size. If so indicated on the plans, the poundage to be paid for shall include the weight of metal pipes and drains, metal conduits and ducts, or similar materials indicated and included.~~ No direct measurement for Structural Portland Cement Concrete shall be made. All work under this item shall be subsidiary to the applicable bid items under which the work is performed.

BASIS OF PAYMENT

610-5.1 ~~Payment shall be made at the contract unit price per cubic yard (cubic meter) for structural Portland cement concrete and per pound (kg) for reinforcing steel. These prices shall be full compensation for furnishing all materials and for all preparation, delivery and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.~~ No separate payment will be made for Structural Portland Cement Concrete, including furnishing all materials, for all preparation, delivering, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

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

Intentionally Left Blank

Item P-620 Runway and Taxiway Marking

DESCRIPTION

620-1.1 This item shall consist of the preparation and ~~painting~~application 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~~paint shall arrive in sealed containers 55 gallons or smaller for inspection by the Engineer. ~~Material~~Paint shall not be loaded into the equipment until inspected by the Engineer.

620-2.2 Marking materials. ~~Paint~~Marking materials shall be waterborne paint in accordance with the requirements of paragraph 620-2.2a. Paint shall be furnished in yellow (number 33538 or 33655); white (number 37925); red (number 31136); and black (number 37038) in accordance with Federal Standard No. 595.

a. Waterborne. Paint shall meet the requirements of Federal Specification TT-P-1952E, Type II. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis.

b. Epoxy. Not used.

c. Methacrylate. Not used.

d. Solvent-Base. Not used.

e. Preformed Thermoplastic Airport Pavement Markings. Not used.

620-2.3 Reflective media. Glass beads shall meet the requirements for TT-B-1325D, Type III, 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 pavement temperature is greater than 130°F (55°C). 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 sweeping, blowing, rinsing with pressurized water, 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.

Paint shall not be applied to Portland cement concrete pavement until the areas to be painted are clean of curing material (per Item P-501-4.14 CURING). Sandblasting or high-pressure water shall be used to remove curing materials.

At least 24 hours prior to remarking existing markings, existing markings must be removed such that 100% of the existing markings are removed. After removal, the surface shall be cleaned of all residue or debris either with sweeping or blowing with compressed air or both.

Prior to the application of any 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 Paint 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 30 calendar days 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.

Permanent painted markings, with the exception of black outline, shall be performed using two applications. The final application shall not be performed until the initial application has dried completely in the opinion of the Owner's Authorized Representative.

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.

620-3.6 Test strip. Prior to the full application of airfield markings, the Contractor shall produce a test strip in the presence of the Engineer.

a. Painted Test Strip. 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

Paint Type	Paint Maximum square feet per gallon, ft^2/gal	Glass Beads, Type III Minimum pounds per gallon of paint, lb/gal
Waterborne, Type II, Temporary Markings	115	10
Waterborne, Type II, Black Outline	115	N/A
Waterborne, Type II, Permanent Markings, Initial Application	230	N/A
Waterborne, Type II, Permanent Markings, Final Application	115	10

Glass beads shall be distributed ~~upon the marked areas at the locations shown on the plans to receive glass beads~~as indicated 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 rates 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.

620-3.7 Application--preformed thermoplastic airport pavement markings. Not used.

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~~painted markings to be paid for shall be the number of completed, visible square feet (square meters) of painting ~~and the number of pounds (km) of reflective media~~performed in accordance with the specifications and accepted by the Engineer.

BASIS OF PAYMENT

620-5.1 Payment shall be made at the respective contract price per square foot (square meter) for completed, visible painted markings~~runway and taxiway painting, and price per pound (km) for reflective media~~**.** This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item.

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,	Determination of volatile matter content, water content, density, volume

Appendix A-7, Method 24	solids, and weight solids of surface coatings
29 CFR Part 1910.1200	Hazard Communication
FED SPEC TT-B-1325D	Beads (Glass Spheres) Retro-Reflective
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

Intentionally Left Blank

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.

All Storm Drain shall be Reinforced Concrete Pipe Class V ASTM C-76.

701-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

701-2.3 Concrete. Concrete for pipe cradles shall have a minimum compressive strength of 2000 psi (13.8 MPa) at 28 days and conform to the requirements of ASTM C94.

701-2.4 Rubber gaskets. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the “RE” closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

701-2.5 Joint mortar. 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).

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 as indicated on the plan details. 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.

a. Rigid pipe. Class A bedding shall comform to the plan details.

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.

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.

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 selected from the excavation or a source of the Contractor's choosing**.** 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.

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 (m) 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.

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.

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 701-5.1a	**[**30**]** inch **[**Class V**]** per linear foot ~~(meter)~~
	[36**]** inch **[**Class V**]** per linear foot ~~(meter)~~
	[42**]** inch **[**Class V**]** per linear foot ~~(meter)~~
	[48**]** inch **[**Class V**]** per linear foot ~~(meter)~~

MATERIAL REQUIREMENTS

AASHTO M198	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
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 C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain

END ITEM D-701

Item D-705 Pipe Underdrains for Airports

DESCRIPTION

705-1.1 This item shall consist of the construction of pipe drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

705-2.1 General. Materials shall meet the requirements shown on the plans and specified below.

705-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements.

ASTM F758 Standard Specification for Smooth-Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

705-2.3 ~~Joint mortar~~Mortar. ~~Pipe joint mortar~~Mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

705-2.4 Elastomeric seals. Elastomeric seals shall conform to the requirements of ASTM F477.

705-2.5 Porous backfill. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

Table 1. Gradation of Porous Backfill

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
	Porous Material No. 2
1-1/2 inch (38 mm)	100
1 inch (25 mm)	90-100
3/8 inch (9 mm)	25-60
No. 4 (4.75 mm)	5-40
No. 8 (2.36 mm)	0-20
No. 16 (1.18 mm)	
No. 50 (0.30 mm)	
No. 100 (0.15 mm)	

705-2.6. Granular material. Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials, or shall meet the requirements of AASHTO Standard Specification for Highway Bridges Section 30.

705-2.7. Filter fabric. The filter fabric shall conform to the requirements of AASHTO M288 Class 2.

Table 2

Fabric Property	Test Method	Test Requirement
Grab Tensile Strength, lbs	ASTM D4632	125 min
Grab Tensile Elongation %	ASTM D4632	50 min
Burst Strength, psi	ASTM D3785	125 min
Trapezoid Tear Strength, lbs	ASTM D4533	55 min
Puncture Strength, lbs	ASTM D4833	40 min
Abrasion, lbs	ASTM D4886	15 max loss
Equivalent Opening Size	ASTM D4751	70-100
Permittivity sec^{-1}	ASTM D4491	0.80
Accelerated Weathering (UV Stability) (Strength Retained - %)	ASTM D4355 *(500 hrs exposure)	70

705-2.8. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of ~~Item P-153~~ Section 02322 Flowable Fill. When CLSM is used for backfill around non-perforated pipe, all pipe joints shall have elastomeric seals.

705-2.9. Cleanout Frame and Cover. Equivalent products for the cleanout frame and cover are 1) Neenah Foundry Model R-3487; 2) Pacific Marine Industrial Model R-3487; and 3) EJ Co. Model 1565.

705-2.10. Inspection Pit Frame and Cover. Equivalent products for the inspection pit frame and cover are 1) Neenah Foundry Model R-3495; 2) Pacific Marine Industrial Model R-3495; and 3) EJ Co. Model 8080.

705-2.11. Terminal Backwater Valve. Equivalent products for the terminal backwater valve are 1) Stan Roberts & Assoc. Model P0206; 2) NDS Model 675P; and 3) Spears Model S675P.

CONSTRUCTION METHODS

705-3.1 Equipment. All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the Engineer before construction is permitted to start.

705-3.2 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The Engineer shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the Engineer. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the Engineer and compacted to the density of the surrounding material.

The pipe bed shall be shaped so at least the lower quarter of the pipe shall be in continuous contact with the bottom of the trench. Spaces for the pipe bell shall be excavated to allow the pipe barrel to support the entire weight of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to Federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

705-3.3 Laying and installing pipe.

a. Concrete pipe. Not used.

b. Metal pipe. Not used.

c. PVC or polyethylene pipe. PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321 or AASHTO Standard Specification for Highway Bridges Section 30. Perforations shall meet the requirements of AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade.

d. All types of pipe. The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the Engineer.

~~Unless otherwise shown on the plans, a 4 inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.~~

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

e. Filter fabric. The filter fabric shall be installed in accordance with the manufacturer's recommendations, or in accordance with AASHTO M288 Appendix, unless otherwise shown on the plans.

705-3.4 Mortar. The mortar shall be of the desired consistency ~~for caulking and filling the joints of the pipe and~~ for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

705-3.5 Joints in concrete pipe. Not used.

705-3.6 Backfilling.

a. Earth. All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The backfill material shall be select material from excavation or borrow and shall be approved by the Engineer. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the Engineer. The material shall be moistened or dried, as required to aid compaction.

~~The~~ For non-perforated pipe, select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and ~~one foot (30 cm)~~ over the top of the pipe and shall be readily compacted. Placement of the backfill shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe, and not exceeding 8 inches (200 mm) over the pipe. Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the Engineer, until the trench is completely filled and brought to the planned elevation. Backfilling shall be done to avoid damaging top or side pressures on the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

b. ~~Granular~~Porous backfill. ~~When granular backfill is required, placement~~Placement in the trench and about the pipe shall be as shown on the plans. The ~~granular~~backfill shall not contain ~~an excessive amount of~~ foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the ~~granular~~backfill. ~~When required by the Engineer, a template shall be used to properly place and separate the two sizes of backfill.~~ The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The ~~granular~~ backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The ~~granular~~ backfill shall extend to the elevation of the trench or as shown on the plans.

~~When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.~~

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. ~~The depth of the granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill.~~ Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

~~If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.~~

c. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of ~~Item P-153~~ Section 02322.

d. Deflection testing. The Engineer may at any time, notwithstanding previous material acceptance, reject or require re-installation of pipe that exceeds 5% deflection when measured in accordance with ASTM D2321, including Appendices.

705-3.7 Connections. When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

705-3.8 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the Engineer. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

METHOD OF MEASUREMENT

705-4.1 The length of pipe shall be the number of linear feet (meters) of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. ~~The several classes, types, and sizes~~The identified pipe types and sizes ~~-~~shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured. All other associated items including, but not limited to, subgrade removal, filter fabric, porous backfill, backfill, and connections to structures shall be incidental to the associated pipe length as applicable.

705-4.2 Underdrain junction boxes and underdrain cleanouts shall be measured by the unit.

~~**705-4.2** The quantity of porous backfill shall be the number of cubic yards (cubic meters) of porous backfill No. 1 and No. 2, complete in place and accepted, and shall be determined from the dimensions given on the plans by typical trench sections indicating the placement of porous backfill or dimensions directed by the Engineer.~~

~~**705-4.3** The quantity of filter fabric shall be the number of square yards (square meters) of filter fabric in place, completed, and approved; and shall be determined from the dimensions given on the plans by typical trench sections indicating the placement of filter fabric or dimensions directed by the Engineer.~~

BASIS OF PAYMENT

705-5.1 Payment will be made at the contract unit price per linear foot (meter) for pipe underdrains of the type, class, and size designated. The price shall include, but not be limited to, subgrade removal, filter fabric, porous backfill, select backfill, backfill, and connections to structures as applicable.

705-5.1 The quantities of underdrain junction boxes and underdrain cleanouts will be paid for at the contract unit price per each in place when completed and accepted.

705-5.3 These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

MATERIAL REQUIREMENTS

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C444	Standard Specification for Perforated Concrete Pipe
ASTM C654	Standard Specification for Porous Concrete Pipe
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F758	Standard Specification for Smooth Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
AASHTO M190	Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M288	Standard Specification for Geotextile Specification for Highway Applications
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500- mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter
AASHTO	Standard Specifications for Highway Bridges

END OF ITEM D-705

Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the Engineer.

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.

751-2.6 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.

751-3.6 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 manholes, catch basins, inlets, and inspection holes will be paid for at the contract unit price per each in place when completed. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials; furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown on the plans; and for all labor equipment, tools and incidentals necessary to complete the structure.

Payment will be made under:

Item D-751-5.3 Inlets - 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 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.

~~Seeds shall be applied as follows:~~

~~Seed~~	~~Minimum Seed Purity~~	~~Minimum Germination~~	~~Rate of Application, lb/acre~~
*	*	*	*

~~Seeding shall be performed during the period between [ ] and [ ] inclusive, unless otherwise approved by the Engineer.~~

Conform to U.S. Department of Agriculture rules and regulations of Federal Seed Act and Texas Seed Law. Seed shall be certified 90 percent pure and furnish 80 percent germination and meet following requirements:

a. Rye: Fresh, clean, Italian rye grass seed (lollium multi-florum), mixed in labeled proportions.

b. Bermuda: Extra-fancy, treated, lawn type common bermuda (Cynodon dactylon).

c. Wet, moldy, or otherwise damaged seed will not be accepted.

d. Seed requirements, application rates, and planting dates are:

TYPE	APPLICATION RATE (LBS./ACRE)	PLANTING DATE
Hulled Common Bermuda Grass 98/88	40	Jan. 1 to Mar. 31
Unhulled Common Bermuda Grass 98/88	40	
Hulled Common Bermuda Grass 98/88	40	Apr. 1 to Sep. 30
Hulled Common Bermuda Grass 98/88	40	Oct. 1 to Dec. 31
Unhulled Common Bermuda Grass 98/88	40	
Annual Rye Grass (Gulf)	30	

901-2.2 LIME.

~~Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 mesh sieve and 50% will pass through a No. 100 mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate of **[___]**. All liming materials shall conform to the requirements of ASTM C602.~~

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.

Caked, damaged, or otherwise unsuitable fertilizer will not be accepted. Fertilizer shall contain minimum percentages of following elements:

a. Nitrogen: 10 Percent

b. Phosphoric Acid: 20 Percent

c. Potash: 10 Percent

Fertilizers ~~shall be **[___]** commercial fertilizer and~~ shall be spread at the rate of 500 pounds per acre, minimum.

This item will not be measured for separate payment but shall instead be considered subsidiary to the cost of seed application.

901-2.4 SOIL RETENTION BLANKET.

Provide and install soil retention blankets (SRB) on all seeded areas. Provide only SRB that meet the requirements of the Texas Department of Transportation (TxDOT) DMS-6370, Soil Retention Blankets, and are on the TxDOT Approved Products List, *Erosion Control Approved Products:*

http://www.txdot.gov/business/resources/erosion-control.html

Use material of the following class and type as shown on the plans and provide a copy of the manufacturer's label for the selected product.

a. **Class 1: Slope Protection**, **Type A**. Slopes 3:1 or flatter—clay soils.

b. **Class 1: Slope Protection**, **Type B**. Slopes 3:1 or flatter—sandy soils.

c. **Class 1: Slope Protection**, **Type C**. Slopes steeper than 3:1—clay soils.

d. **Class 1: Slope Protection**, **Type D**. Slopes steeper than 3:1—sandy soils.

Provide a copy of the manufacturer's installation instructions to the Engineer before placement of the material. Place the SRB within 24 hours after the seeding operation, or when directed. Install and anchor the SRB in strict accordance with the recommendations contained within the manufacturer's published literature. Installation includes the repair of ruts, reseeding, and the removal of rocks, clods, and other foreign materials which may prevent contact of the blanket with the soil.

This item will not be measured for separate payment but shall instead be considered subsidiary to the cost of seed application.

901-2.5 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

901-3.1 ADVANCE PREPARATION AND CLEANUP.

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

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

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches

(75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 DRY APPLICATION METHOD.

~~**a. Liming.** Lime shall be applied separately and prior to the application of any fertilizer or seed and only on seedbeds that have previously been prepared as described above. The lime shall then be worked into the top 3 inches (75 mm) of soil after which the seedbed shall again be properly graded and dressed to a smooth finish.~~

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

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

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

901-3.3 WET APPLICATION METHOD.

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

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

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

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

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

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

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. 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 WATERING.

Adequate water and watering equipment must be on hand before seeding begins, and seed shall be watered until it has become established and its continued growth assured. In all cases, watering shall be done in a manner that will avoid erosion from the application of excessive quantities and will avoid damage to the finished surface. The Contractor shall submit a watering plan to Airport Operations prior to application of any seed materials. The watering plan shall detail the Contractor's proposed method of watering and proposed watering schedule. The proposed method of watering shall not require the closure of any active pavements. The top elevation of all proposed fixed irrigation system components within an RSA or TOFA must not be higher than three (3) inches above finished grade. Any proposed irrigation

system components higher than three (3) inches above finished grade must meet the break-away and failure mechanism requirements of FAA AC 150/5220-23, Frangible Connections. All proposed irrigation system components are subject to approval of Airport Operations.

901-3.5 ESTABLISHING TURF.

a. General. The Contractor shall provide general care for the seeded areas as soon as the seed has been placed and shall continue until final inspection and acceptance of the work.

b. Protection. All seeded 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 seeded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. In the event that weeds or other undesirable vegetation are permitted to grow to such an extent that, either cut or uncut, they threaten to smother the sodded species, they shall be mowed and the clippings raked and removed from the area. The Contractor shall mow installed vegetated areas so that the grass height is maintained between six (6) and twelve (12) inches at no expense to the Owner.

901-3.6 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 acres of seed coverage, 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 under:

Item T-901-5.1 Seeding, Fertilizing, Soil Retention Blanket - 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

Intentionally Left Blank

ITEM T-904 SODDING

DESCRIPTION

904-1.1 This item shall consist of furnishing, hauling, and placing approved live sod on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the Engineer.

MATERIALS

904-2.1 SOD. Sod furnished by the Contractor shall have a good cover of living or growing grass. This shall be interpreted to include grass that is seasonally dormant during the cold or dry seasons and capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is reasonably fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matted turf relatively free of weeds or other undesirable foreign plants, large stones, roots, or other materials that might be detrimental to the development of the sod or to future maintenance. At least 70% of the plants in the cut sod shall be composed of the species stated in the special provisions, and any vegetation more than six (6) inches (150 mm) in height shall be mowed to a height of three (3) inches (75 mm) or less before sod is lifted. Sod, including the soil containing the roots and the plant growth showing above, shall be cut uniformly to a thickness of two (2) inches ~~not less than that stated in the special provisions~~.

a. Species: Bermuda (Cynodon Dactylon), Buffalo (Buchloe Dactyloides), or St. Augustine (Stenotaphrum Secundatum) Gulf Coast variety to match existing sod.

b. Contents: 95 percent permanent grass suitable to climate in which it is to be placed; not more than 5 percent weeds and undesirable grasses; good texture, free from obnoxious grasses, roots, stones and foreign materials.

c. Sod is to be supplied and maintained in healthy condition as evidenced by grass being normal green color.

904-2.2 LIME.

~~Lime shall be ground limestone containing not less than 85% of total carbonates, and shall be ground to such fineness that 90% will pass through a No. 20 mesh sieve and 50% will pass through a No. 100 mesh sieve. Coarser material will be acceptable, providing the rates of application are increased to provide not less than the minimum quantities and depth specified in the special provisions on the basis of the two sieve requirements above. Dolomitic lime or a high magnesium lime shall contain at least 10% of magnesium oxide. Lime shall be applied at the rate of **[___]**. All liming materials shall conform to the requirements of ASTM C602.~~

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

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

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

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

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

Caked, damaged, or otherwise unsuitable fertilizer will not be accepted. Fertilizer shall contain minimum percentages of following elements:

a. Nitrogen: 12 Percent

b. Phosphoric Acid: 4 Percent

c. Potash: 8 Percent

Fertilizers ~~shall be **[ ]** commercial fertilizer and~~ shall be spread at the rate of 25 pounds per 1,000 square feet, minimum.

This item will not be measured for separate payment but shall instead be considered subsidiary to the cost of seed application.

904-2.4 WATER.

The water shall be sufficiently free from oil, acid, alkali, salt, or other harmful materials that would inhibit the growth of grass. It shall be subject to the approval of the Engineer prior to use.

904-2.5 SOIL FOR REPAIRS.

The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials 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. The Contractor shall submit a watering plan to Airport Operations prior to application of any sod materials. The watering plan shall detail the Contractor's proposed method of watering and proposed watering schedule. The proposed method of watering shall not require the closure of any active pavements. The top elevation of all proposed fixed irrigation system components within an RSA or TOFA must not be higher than three (3) inches above finished grade. Any proposed irrigation system components higher than three (3) inches above finished grade must meet the break-away and failure mechanism requirements of FAA AC 150/5220-23, Frangible Connections. All proposed irrigation system components are subject to approval of Airport Operations.

904-3.7 ESTABLISHING TURF.

a. General. The Contractor shall provide general care for the sodded areas as soon as the sod has been laid and shall continue until final inspection and acceptance of the work.

b. Protection. All sodded areas shall be protected against traffic or other use by warning signs or barricades approved by the Engineer.

c. Mowing. The Contractor shall mow the sodded areas with approved mowing equipment, depending upon climatic and growth conditions and the needs for mowing specific areas. In the event that weeds or other undesirable vegetation are permitted to grow to such an extent that, either cut or uncut, they threaten to smother the sodded species, they shall be mowed and the clippings raked and removed from the area. The Contractor shall mow installed vegetated areas so that the grass height is maintained between six (6) and twelve (12) inches at no expense to the Owner.

904-3.8 REPAIRING.

When the surface has become gullied or otherwise damaged during the period covered by this contract, the affected areas shall be repaired to re-establish the grade and the condition of the soil, as directed by the Engineer, and shall then be sodded as specified in paragraph 904-3.5.

904-3.9 MAINTENANCE OF SODDED AREAS.

The Contractor shall protect sodded areas against traffic or other use by warning signs or barricades, as approved by the Engineer. Surfaces gullied or otherwise damaged following sodding shall be repaired by regrading and resodding as directed. The Contractor shall mow, water as directed, and otherwise maintain sodded areas to the conditions as specified herein until final inspection and acceptance of the work.

METHOD OF MEASUREMENT

904-4.1 This item shall be measured on the basis of the area in square yards of the surface covered with sod and accepted.

BASIS OF PAYMENT

T-904-5.1 This item will be paid for on the basis of the contract unit price per square yard for sodding, which price shall be full compensation for all labor, equipment, material, staking, maintenance, and incidentals necessary to satisfactorily complete the items as specified.

Payment will be made under:

Item T-904-5.1	Sodding, Fertilizer - per square yard

MATERIAL REQUIREMENTS

ASTM C602	Standard Specification for Agricultural Liming Materials

END OF ITEM T-904

Intentionally Left Blank

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 (two (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.~~ All areas to be vegetated within the project shall receive topsoil prior to vegetation installation. ~~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.~~ Topsoil onsite shall be excavated or stripped in all areas to be disturbed to a depth of four (4) inches in accordance with the requirements of FAA Item P-152-2.10.

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 two (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 two (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 (two (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
~~Item T-905-5.2~~	~~Topsoiling (Furnished from Off the Site) - 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

INTENTIONALLY LEFT BLANK

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.

108-1.2 **References**. Additional information pertaining to the items covered in this section are contained in the Federal Aviation Administration (FAA) Advisory Circulars (AC's), latest edition, listed below:

150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
150/5345-53	Airport Lighting Equipment Certification Program
150/5370-2	Operational Safety on Airports During Construction
150/5370-10	Standard for Specifying Construction of Airports

The contractor is responsible for obtaining and using the latest edition of the referenced FAA Advisory Circulars. This list is not all inclusive but is offered as a convenience to the Contractor.

ALL NEW ELECTRICAL SYSTEMS SHOULD BE TESTED TO COMPARE THEIR COMPATIBILITY TO INSTALLED EQUIPMENT. OPERATIONAL TESTS SHALL BE PERFORMED TO ENSURE NO INCREASE IN ELECTROMAGNETIC INTERFERENCE (EMI) OCCURS OVER THE ORIGINAL FINDINGS.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. 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..

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. The Contractor's submittals shall be in accordance with Item L-106, Submittals, Record Documents and Maintenance Manuals.

e. The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the plans and specifications. The Engineer reserves the right to reject any and all equipment, materials, or procedures which, in the Engineer's opinion, does not meet the system design and the standards and codes specified herein..

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. A copy of the megger test results are required to be furnished to the engineer for review at the completion of the project. Results are required for all new circuits and modified circuits. The meggar results for all new circuits and all new portions of modified circuits must meet the FAA criteria. Any circuits that do not meet the FAA criteria will be required to be repaired at the contractors expense until acceptable meggar results are achieved.

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, with cross-linked polyethylene insulation. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or 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 shall they be less than 10-feet (305 cm) long nor less than 3/4-inch (19 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 back fill conduit and duct bank trenches shall be designed utilizing a minimum of 5 lb cement (ASTM C150 – Type II) and 250 lb fly ash (ASTM C618, Class C or F) per cubic yard with remainder of volume consisting of sand, water and only approved admixtures to achieve a compressive strength of 100 to 200 psi when tested in accordance with ASTM D 4832 after 28 days.

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.

In addition to a cable tag, all cables shall be further identified using color coded tape (Scotch 88, 1.5" wide, 8.5mil thick vinyl or equal). The tape shall be located on each cable end, including all connector kit and splice ends and in each pullcan, manhole or handhole. The contractor shall thoroughly swab, clean and dry the portion of cable to receive the tape. The tape shall include a minimum of 3 full wraps. Use separate color for all conductors. Where color coded conductors are installed, the additional of tape is not required.

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.

108.2.13 Temporary Circuiting and Electrical Provisions. Provide temporary circuiting and electrical provisions as required by the airport operations representative to maintain operational needs of the airport during construction. The temporary circuit may include #8AWG L-824C conductors installed in new or existing ducts, taping or otherwise covering existing lighted fixtures to blank out and sign panel modifications (temporary blanking out all or portions of a legend). All outages of airfield nav-aid components shall be approved by the owner prior to construction of the area. The electrical contractor shall provide a phasing plan for review and approval prior to construction. The phasing plan shall show all temporary connections and associated outages broken out for each phase of the project.

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 flexible mandrel 1/4-inch less than the conduit size, 2 wire brushes, and a rag 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. 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.

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 to the engineer, a cable installation plan for all cable pulls. Cable installation plan shall include:

1. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
2. List of cable installation equipment.
3. Lubricant manufacturer's application instructions.
4. Procedure for resealing cable ends to prevent moisture from entering cable.
5. Cable pulling tension calculations of all cable pulls.
6. Cable percentage conduit fill.
7. Cable sidewall thrust pressure.
8. Cable minimum bend radius and minimum diameter of pulling wheels used.
9. Cable jam ratio.
10. Maximum allowable pulling tension on each different type and size of conductor.

Maximum allowable pulling tension on pulling device.

The Contractor shall submit the recommended pulling tension values to the Engineer prior to any cable installation. 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. Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the seeding, and topsoiling as shown on the plans. Refer to specifications T-901 Seeding, and T-905 TopSoiling. 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 Excavation and Embankment. Restoration shall be considered incidental to the pay item of which it is a component part.

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. Where the cable or duct/conduit trench runs parallel to the edge of pavement, the counterpoise shall be installed in a separate trench located half the distance between the pavement edge and the cable or duct/conduit trench. In trenches not parallel to pavement edges, counterpoise wire shall be installed continuously a minimum of 4-inches above the cable, conduit or duct bank, or as shown on the plans if greater.

The counterpoise wire shall be attached to the light fixture base grounding lug for light cans installed in pavement. More than one counterpoise may be needed for wider ductbanks. The counterpoise wire shall also be exothermic welded to copper or copper-clad ground rods installed not more than 500 feet apart around the entire circuit. The ground rods shall be of the length, diameter and type specified in the plans, but in no case shall they be less than 10 feet long nor less than ¾ inch in diameter.

Additionally, counterpoise wire shall be installed at least 8-inches below the top of subgrade in paved areas or 10-inches below finished grade in un-paved areas. This dimension may be less than 4-inches

where conduit is to be embedded in existing pavement. Counterpoise wire shall not be installed in conduit.

Where hard or rocky earth is encountered during the ground rod installation, the contractor shall drill at least 18" down to break thru the layer for installation of the ground rod. If after drilling, the ground rod still cannot be driven into the ground, them the contractor shall submit the findings in writing to the engineer for review. The engineer may either require an additional 6" of drilling or allow the contractor to install UL Listedground plates in lieu of ground rods. The ground plates must be Listed and at least 2 ft square and 0.032" deep copper flat plate installed at a depth of 18" below grade. The plate must be installed horizontally, thereby requiring an excavation area of at least 28x28x18"d.

The counterpoise system shall be continuous and terminate at one of the following locations: (1) the existing counterpoise system, (2) the transformer vault, or (3) 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.

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.

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.

The counterpoise conductor is bonded to ground rods that are located on each side of a duct crossing. Where conduit or duct runs continue beneath pavement (i.e., apron areas, etc.), install the counterpoise a minimum of 4 inches above conduits or ducts along the entire run.

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 20 Giga-Ohms.

f. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 1000 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. Refer to Spec 26 0820 for additional testing requirements.

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.

108-3.11 **CABLE INSTALLATION REPORTS**. Submit copies of the information described below in 8-1/2-inch by 11-inch binders having a minimum of 5 rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

a. Site layout drawing with all cable pulls numerically identified.

b. A list of all equipment used, with calibration certifications.

c. The manufacturer of and quantity of lubricant used on pull.

d. The cable manufacturer and type of cable. The dates of cable pulls, time of day, and ambient temperature.

e. The length of cable pulls and calculated cable pulling tensions.

f. The actual cable pulling tensions encountered during pull.

METHOD OF MEASUREMENT

108-4. Cable or counterpoise wire installed in trench, duct bank or conduit shall be measured by the number of linear feet of cable or counterpoise wire installed in trenches, duct bank or conduit, including trenching, ground rods with test reports and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory by the Engineer. Also included in this pay item is the associated trenching for counterpoise cable, including the excavation. backfill, and restoration, seeding, complete 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. Measurement and payment for counterpoise cable installed at encased duct banks, directional drill or cased bore drill locations will be incidental to the item in which it is installed.

108-4.2 Temporary Circuitry and Electrical Provisions shall be measured on a lump sum basis and shall include all the proposed temporary cabling and electrical provisions required to coordinate with the contractors phasing plan. This item includes the temporary cables, associated installation, labels, trenching, terminations, splice kits and all incidentals and materials required for temporary cable

requirements. In addition, this shall include blanking out existing lighted fixtures and/or sign panels as required by airport operations.

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.

108.5.2 Payment for conductors will be paid at the contract unit price for electrical circuits 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 necessary to complete this item.

Payment will be made under:

Item L-108-5.1	No. 8 AWG, L824C Cable, Installed in conduit or duct - per linear foot
Item L-108-5.2	No. 6 AWG Bare Counterpoise Wire, Installed in Conduit Trench, Including Ground Rods and Ground Connections - per linear foot
Item L-108-5.3	FAA RWSL circuit with (2) #8AWG L-824C cables (1-red, 1-Black) and (1) #6AWG USE solid ground with green jacket, installed in Conduit or Duct - per linear foot
Item L-108-5.4	No. 1/0 AWG Bare Counterpoise Wire, Installed in Conduit Trench, Including Ground Rods and Ground Connections - 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 submitted to the Engineer within fifteen (15) days of the notice to proceed. The contractor's submittals shall follow requirements in Specification 01 33 00. 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 **1/8** 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 be designed utilizing a minimum of 5 lb cement (ASTM C150 – Type II) and 250 lb fly ash (ASTM C618, Class C or F) per cubic yard with remainder of volume consisting of sand, water and only approved admixtures to achieve a compressive strength of 100 to 200 psi when tested in accordance with ASTM D 4832 after 28 days.

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.

110-2.9 Counterpoise Wire. Counterpoise wire shall be as specified in Item L-108 Underground Power Cable for Airports.

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.

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, proper 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. Where two or more conduits in the duct bank are intended to carry conductors of equivalent voltage insulation rating, the Contractor shall space the conduits not less than 1.5 inch (37 mm) apart (measured from outside wall to outside wall). Where two or more conduits in the duct bank are intended to carry conductors of differing voltage insulation rating, the Contractor shall space the conduits not less than 3-inches 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. End bells or couplings shall be installed flush with the concrete encasement at access points.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 a minimum of 4" seeding and topsoiling.asshown 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.

110-3.8 Bore Drill. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing and delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of the project. Perform the work in general conformance with ASTM F1962, current revision, “Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit under Obstacles, Including River Crossings.”

Locate all existing utilities in the area of the bore drill pathway prior to construction. Call all applicable municipalities and review existing landmarks. The contractor shall install a pilot bore prior to actual bore drilling operation to assure clear pathway. Keep detailed records of bore depth, pitch, fluids used and any special conditions. Monitor and adjust the drilling fluid mix as needed to match soil conditions. Once pilot bore has verified a clear pathway, then bore hole may be reamed and enlarged for installation of pipe.

Where pipe joints are required consult the PVC manufacturer on guidance for the proper connection methods approved for their products. Where butt fusion is approved, follow ASTM D3261. Test butt splice joint in accordance with ASTM D638. Use a data logging device to record the critical butt fusion parameters and procedures used in making each butt fusion joint. Compare the records to the pipe manufacturers butt fusion procedures to make sure the joints were made properly before pulling the pipe back into the bore hole.

The guidance system shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

The conduit duct shall be HDPE Schedule 80 PVC conduit. Conduit shall have an SDR ration of 9 or 11. The Contractor is responsible for selection of Schedule 80 PVC raceway that is compatible with the proposed directional bore method and equipment."

The drilling fluid must be a mixture of Bentonite drilling clay, project specific cutting fluid additives and potable water is to be used at the cutting fluid and over ream hole filler. The drilling fluid mixture shall have the following viscosities as measured by a March Funnel:

a. Rock Clay - 60 sec.
b. Hard Clay - 40 sec.
c. Soft Clay - 45 sec.
d. Sandy Clay - 90 sec
e. Stable Sand - 120 sec.
f. Loose Sand - 150 sec.
g. Wet Sand - 150 sec.

The Contractor will contain all drilling and pipe lubricating mud by taking special measures to prevent run-off onto adjacent properties and/or waterways. All surplus drilling and pipe lubricating mud will be removed from the site and properly disposed of by the Contractor at no cost to the Owner. The Contractor will also be responsible for all required erosion control measures at no cost to the Owner.

110-3.9 Counterpoise Wire. Counterpoise wire shall be installed as specified in Item L-108.

METHOD OF MEASUREMENT

110-4.1 Underground conduits and duct banks shall be measured by the linear feet of conduits and duct banks installed, including encasement, locator tape, couplings, end bells, conduit transitions, conduit connection to existing light base, trenching and backfill with designated material, and for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Also incidental to the ductbank item is modifications to existing manhole, handhole or pullbox to accept new ducts. Where multiple encased ducts are routed in a single trench, this item includes a No. 6 counterpoise wire with ground rods and ground connections. Separate measurement shall be made for the various types and sizes. There is no separate measurement for multiple encased ducts installed modified pavement areas or earth.

110.4.2 Underground conduits and duct banks directional drilled shall be measured by the linear feet of conduits and duct banks installed, including drilling equipment, drill pit with associated excavation, backfill and restoration, drill fluids and all incidentals, conduit plugs, all measured in place, completed, and accepted. Separate measurement shall be made for the various types, sizes and installed location.

110-4.3 Conduit transitions under pavement shall be measured by each transition installed, complete in place, including preparing existing conduit end and surrounding pavement, couplers, bonding materials and all tools and incidentals required all measured in place, completed and accepted. Payment for conduit transitions in earth are incidental to the line item in which they are installed.

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	1-way, 2" PVC Conduit, Concrete Encased in New Shoulder Pavement – per Linear Foot
Item L-110-5.2	1-way, 2" PVC Conduit, Concrete Encased in New Full Strength Pavement – per Linear Foot
Item L-110-5.3	1-way, 2" PVC Conduit, Direct Earth Buried - per Linear Foot
Item L-110-5.4	1-way, 4" PVC Conduit, Direct Earth Buried - per Linear Foot
Item L-110-5.5	2-way, 2" PVC Conduit, Concrete Encased in New Shoulder Pavement – per Linear Foot
Item L-110-5.6	2-way, 2" PVC Conduit, Concrete Encased in New Full Strength Pavement – per Linear Foot
Item L-110-5.7	4-way, 4" PVC Conduit, Concrete Encased including Ground Rods and Counterpoise Cable – per Linear Foot
Item L-110-5.8	Conduit Transition under Pavement – Per Each

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 The Contractor's submittals shall be in accordance with Specification 01 3300.

d. The data submitted shall be sufficient, in the opinion of the Engineer, to determine compliance with the plans and specificationsThe 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) 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 100,000 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 by a registered professional engineer within the state the project is being performed, along with all 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 and shall be 4,000 psi at 28-days..

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 load of 200,000 lbs.

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

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

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

Each cover shall have the word “ELECTRIC” or other approved designation cast on it. 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 back fill conduit and duct bank trenches shall be designed utilizing a minimum of 5 lb cement (ASTM C150 – Type II) and 250 lb fly ash (ASTM C618, Class C or F) per cubic yard with remainder of volume consisting of sand, water and only approved admixtures to achieve a compressive strength of 100 to 200 psi when tested in accordance with ASTM D 4832 after 28 days..

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 10 feet (304.8 cm) long nor less than 3/4 inch (19.05 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. All manhole and handhole adjustments must preserve the structural rating of the existing manhole. Where the existing structural rating is not known, adjustments and new components must be aircraft rated. Submit structural calculations to show compliance where applicable.

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, Handholes, Junction Can Plazas and Pullboxes, shall be measured by each unit, completed in place and accepted. This shall include the manhole, handhole, junction can plaza or pullbox structure, lid cover and ID tag, saddle racks, ducts plugs, encasement, labels, ground rod with test report and connections, sump drain and all required excavation, foundation, dewatering, backfilling, sheeting and bracing, restoration of disturbed areas, sodding, connections, and for drain lines and the termination at the drainage structure, and ground rod testing. Separate measurement shall be made for the various types and sizes.

115-4.2 The manhole or handhole structure elevation adjustment and/or making aircraft rated shall be measured by each unit modified, complete in place and accepted. This shall include all required materials, cutting of existing manhole top section, if required, structural top sections, covers, labels, excavation, and sodding and incidentals necessary all measured in place, completed, and accepted. Separate measurement will be made if the manhole requires structural modifications only or structural modifications as well as grade adjustments.

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	L-867D Pullbox – Per Each
Item L-115-5.2	Install new aircraft-rated handhole 4'x4'x4' – per Each
Item L-115-5.3	Adjust Elevation of Existing Structure and Make Aircraft Rated – Per Each
Item L-115-5.4	Modify Existing Structure to make Aircraft Rated – 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