Item C-100 Contractor Quality Control Program (CQCP)

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

The Contractor shall establish a CQCP that will:

a. Provide qualified personnel to develop and implement the CQCP.

b. Provide for the production of acceptable quality materials.

c. Provide sufficient information to assure that the specification requirements can be met.

d. Document the CQCP process.

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

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

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

a. Review of the CQCP including submittals, QC Testing, Action & Suspension Limits for Production, Corrective Action Plans, Distribution of QC reports, and Control Charts.

b. Discussion of the QA program.

c. Discussion of the QC and QA Organization and authority including coordination and information exchange between QC and QA.

d. Establish regular meetings to discuss control of materials, methods and testing.

e. Establishment of the overall QC culture.

100-2 Description of program.

a. General description. The Contractor shall establish a CQCP to perform QC inspection and testing of all items of work required by the technical specifications, including those performed by subcontractors. The CQCP shall ensure conformance to applicable specifications and plans with respect to materials, off-

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

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

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

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

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

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

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

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

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

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

(1) Professional Engineer with one (1) year of airport paving experience.

(2) Engineer-in-training with two (2) years of airport paving experience.

(3) National Institute for Certification in Engineering Technologies (NICET) Civil Engineering Technology Level IV with three (3) years of airport paving experience.

(4) An individual with four (4) years of airport paving experience, with a Bachelor of Science Degree in Civil Engineering, Civil Engineering Technology or Construction.

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

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

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

(1) Inspection of all materials, construction, plant, and equipment for conformance to the technical specifications, and as required by paragraph 100-6.

(2) Performance of all QC tests as required by the technical specifications and paragraph100-8.

(3) Performance of tests for the RPR when required by the technical specifications.

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

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

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

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

a. Specification item number

b. Item description

c. Description of submittal

d. Specification paragraph requiring submittal

e. Scheduled date of submittal

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

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

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

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

100-7 Contractor QC testing facility.

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

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

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

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

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

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

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

b. Item description (e.g., Hot Mix Asphalt Pavements)

c. Test type (e.g., gradation, grade, asphalt content)

d. Test standard (e.g., ASTM or American Association of State Highway and Transportation Officials (AASHTO) test number, as applicable)

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

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

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

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

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

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

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

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

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

(1) Technical specification item number and description

(2) Compliance with approved submittals

(3) Proper storage of materials and equipment

(4) Proper operation of all equipment

(5) Adherence to plans and technical specifications

(6) Summary of any necessary corrective actions

(7) Safety inspection.

(8) Photographs and/or Video

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

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

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

(1) Technical specification item number and description

(2) Test designation

(3) Location

(4) Date of test

(5) Control requirements

(6) Test results
(7) Causes for rejection
(8) Recommended remedial actions
(9) Retests

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

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

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

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

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

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

100-12 Noncompliance.

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

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

(1) Order the Contractor to replace ineffective or unqualified QC personnel or subcontractors and/or

(2) Order the Contractor to stop operations until appropriate corrective actions are taken.

METHOD OF MEASUREMENT

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

a. With first pay request, 25% with approval of CQCP and completion of the Quality Control (QC)/Quality Assurance (QA) workshop.

b. When 25% or more of the original contract is earned, an additional 25%.

c. When 50% or more of the original contract is earned, an additional 20%.

d. When 75% or more of the original contract is earned, an additional 20%

e. After final inspection and acceptance of project, the final 10%.

BASIS OF PAYMENT

100-14 Payment will be made under:

900.645 (FAA C-100 CONTRACTOR QUALITY CONTROL PROGRAM (CQCP))

per Lump Sum

REFERENCES

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

National Institute for Certification in Engineering Technologies (NICET)

ASTM International (ASTM)

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

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

DESCRIPTION

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

The Erosion Prevention and Sedimentation Control (EPSC) measures provided within the specification and as depicted on the Contract Drawings represent the minimum effort that is anticipated to be required. This does not relieve the Contractor from the responsibility to provide additional ESPC measures beyond this minimum should they be required. If additional ESCP measures are required, they shall not be paid for separately rather shall be considered subsidiary to 900.645 Special Provision (C-102; Sediment and Erosion Control).

Temporary erosion control shall be in accordance with the approved erosion control plan; the approved Construction Safety and Phasing Plan (CSPP) and AC 150/5370-2, *Operational Safety on Airports During Construction* and the project's Construction General Permit issued by the Vermont Agency of Natural Resources. 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.

The work of the contractor shall include but not be limited to the following:

1. Compliance with the Low Risk Site Handbook and all requirements of the State of Vermont permitting requirements, including the Construction General Permit conditions received for the project.

2. The Contractor shall adhere to the Erosion Prevention and Sediment Control Plan (EPSCP) for the project and provide an On-site Plan Coordinator responsible for implementing and monitoring the EPSCP. The Contractor shall prepare and submit for approval, any amendments necessary to the EPSCP in order to control pollution of air and water, soil erosion, and siltation until final acceptance of the project.

3. The installation and maintenance of all ESPC measures as detailed on the plans or these specifications.

4. All necessary precautions and actions to prevent the transport of sediment, or debris, to off-site or undisturbed on-site areas, and to all watercourses/wetlands.

5. The Contractor shall take all reasonable steps to prevent any discharge in violation of this Specification or the Project Permits. The Contractor shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances), which are

installed or used, to achieve compliance with the conditions of this specification and all application permits and regulations

MATERIALS

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

102-2.2 Mulches. Mulches may be wood fiber or cellulous fiber and free of noxious weeds and deleterious materials per Item T-908. Mulches shall not create a wildlife attractant.

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

102-2.4 Slope Drains. Not used.

102-2.5 Straw Wattles. Straw wattles shall be cylinders of compressed, weed free of straw, between 8 to 12 inches in diameter and 10 to 25 feet long. Encased in a durable netting such as jute, nylon, or other photo degradable material.

102-2.6 Barrier Fence. Barrier fence shall be 48" tall (min.) high density polyethylene safety fence installed on hardwood stakes or steel t-posts as details on the contract plans.

102-2.7 Rolled Erosion Control Product. Rolled erosion control matting (product) shall be a wood excelsior matting as detailed on the contract plans.

102-2.8 Inlet Protection. Inlet protection shall consist of a permeable geotextile that allows water to pass but prevents silt and sediment from entering the drainage system. The geotextile shall be installed under and integral to the catch basin grate. The geotextile shall have lifting devices to allow the removal of the geotextile without allowing sediment to enter the drainage network. The Contractor shall confirm drain grate sizes prior to ordering. Inlet protection shall meet the following:

Table 1 Physical Requirements

Grab Strength (lbs.)	ASTM D 4632	375
Max. Elongation (%)	ASTM D 4632	30%
Puncture Strength (lbs.)	ASTM D 4833	140
Burst Strength (psi)	ASTM D 3768	600
Trapezoid Tear (lbs.)	ASTM D 4533	120
Apparent Opening Size (mm)	ASTM D 4751	0.212
Permittivity (Sec^{-1})	ASTM D 4491	1.5
Water Flow Rate (gal/min/sf)	ASTM D 4491	140

Ultraviolet Degradation (% Retained Strength)	ASTM D 4355	90

102-2.9 Stone Check Dams. Stone check dams shall be constructed of 2 inches – 9 inches diameter stone placed on filter fabric in accordance with the contract plans.

102-2.10 Other. All other materials shall meet the requirements of the Vermont Standards and Specifications for Erosion Prevention & Sediment Control (Current Edition) and shall be approved by the RPR before being incorporated into the project.

102-2.11 Shop Drawings and Certifications. The Contractor shall submit manufacturer's Shop Drawings and Certifications of Compliance on all sediment and erosion control products to be used on-site.

CONSTRUCTION REQUIREMENTS

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

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

102-3.2 Erosion Prevention and Sediment Control Plan (EPSCP). As required or as directed, the Contractor shall make revisions to the EPSCP in order to prevent the discharge of sediment from the site. The EPSCP is a necessary component in complying with the Individual Construction Stormwater Discharge Permit conditions received for the project. The EPSCP and all amendments shall be kept on site for use at all times. Additionally, the Contractor shall provide a qualified On-Site Plan Coordinator, subject to the approval of the Owner and Agency of Natural Resources, responsible for implementation of EPSCP and compliance with the conditions of the Individual Stormwater Discharge Permit.

102-3.3 Schedule. Prior to the start of construction, the Contractor shall submit schedules in accordance with the approved Construction Safety and Phasing Plan (CSPP) and the plans for accomplishment of temporary and permanent erosion control work for clearing and grubbing; grading; construction; paving; and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the RPR.

102-3.4 Construction details. The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the plans and approved CSPP. Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

Where erosion may be a problem, schedule and perform clearing and grubbing operations so that grading operations and permanent erosion control features can follow immediately if project conditions permit. Temporary erosion control measures are required if permanent measures cannot immediately follow grading operations. The RPR shall limit the area of clearing and grubbing, excavation, borrow, and

embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current with the accepted schedule. If seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified as directed by the RPR.

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

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

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

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

102-3.5 Installation, maintenance and removal of silt fence. Silt fences shall extend a minimum of 16 inches (41 cm) and a maximum of 34 inches (86 cm) above the ground surface. Posts shall be set no more than 10 feet (3 m) on center. Filter fabric shall be cut from a continuous roll to the length required minimizing joints where possible. When joints are necessary, the fabric shall be spliced at a support post with a minimum 6-inch (300-mm) overlap and securely sealed. A trench shall be excavated approximately 6 inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the silt fence. The trench shall be backfilled and the soil compacted over the silt fence fabric. The Contractor shall remove and dispose of silt that accumulates during construction and prior to establishment of permanent erosion control. The fence shall be maintained in good working condition until permanent erosion control is established. Silt fence shall be removed upon approval of the RPR.

102.3.6 Straw Wattles. Straw wattles shall be placed where shown on the Plans, as needed, or directed by the RPR. The straw wattles shall be constructed in accordance with the details shown on the Plans. The Contractor shall frequently inspect the straw wattles to determine if sediment has accumulated. Accumulated sediment behind straw wattles shall be removed when accumulation reaches half the height of the wattle. Removed material shall be placed in an upland location and stabilized as necessary. Straw wattles shall be reshaped or replaced if they become flattened, cakes with sediment, or otherwise are no longer effective for runoff or sediment control. No separate measurement for payment will be made for maintenance, repair, replacement, and removal of straw wattles, rather this work shall be considered incidental to the original installation of the straw wattles.

102-3.7 Inlet Protection. Inlet protection shall be installed on all new and existing catch basins/inlets that will receive flow from the work area(s). At a minimum, inlet protection shall be inspected weekly and after every half-inch of rainfall and cleaned as needed. Captured sediment must be removed when it reaches or exceeds 1/3 capacity. Devices shall be removed after final stabilization and upon approval of the RPR.

102-3.8 Geotextile Fabric. Geotextile fabric shall be used in conjunction with other EPSC measures where required. Fabric shall be checked before and after each storm event, and as part of weekly inspections. If fabric is clogged, it shall be replaced. All sediment accumulated on the fabric shall be

removed on a regular basis. Geotextile shall also be used to line any and all sediment traps constructed onsite, at no additional cost to the Owner.

102-3.9 Stone Check Dams Stone check dams shall be placed where shown on the Plans, as needed, or directed by the RPR. The stone check dams shall be constructed in accordance with the details shown on the Plans. The Contractor shall frequently inspect the stone check dams on a daily basis and after every rain event after installation. Stone check dams and inlet protection shall be repaired or replaced when they become damaged or ineffective and remove any silt that accumulates. No separate measurement for payment will be made for the maintenance, repair replacement and removal of stone check dams, rather this work shall be considered incidental to the original installation of the stone check dams.

102-3.10 Barrier Fence. Barrier Fence shall be installed where shown on the plans or as directed by the RPR. Barrier Fence shall be installed on hardwood stakes or steel posts. The fence shall have a minimum height of 4 feet. The posts shall be embedded a minimum of 18 inches into the ground, shall extend above the fabric, and shall be installed at a 10-foot maximum spacing. The fabric shall be securely attached to the posts with zip ties, wire or other approved means. The Contractor shall inspect, and maintain barrier fence on a daily basis. If the fence is damaged or becomes loose or requires relocation the work shall be performed at no additional cost to the Owner. At the completion of the work or when the barrier fence is no longer needed it shall be removed by the contractor and the surrounding ground restored to preconstruction condition or better. No separate measurement for payment will be made for the maintenance, repair, replacement, relocation and removal of barrier fence, rather this work shall be considered incidental to the original installation of the barrier fence.

102-3.11 Dust Control. The Contractor shall maintain at the construction site the equipment necessary for the application of water for dust control within the construction site and on haul roads. The equipment shall be equipped with a shut-off control valve that can be operated from the cab by the operator. The Contractor shall have a sufficient number of pieces of equipment to control the dust. The Contractor shall apply water for dust control as necessary to prevent dust from the construction site and/or haul roads from being a hazard to aircrafts, from being a nuisance to the public, and as directed by the RPR.

The Contractor shall furnish water for dust control that is clear and free of harmful amounts of oil, salts, acids, alkalis, sugar, silt, mud, grasses, organic matter or other substances injurious to the finished product, plant life, or the establishment of plant life. The Contractor shall be responsible for providing all water necessary for dust control and shall pay all fees relating thereto.

No separate measurement for payment will be made for dust control, rather this work shall be considered incidental to the project.

102-3.12 Rolled Erosion Control Product (RECP) Surfaces with slopes equal to, or greater than three to one (3h:1v), areas indicated on the Plans, and other areas as directed by the RPR, shall receive erosion control matting to assist in the control of erosion.

All areas to receive matting shall conform to the grades and cross sections shown on the Plans, and shall be finished to a smooth and even condition with all debris, roots, stones, and lumps raked out and removed. The soil surface shall be sufficiently loose to permit bedding of the matting. Unless otherwise directed, seed shall be applied prior to placement of the matting.

In low velocity drainage swales, the material shall be unrolled in the direction of the flow of water. Where strips of excelsior matting are laid end to end, the adjoining ends shall be butted.

Erosion control matting shall be installed as detailed on the Contract Plans.

102-3.13 Soil Stockpiling. The following shall apply to soil stockpiling:

No soil stockpiles shall be stored within the one hundred (100) feet a buffer zone, or within fifteen (15) feet of any property line. Stockpiles shall be in areas as shown on the Plans or approved by the RPR.

Any stockpiles of potentially erodible soil which are to remain in place for more than one (1) week shall receive temporary seeding and mulching, or be covered, and shall have an erosion control barrier (straw wattle) installed on the down gradient side of the pile. Said erosion control barrier shall be in addition to any project perimeter barriers indicated on the Plans.

Stockpiles which show signs of erosion shall have additional mulch or placed on them.

No separate measurement for payment will be made for soil stockpiling erosion protection, rather this work shall be considered incidental to the project

METHOD OF MEASUREMENT

102-4.1 Temporary erosion and pollution control work required will be performed as scheduled or directed by the RPR. Completed and accepted work will be measured as follows:

a. Temporary seeding including mulch and fertilizer will not be measured for payment rather it will be considered incidental to the Sediment and Erosion Control item.

b. Temporary benches, dikes, dams, and sediment basins will not be measured for payment rather they will be considered subsidiary to the Sediment and Erosion Control.

c. Straw wattles shall be measured by the number of linear feet of straw wattles installed and accepted including furnishing, installing, maintaining, repairing and removal.

d. Stone check dams will be measured by the number of each stone check dam including geotextile constructed, maintained, repaired and ultimately removed as shown on the plans or as direct by the RPR.

e. Rolled Erosion Control Matting (Product) shall be measured by the number of square yards of matting measured in-place installed and accepted by the RPR. No additional measurement will be made for overlapping matting.

f. Inlet protection will be measured by the number of each inlet protector installed and accepted including furnishing, installing, maintaining, repairing and removal.

g. Barrier fence shall be measured by the number of linear feet of barrier fence installed and accepted including furnishing, installing, maintaining, repairing, and removal.

h. Sedimentation Control Inspection and Reporting is required by the EPSCP, ICSDP, and all other applicable Local, State, and Federal permits, regulations, policies. Measurement for payment for the inspections, monitoring and reporting shall not be measured for payment, but rather as a single lump sum item.

i. Sediment and Erosion Control shall be measured as a single lump sum item to include the installation, maintenance, and removal of all EPSC measures not otherwise called to be paid for required to maintain compliance with this specification, the EPSCP, the project permits, and all

applicable state, federal, and local regulations. Items may include but not be limited to temporary seed, mulch, fertilizer, stone, filter bags, sandbags, dust control, and temporary sediment basis. This items also includes preparing any amendments to the projects EPSCP as required during the project.

102-4.2 Control work performed for protection of construction areas outside the construction limits, such as borrow and waste areas, haul roads, equipment and material storage sites, and temporary plant sites, will not be measured and paid for directly but shall be considered as a subsidiary obligation of the Contractor.

BASIS OF PAYMENT

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

900.640	(FAA C-102 STRAW WATTLES)	per Linear Foot
900.620	(FAA C-102 STONE CHECK DAMS)	per Each
900.675	(FAA C-102 ROLLED EROSION CONTROL MATTING) per Square Yard	
900.620	(FAA C-102 INLET PROTECTION)	per Each
900.640	(FAA C-102 BARRIER FENCE)	per Linear Foot
900.645	(FAA C-102 SEDIMENTATION CONTROL INSPECTION AND REPORTING)	per Lump Sum
900.645	(FAA C-102 SEDIMENT AND EROSION CONTROL)	per Lump Sum

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

Temporary control features not covered by contract items that are ordered by the RPR will be paid for in accordance with Section 90, paragraph 90-05 *Payment for Extra Work.*

REFERENCES

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

Advisory Circulars (AC)

AC 150/5200-33 *Hazardous Wildlife Attractants on or Near Airports*

AC 150/5370-2 *Operational Safety on Airports During Construction*

ASTM International (ASTM)

ASTM D6461 *Standard Specification for Silt Fence Materials*

United States Department of Agriculture (USDA)

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

END OF ITEM C-102

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Item C-105 Mobilization

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

105-2 Mobilization limit. Mobilization shall be limited to **5** percent of the total project cost.

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

105-4 Engineer/RPR field office. The Contractor shall provide dedicated space for the use of the field RPR and inspectors, as a field office for the duration of the project. This space shall be located conveniently near the construction and shall be separate from any space used by the Contractor. The Contractor shall furnish drinking water, sanitary facilities, heat, air conditioning, high speed internet and electricity in accordance with local building codes**.** The field office and all associated equipment shall be in good working order, acceptable to the Resident Project Representative (RPF).

The field office shall be equipped with the following equipment:

2-Suitable office desk with file drawers, locks and 2 sets of keys
1 - Office swivel chair
2 - Office straight back chair
8 - Folding Chairs
1 - Folding Table (6' length)
1 - Plan table with stool
1 - 3'x6' cork bulletin board
1 - Plain paper multi-function printer (capable of printing/copying/scanning/faxing)
2 - Waste Baskets
1 - Fully equipped first aid kit, wall-mounted
1 - Fire extinguisher, dry chemical type for A, B, C ratings
1 - Coffee Maker
1 - Refrigerator

METHOD OF MEASUREMENT

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

a. With first pay request, 25%.

b. When 25% or more of the original contract is earned, an additional 25%.

c. When 50% or more of the original contract is earned, an additional 40%.

d. After Final Inspection, Staging area clean-up and delivery of all Project Closeout materials as required by Section 90, paragraph 90-11, *Contractor Final Project Documentation,* the final 10%**.**

BASIS OF PAYMENT

105-6 Payment will be made under:

900.645	(FAA C-105 MOBILIZATION 5% MAX)	per Lump Sum
900.645	(FAA C-105 ENGINEER'S FIELD OFFICE)	per Lump Sum

REFERENCES

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

Office of Federal Contract Compliance Programs (OFCCP)

Executive Order 11246, as amended

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

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

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

END OF ITEM C-105

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

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

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

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

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

a. Divide the lot into n sublots in accordance with the acceptance requirements of the specification.

b. Locate the random sampling position within the sublot in accordance with the requirements of the specification.

c. Make a measurement at each location, or take a test portion and make the measurement on the test portion in accordance with the testing requirements of the specification.

d. Find the sample average (X) for all sublot test values within the lot by using the following formula:

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

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

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

n = Number of sublot test values

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

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

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

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

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

n = Number of sublot test values

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

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

Where: L = specification lower tolerance limit

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

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

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

and

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

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

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

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

Where: P_L = percent within lower specification limit

P_U = percent within upper specification limit

EXAMPLE OF PWL CALCULATION

Project: Example Project

Test Item: Item P-401, Lot A.

A. PWL Determination for Mat Density.

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

A-1 = 96.60

A-2 = 97.55

A-3 = 99.30

A-4 = 98.35

n = 4

2. Calculate average density for the lot.

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

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

$X = 97.95\%$ density

3. Calculate the standard deviation for the lot.

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

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

$S_n = 1.15$

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

$Q_L = (X - L) / S_n$

$Q_L = (97.95 - 96.30) / 1.15$

$Q_L = 1.4348$

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

PWL = 98

B. PWL Determination for Air Voids.

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

A-1 = 5.00

A-2 = 3.74

A-3 = 2.30

A-4 = 3.25

2. Calculate the average air voids for the lot.

$X = (x_1 + x_2 + x_3 . . . n) / n$

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

$X = 3.57\%$

3. Calculate the standard deviation S_n for the lot.

$S_n = [((3.57 - 5.00)^2 + (3.57 - 3.74)^2 + (3.57 - 2.30)^2 + (3.57 - 3.25)^2) / (4 - 1)]^{1/2}$

$S_n = [(2.04 + 0.03 + 1.62 + 0.10) / 3]^{1/2}$

$S_n = 1.12$

4. Calculate the Lower Quality Index Q_L for the lot. (L= 2.0)

$Q_L = (X - L) / S_n$

$Q_L = (3.57 - 2.00) / 1.12$

$Q_L = 1.3992$

5. Determine P_L by entering Table 1 with $Q_L = 1.41$ and n = 4.

$P_L = 97$

6. Calculate the Upper Quality Index Q_U for the lot. (U= 5.0)

$Q_U = (U - X) / S_n$

$Q_U = (5.00 - 3.57) / 1.12$

$Q_U = 1.2702$

7. Determine P_U by entering Table 1 with $Q_U = 1.29$ and n = 4.

$P_U = 93$

8. Calculate Air Voids PWL

$PWL = (P_L + P_U) - 100$

$PWL = (97 + 93) - 100 = 90$

EXAMPLE OF OUTLIER CALCULATION (REFERENCE ASTM E178)

Project: Example Project

Test Item: Item P-401, Lot A.

A. Outlier Determination for Mat Density.

1. Density of four random cores taken from Lot A arranged in descending order.

A-3 = 99.30
A-4 = 98.35
A-2 = 97.55
A-1 = 96.60

2. From ASTM E178, Table 1, for n=4 an upper 5% significance level, the critical value for test criterion = 1.463.

3. Use average density, standard deviation, and test criterion value to evaluate density measurements.

a. For measurements greater than the average:

If (measurement - average)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-3, check if (99.30 - 97.95) / 1.15 is greater than 1.463.

Since 1.174 is less than 1.463, the value is not an outlier.

b. For measurements less than the average:

If (average - measurement)/(standard deviation) is less than test criterion, then the measurement is not considered an outlier.

For A-1, check if (97.95 - 96.60) / 1.15 is greater than 1.463.

Since 1.435 is less than 1.463, the value is not an outlier.

Note: In this example, a measurement would be considered an outlier if the density were:

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

OR

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

Table 1. Table for Estimating Percent of Lot Within Limits (PWL)

Percent Within Limits (P_L and P_U)	Positive Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
99	1.1541	1.4700	1.6714	1.8008	1.8888	1.9520	1.9994	2.0362
98	1.1524	1.4400	1.6016	1.6982	1.7612	1.8053	1.8379	1.8630
97	1.1496	1.4100	1.5427	1.6181	1.6661	1.6993	1.7235	1.7420
96	1.1456	1.3800	1.4897	1.5497	1.5871	1.6127	1.6313	1.6454
95	1.1405	1.3500	1.4407	1.4887	1.5181	1.5381	1.5525	1.5635
94	1.1342	1.3200	1.3946	1.4329	1.4561	1.4717	1.4829	1.4914
93	1.1269	1.2900	1.3508	1.3810	1.3991	1.4112	1.4199	1.4265
92	1.1184	1.2600	1.3088	1.3323	1.3461	1.3554	1.3620	1.3670
91	1.1089	1.2300	1.2683	1.2860	1.2964	1.3032	1.3081	1.3118
90	1.0982	1.2000	1.2290	1.2419	1.2492	1.2541	1.2576	1.2602
89	1.0864	1.1700	1.1909	1.1995	1.2043	1.2075	1.2098	1.2115
88	1.0736	1.1400	1.1537	1.1587	1.1613	1.1630	1.1643	1.1653
87	1.0597	1.1100	1.1173	1.1192	1.1199	1.1204	1.1208	1.1212
86	1.0448	1.0800	1.0817	1.0808	1.0800	1.0794	1.0791	1.0789
85	1.0288	1.0500	1.0467	1.0435	1.0413	1.0399	1.0389	1.0382
84	1.0119	1.0200	1.0124	1.0071	1.0037	1.0015	1.0000	0.9990
83	0.9939	0.9900	0.9785	0.9715	0.9671	0.9643	0.9624	0.9610
82	0.9749	0.9600	0.9452	0.9367	0.9315	0.9281	0.9258	0.9241
81	0.9550	0.9300	0.9123	0.9025	0.8966	0.8928	0.8901	0.8882
80	0.9342	0.9000	0.8799	0.8690	0.8625	0.8583	0.8554	0.8533
79	0.9124	0.8700	0.8478	0.8360	0.8291	0.8245	0.8214	0.8192
78	0.8897	0.8400	0.8160	0.8036	0.7962	0.7915	0.7882	0.7858
77	0.8662	0.8100	0.7846	0.7716	0.7640	0.7590	0.7556	0.7531
76	0.8417	0.7800	0.7535	0.7401	0.7322	0.7271	0.7236	0.7211
75	0.8165	0.7500	0.7226	0.7089	0.7009	0.6958	0.6922	0.6896
74	0.7904	0.7200	0.6921	0.6781	0.6701	0.6649	0.6613	0.6587
73	0.7636	0.6900	0.6617	0.6477	0.6396	0.6344	0.6308	0.6282
72	0.7360	0.6600	0.6316	0.6176	0.6095	0.6044	0.6008	0.5982
71	0.7077	0.6300	0.6016	0.5878	0.5798	0.5747	0.5712	0.5686
70	0.6787	0.6000	0.5719	0.5582	0.5504	0.5454	0.5419	0.5394
69	0.6490	0.5700	0.5423	0.5290	0.5213	0.5164	0.5130	0.5105
68	0.6187	0.5400	0.5129	0.4999	0.4924	0.4877	0.4844	0.4820
67	0.5878	0.5100	0.4836	0.4710	0.4638	0.4592	0.4560	0.4537
66	0.5563	0.4800	0.4545	0.4424	0.4355	0.4310	0.4280	0.4257
65	0.5242	0.4500	0.4255	0.4139	0.4073	0.4030	0.4001	0.3980
64	0.4916	0.4200	0.3967	0.3856	0.3793	0.3753	0.3725	0.3705
63	0.4586	0.3900	0.3679	0.3575	0.3515	0.3477	0.3451	0.3432
62	0.4251	0.3600	0.3392	0.3295	0.3239	0.3203	0.3179	0.3161
61	0.3911	0.3300	0.3107	0.3016	0.2964	0.2931	0.2908	0.2892
60	0.3568	0.3000	0.2822	0.2738	0.2691	0.2660	0.2639	0.2624
59	0.3222	0.2700	0.2537	0.2461	0.2418	0.2391	0.2372	0.2358
58	0.2872	0.2400	0.2254	0.2186	0.2147	0.2122	0.2105	0.2093
57	0.2519	0.2100	0.1971	0.1911	0.1877	0.1855	0.1840	0.1829
56	0.2164	0.1800	0.1688	0.1636	0.1607	0.1588	0.1575	0.1566
55	0.1806	0.1500	0.1406	0.1363	0.1338	0.1322	0.1312	0.1304
54	0.1447	0.1200	0.1125	0.1090	0.1070	0.1057	0.1049	0.1042
53	0.1087	0.0900	0.0843	0.0817	0.0802	0.0793	0.0786	0.0781
52	0.0725	0.0600	0.0562	0.0544	0.0534	0.0528	0.0524	0.0521
51	0.0363	0.0300	0.0281	0.0272	0.0267	0.0264	0.0262	0.0260
50	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Percent Within Limits (P_L and P_U)	Negative Values of Q (Q_L and Q_U)							
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10
49	-0.0363	-0.0300	-0.0281	-0.0272	-0.0267	-0.0264	-0.0262	-0.0260
48	-0.0725	-0.0600	-0.0562	-0.0544	-0.0534	-0.0528	-0.0524	-0.0521
47	-0.1087	-0.0900	-0.0843	-0.0817	-0.0802	-0.0793	-0.0786	-0.0781
46	-0.1447	-0.1200	-0.1125	-0.1090	-0.1070	-0.1057	-0.1049	-0.1042
45	-0.1806	-0.1500	-0.1406	-0.1363	-0.1338	-0.1322	-0.1312	-0.1304
44	-0.2164	-0.1800	-0.1688	-0.1636	-0.1607	-0.1588	-0.1575	-0.1566
43	-0.2519	-0.2100	-0.1971	-0.1911	-0.1877	-0.1855	-0.1840	-0.1829
42	-0.2872	-0.2400	-0.2254	-0.2186	-0.2147	-0.2122	-0.2105	-0.2093
41	-0.3222	-0.2700	-0.2537	-0.2461	-0.2418	-0.2391	-0.2372	-0.2358
40	-0.3568	-0.3000	-0.2822	-0.2738	-0.2691	-0.2660	-0.2639	-0.2624
39	-0.3911	-0.3300	-0.3107	-0.3016	-0.2964	-0.2931	-0.2908	-0.2892
38	-0.4251	-0.3600	-0.3392	-0.3295	-0.3239	-0.3203	-0.3179	-0.3161
37	-0.4586	-0.3900	-0.3679	-0.3575	-0.3515	-0.3477	-0.3451	-0.3432
36	-0.4916	-0.4200	-0.3967	-0.3856	-0.3793	-0.3753	-0.3725	-0.3705
35	-0.5242	-0.4500	-0.4255	-0.4139	-0.4073	-0.4030	-0.4001	-0.3980
34	-0.5563	-0.4800	-0.4545	-0.4424	-0.4355	-0.4310	-0.4280	-0.4257
33	-0.5878	-0.5100	-0.4836	-0.4710	-0.4638	-0.4592	-0.4560	-0.4537
32	-0.6187	-0.5400	-0.5129	-0.4999	-0.4924	-0.4877	-0.4844	-0.4820
31	-0.6490	-0.5700	-0.5423	-0.5290	-0.5213	-0.5164	-0.5130	-0.5105
30	-0.6787	-0.6000	-0.5719	-0.5582	-0.5504	-0.5454	-0.5419	-0.5394
29	-0.7077	-0.6300	-0.6016	-0.5878	-0.5798	-0.5747	-0.5712	-0.5686
28	-0.7360	-0.6600	-0.6316	-0.6176	-0.6095	-0.6044	-0.6008	-0.5982
27	-0.7636	-0.6900	-0.6617	-0.6477	-0.6396	-0.6344	-0.6308	-0.6282
26	-0.7904	-0.7200	-0.6921	-0.6781	-0.6701	-0.6649	-0.6613	-0.6587
25	-0.8165	-0.7500	-0.7226	-0.7089	-0.7009	-0.6958	-0.6922	-0.6896
24	-0.8417	-0.7800	-0.7535	-0.7401	-0.7322	-0.7271	-0.7236	-0.7211
23	-0.8662	-0.8100	-0.7846	-0.7716	-0.7640	-0.7590	-0.7556	-0.7531
22	-0.8897	-0.8400	-0.8160	-0.8036	-0.7962	-0.7915	-0.7882	-0.7858
21	-0.9124	-0.8700	-0.8478	-0.8360	-0.8291	-0.8245	-0.8214	-0.8192
20	-0.9342	-0.9000	-0.8799	-0.8690	-0.8625	-0.8583	-0.8554	-0.8533
19	-0.9550	-0.9300	-0.9123	-0.9025	-0.8966	-0.8928	-0.8901	-0.8882
18	-0.9749	-0.9600	-0.9452	-0.9367	-0.9315	-0.9281	-0.9258	-0.9241
17	-0.9939	-0.9900	-0.9785	-0.9715	-0.9671	-0.9643	-0.9624	-0.9610
16	-1.0119	-1.0200	-1.0124	-1.0071	-1.0037	-1.0015	-1.0000	-0.9990
15	-1.0288	-1.0500	-1.0467	-1.0435	-1.0413	-1.0399	-1.0389	-1.0382
14	-1.0448	-1.0800	-1.0817	-1.0808	-1.0800	-1.0794	-1.0791	-1.0789
13	-1.0597	-1.1100	-1.1173	-1.1192	-1.1199	-1.1204	-1.1208	-1.1212
12	-1.0736	-1.1400	-1.1537	-1.1587	-1.1613	-1.1630	-1.1643	-1.1653
11	-1.0864	-1.1700	-1.1909	-1.1995	-1.2043	-1.2075	-1.2098	-1.2115
10	-1.0982	-1.2000	-1.2290	-1.2419	-1.2492	-1.2541	-1.2576	-1.2602
9	-1.1089	-1.2300	-1.2683	-1.2860	-1.2964	-1.3032	-1.3081	-1.3118
8	-1.1184	-1.2600	-1.3088	-1.3323	-1.3461	-1.3554	-1.3620	-1.3670
7	-1.1269	-1.2900	-1.3508	-1.3810	-1.3991	-1.4112	-1.4199	-1.4265
6	-1.1342	-1.3200	-1.3946	-1.4329	-1.4561	-1.4717	-1.4829	-1.4914
5	-1.1405	-1.3500	-1.4407	-1.4887	-1.5181	-1.5381	-1.5525	-1.5635
4	-1.1456	-1.3800	-1.4897	-1.5497	-1.5871	-1.6127	-1.6313	-1.6454
3	-1.1496	-1.4100	-1.5427	-1.6181	-1.6661	-1.6993	-1.7235	-1.7420
2	-1.1524	-1.4400	-1.6016	-1.6982	-1.7612	-1.8053	-1.8379	-1.8630
1	-1.1541	-1.4700	-1.6714	-1.8008	-1.8888	-1.9520	-1.9994	-2.0362

REFERENCES

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

ASTM International (ASTM)

ASTM E178 Standard Practice for Dealing with Outlying Observations

END OF ITEM C-110

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ITEM G-001
Special Work Requirements

GENERAL

001-1.1 General. The purpose of these requirements is to ensure that the contract work does not damage private property or create any hazard to aircraft operations, and to bring to the Contractor's attention special coordination that the Contractor should be aware of that may be unique to airfield construction or unique to the Owner's Facility. It is Contractor's responsibility to conduct all work in strict accordance with the requirements set forth herein and to fully cooperate with the Resident Project Representative (RPR) in every way necessary to fulfill the purposes of these requirements as set forth above.

001-1.2 Work Limitations. All work shall be performed during the hours indicated on the contract drawings and/or as specified in these specifications. Work may not be allowed on specific days as determined by the RPR and/or the Owner. Such days will not count towards exhausted contract time.

The following specification sections and regulations further define how work must be executed.

- General Provisions Section 80-04 Limitation of Operations
- General Provisions Section 80-04.1 Operational Safety on Airport During Construction
- FAA Advisory Circular 150/5370-2G "Operational Safety on Airports during Construction"
- The Construction Safety and Phasing Plans

001-1.3 Prior Notification. In accordance with Section 80-03 *Execution and Progress* of the General Provisions, the Contractor shall provide an overall project schedule prior to the pre-construction meeting. This schedule shall be updated during the project as specified.

In addition, the Contractor shall coordinate with the RPR and Owner and submit a detailed weekly schedule of work in accordance with Section 15.0 *Construction Schedule* of the Supplemental Provisions. The weekly schedule shall be submitted each week for the duration of the project, a minimum of 3-days prior to the week covered by the schedule.

In accordance with Section 80-04 of the General Provisions, the Contractor shall notify the RPR at least 48 hours in advance of the time he intends to start work or begin work in a new work area. It should be noted by the Contractor that 48 hours is the minimum time required by the Owner to issue a proper Notice to Airmen (NOTAM) of the pending construction activities. The Contractor's weekly construction schedules will also provide advance notice. The RPR and/or Owner may disallow work in areas not included in the weekly schedule and for which the required 48-hours advance notice is not provided. Such instance shall not be a valid claim for delays. Prior to the beginning of work each day, the Contractor's Site Superintendent shall meet with the RPR to discuss the days' work schedule. The Contractor must notify the RPR at least 24-hours in advance of any items that will require acceptance testing. 72-hours' notice must be provided for testing on Mondays or testing the day immediately following a Holiday.

001-1.4 Operational Safety. Work performed under this contract will require safety and phasing in accordance with FAA regulations defined in Section 80-04.1 *Operational Safety on Airports During Construction* of the General Provisions. The Contractor shall take all precautions necessary to ensure the safety of operating aircraft, as well as his/her own equipment and personnel.

001-1.5 Coordination. The Contractor must coordinate all operations with the RPR and/or Owner. The RPR or Owner will handle coordination with the Federal Aviation Administration, Air Traffic Control Tower, and Tenants.

001-1.6 Regulations. All work shall be performed in accordance with FAA Advisory Circular 150/5370-2G "Operational Safety on Airports during Construction".

001-1.7 Construction Safety and Phasing Plans. In addition, all work shall be performed in accordance with the approved Construction Safety and Phasing Plans. The plans have been prepared by the Owner and Engineer and approved by the FAA. It outlines the site specific requirements for safely performing the work in accordance with AC 150/5370-2G. The Contractor shall review, in detail, the Construction Safety and Phasing Plans.

001-1.8 Contractor's Safety Plan Compliance Document (SPCD). Once the Contractor has read and fully understands the CSPP, they shall prepare and submit for approval a Safety Plan Compliance Document (SPCD) as required by FAA AC 150/5370-2G.

Similar to a shop drawing the SPCD, including all requirements of this specification, shall be submitted to the RPR for review prior to the Pre-Construction Meeting. The SPCD must be reviewed and approved by the Owner prior to issuance of the notice-to-proceed.

The Contractor shall designate an individual as the Site Safety officer (SSO). The SSO may be the Contractor's Site Superintendent who is responsible for day to day operations on the site. The SSO shall be on site daily and work on a daily basis to implement and enforce the CSPP and SPCD. The SSO shall conduct daily inspections. Among other items, the daily inspections shall include inspection of the barricades, lights, closure markers and protection of the taxiway/runway safety and object free areas. When necessary, the SSO will work with the RPR and Owner on safety related items.

001-1.9 Barricades. The Contractor shall place and maintain construction barricades to clearly define and close work areas to aircraft operations. The barricades are shown in the safety and phasing plans. Barricades shall be placed as shown or as directed by the RPR and/or Owner. Barricades shall meet the minimum requirement of FAA AC 150/5370-2G. Refer to details in the contract documents. All temporary lights and barricades shall be weighted against jet blasts (100 mph). Reference Section 70-08 *Barricades, Warning Signs, and Hazard Markings* of the General Provisions for further requirements.

001-1.10 Project Barrier Fence. Project Barrier Fence shall be installed as shown on the Contract Documents as a visible barrier. Project Barrier Fence shall be 48" high density orange polyethylene fence that will not sag or tear over time due to natural weather conditions. Project Barrier Fence shall be installed on hardwood posts or steel t-post driven a minimum of 18" below grade. Posts shall be installed at a 10-foot spacing. Wire, zip ties, or other methods approved by the RPR shall be used to secure the fence fabric to the post. The Contractor shall select, inspect, and maintain the Project Barrier Fence in accordance with the Contract Documents or as direct by the RPR.

001-1.11 Runway Closure Markers. The Contractor shall furnish, place, and maintain lighted runway closure markers to clearly define surfaces closed to aircraft operations. The required markers are shown in the contract drawings. Markers shall be placed as shown or as directed by the RPR and/or Owner. Closure Markers shall meet the minimum requirement of FAA AC 150/5370-2G. Refer to marker details in the contract documents. Contractor shall furnish, install, fuel and maintain the lighted closure markers for the duration of the runway closure.

001-1.12 Height Restrictions. No equipment will be allowed to penetrate the Runway approach surfaces and transitions defined in 49 CFR Part 77 when the runway is active. Tall equipment, such as cranes or boom trucks, will be required to have a flag attached to the highest point. Additionally, during periods of darkness or reduced visibility a red light at the highest point shall also be required.

001-1.13 Marking of Vehicles and Equipment. Each motorized vehicle operating on the airport shall be equipped with an amber flashing light. All equipment must have a 3-foot square flag consisting of international orange and white squares not less than one-foot square displayed in full view above the vehicle. Equipment must also have an amber flashing light when operated during periods of limited visibility including darkness, fog, and rain. When not in use, all equipment shall be returned to the designated staging area and lowered to the maximum extent possible. All Contractor and subcontractor vehicles shall have the company identification plainly visible on both sides of the vehicle in order to identify the vehicle.

001-1.14 Setback Requirements. No construction operations shall be carried on within 66 feet from the centerline of any active taxiway or within 250' feet of the centerline of any active runway unless prior approval has been obtained and such actions are included in the phasing plans. The distances above represent the Taxiway Object Free Area and the Runway Object Free Area respectively.

001-1.15 Protection of Restricted Areas. The Contractor shall stake and permanently mark on the ground with a readily recognizable marking (football field marking, flagging, or similar material) the restriction lines adjacent to the work area so that workmen can readily recognize the limitations. The restricted areas are defined in the phasing plans and contract drawings. Limits of work shall be marked out with Project Barrier Fence following section 001-1.10 of this specification.

001-1.16 Trenches and Excavations. The Contractor will not be permitted to leave any trenches or other excavations open at night, on weekends or at other times when the Contractor is not on the site, except as approved by the RPR. Open trenches must be clearly defined, confined to the work area(s), and completely surrounded with construction barricades. In addition, no excavations exceeding three (3") inches in depth shall be left open within the object free areas while the runway, taxiways, or aprons, are in use. All excavations in paved areas must be backfilled and the pavement repaired and properly cured prior to the area being opened to traffic.

001-1.17 Grading of Temporary Conditions. The following applies when runways or taxiways must be re-opened. The Contractor shall ensure that the work area within the safety areas of the runways, taxiways and aprons are graded away from the pavements at a maximum slope of 5% and shall be left in such condition that it will drain readily and effectively and will not pose a hazard to aircraft. No piles of soil shall be left unspread, no drops or projections in excess of three inches, no sharp changes in grade will be permitted, and the surface shall be thoroughly compacted.

001-1.18 Radio Control and Communication. At a minimum the Contractor shall have two-way communications between the superintendent, escorts, and gate guards to coordinate access to and from the work site. No FAA or airport frequency shall be used for this purpose. Cell phones are acceptable for this purpose.

When work areas are adjacent to, within, or require traversing active movement areas (such as taxiways and the runway) the Contractor shall have on site at all times at least one radio capable of communicating on the appropriate frequencies of the airport (122.8). The radio shall be capable of reliable two-way communications from any location on the airport. The Contractor shall, before the start of construction, test his/her radio(s) with the appropriate agencies to demonstrate the capabilities and to demonstrate the performance of the operator and the equipment.

While traversing or working in active movement areas the Contractor shall provide constant radio contact and monitoring of the frequency. The Contractor shall monitor the radio whenever the Contractor's men or equipment are on or crossing active runways, taxiways, or crossing the approach to the runway(s). If air traffic is inbound or outbound, the Contractor shall stay clear of the active areas until the traffic has vacated the area.

001-1.19 Airfield Flagpersons. Not required for this project. Refer to specification M-003 for Maintenance of Traffic.

001-1.20 Owner Provided Escorts. Not required for this project.

001-1.21 Contractor Provided Escorts. The Contractor is responsible for escorting all personnel, deliveries, vehicles and equipment. Employees, subcontractors, trucks, drivers etc. who have not been provided Airport Driver Training by the Owner. The Contractor is responsible for coordinating this training with the Owner prior to the start of construction. The Owner will provide one session of training to the Contractor at no cost.

001-1.22 Haul Routes. When public highways must be used for haul routes, it will become the Contractors responsibility to obtain the proper permits needed for this function and to obey all rules and regulations pertinent to the public highways. **Any damage caused to public highways caused by the Contractor's operations shall be repaired to the satisfaction of the state or municipality having jurisdiction over the highway at no cost to the Owner.**

Haul routes on the airport are shown on the contract drawings and the safety plans. The Contractors vehicles and equipment shall operate within the limits of the indicated haul route.

The Contractors' personnel and vehicles will not have access to the entire airport, but shall be limited to the designated work area(s), staging area(s), and haul route(s).

All paved haul roads or access roads shall be kept clean at all times to prevent the accumulation of dirt and mud and the generation of dust by sweeping, washing or other methods as directed by the Airport. Unpaved haul roads, if any, shall be maintained by blading and filling when directed by the Airport and dust shall be controlled at all times.

All paved haul roads disturbed shall be restored to their original condition or better before the contract will be considered complete. All restoration and dust control on haul roads shall be at the Contractors expense.

All non-paved areas on the airport which are disturbed by the Contractors operations shall be scarified or otherwise loosened to a depth not less than five (5") inches (127mm). Clods shall be broken and the top three (3") inches (76mm) of soil shall be worked into a satisfactory seedbed by disking, or by use of cultipackers, rollers, drags, harrows, or other appropriate means. This area shall be seeded, fertilized and mulched.

001-1.23 Security and Contractor Provided Gate Guards. The Contractor shall comply with all airport security requirements as directed by the Owner. The Contractor's personnel, equipment, materials and deliveries shall be subject to security checks prior to or while on airport property. Any delays incurred due to security inspections shall not be a valid claim for delays.

The Contractor is responsible for maintaining controlled access to the airfield via any and all project access gates. The Contractor shall only allow access to personnel directly working on the project.

When the Runway is closed to aircraft operations, the Contractor shall leave the construction access gate in the open position for the duration of the work day. At times when the Contractor is not on site the gate shall be secured.

At times when the Runway is open to aircraft operations, the Contractor must provide a designated gate guard or close and lock the gate after each use.

Personal Vehicles (POV's) are not permitted on the Airfield. The Contractor shall provide safe and adequate transportation to and from the area where POV's are parked and the work area(s).

001-1.24 Disposal of Surplus and Unsuitable Materials. All surplus and unsuitable materials not identified to be retained by the Owner, whether suitable or unsuitable, shall be legally disposed of by the Contractor off airport property. No separate measurement or payment will be made for the handling, hauling or disposal, but rather shall be incidental to the item that generated that material.

001-1.25 Storm Water Management. The work areas may be located adjacent to or down gradient of large impervious paved areas. **The Contractor is responsible for managing all storm water for the duration of the project including all diversion and dewatering of the site.** The Contractor is also responsible for repairing all damage caused by storm water. All costs associated with the storm water management shall be incidental to the overall project. The Contractor shall follow all applicable state, federal and local regulations related to the protection of the environment. Refer to Specification *C-102 Temporary Air and Water Pollution Control*, for additional information.

001-1.26 Storage of Materials and Equipment. The area for storing materials and parking/servicing equipment is shown in the contract drawings. The Contractor will be required to return all equipment to the appropriate Contractor' staging area at the end of work, each day, unless otherwise approved. Equipment shall be parked in the designated area when not in use.

The Contractor shall provide all necessary temporary fencing and gates to protect materials and equipment from pilferage. The Owner is not responsible for any vandalized equipment or materials stored on the property.

Any area occupied or utilized by the Contractor shall be maintained in a clean and orderly condition satisfactory to the Owner. At the completion of the project, all Contractors' facilities shall be removed promptly and in a workman like manner and the area left clean and free of all debris or surplus material. The Contractor is responsible for restoring to original condition any areas used for the Contractor's operation at no additional cost to the Owner.

001-1.27 Maintenance of the Construction Site. The Contractor shall keep the construction site free of paper, boxes, and other debris that could be blown onto the runways, taxiways, and/or aprons.

All airport pavements shall be kept clear and clean at all times. All rocks, mud, and other debris carried on to the airport pavement by the Contractor's equipment must be reported to the RPR or Airport Operations. Airport Operations will then close the affected area to air traffic and the Contractor will immediately sweep the area to the satisfaction of Airport Operations.

The Contractor shall have access to the equipment for the application of water to control dust within the construction site and on haul roads. The equipment shall be equipped with a shut-off control valve which

can be operated from the cab by the operator. The Contractor shall apply water for dust control as necessary to prevent dust from the construction site and/or haul roads from being a hazard to aircraft and from being a nuisance to the public as direct by the RPR. All water shall be supplied by the Contractor. Refer to Specification *C-102 Temporary Air and Water Pollution Control*, for additional information on dust control.

The Contractor shall maintain at the job site at all times while the construction under this contract is in progress, a self-propelled sweeper with not less than a 4-foot broom approved by the Airport. The sweeper shall operate as necessary to keep active aircraft pavements, access roads and the work areas clean. At the close of each day's work, all active aircraft pavements and airport paved roads used or dirtied by the Contractor shall again be swept.

The Contractor shall also be responsible for supplying any other equipment as may be necessary to clean all areas that are contaminated as a result of his/her operations to the complete satisfaction of the RPR and the Owner.

Trucks loaded in the construction area shall have loads trimmed as necessary to ensure that no particles, stones, or debris will fall off and that no legal load limits are exceeded.

The Contractor shall be particularly careful not to track foreign material onto pavements outside of the work area(s) (e.g., tack-coat, rocks, etc). The Contractor shall be responsible for removing foreign materials from vehicle tires prior to the vehicle leaving its work area.

001-1.28 Maintenance of the Existing Airfield Lighting. All existing airfield lighting systems required to safely operate aircraft shall be operational each night and during inclement weather throughout the construction period.

It shall be the responsibility of the Contractor to check the operation of the existing lights each day, to notify the RPR and the Owner of any problems and make any repairs necessary due to his/her operation.

The Contractor shall furnish and install all materials necessary to provide temporary lighting and make any temporary connections to keep the existing airfield lighting operationssal until the new lighting fixtures, cables, etc. can be installed.

001-1.29 Smoking. Absolutely no smoking will be permitted except in authorized smoking areas. Any Contractor violating this rule shall be asked to leave the premises.

001-1.30 Employee Identification Badges. Not required for this project.

001-1.31 Sequencing of Phases. The phasing of this project was developed with safety and airport operations in mind. Work in a phase must be substantially completed prior to moving onto the next phase. Areas must be usable and open as indicated on the safety and phasing plans for each individual phase.

MATERIALS

001-2.1 Materials. Prior to ordering, the Contractor shall submit shop drawings to the RPR for all materials to be used. The shop drawings shall include a Buy American Certification and manufacturer's certification that each product meets the specified standard(s), when applicable.

METHOD OF MEASUREMENT

001-3.1 Safety and Phasing. Safety and Phasing item shall include; contractor provided barricades, project demarcation fence (PDF) , lighted Xs for runway closure, construction signs, cones, covering existing guidance signs, disabling circuits during closures, lockout/tagout of circuits, temporary cable and connections, maintenance of the construction site, sweeping, application of water for dust control, escorts, radios or cell phones, gate guards, training, preparation of required schedules, and all requirements of the project safety and phasing plans. These items shall be measured as a lump sum.

Assembly, transport, placement, repositioning, maintaining, disassembly and removal of all safety and phasing items shall not be measured separately but rather shall be considered incidental to the item.

001-3.2 Contractor's Safety Plan Compliance Document. This document shall be measured as a lump sum.

BASIS OF PAYMENT

001-4.1 Safety and Phasing. Payment shall be made at the contract unit price, which price and payment thereof shall constitute full compensation for all labor, materials, equipment, expenses and incidentals required. Payment shall be made in two parts: the first payment equal to 50% of the total bid price for safety and phasing items of the awarded contract shall be made on the first application for payment. The final payment equal to 50% of the contract unit price shall be made upon completion of and acceptance of the work.

001-4.2 Contractor's Safety Plan Compliance Document. Payment shall be made at the contract unit price for furnishing and implementing the SPCD, measured as specified above, which price and payment thereof shall constitute full compensation for all labor, preparation, materials, equipment, expenses and incidentals. Payment shall be mad after review and upon acceptance of the document by the Owner.

Payment shall be made under:

900.645	(FAA G-001 SAFETY AND PHASING)	per Lump Sum
900.645	(FAA G-001 CONTRACTOR'S SAFETY PLAN COMPLIANCE DOCUMENT (SPCD))	per Lump Sum

END OF ITEM G-001

AFTER CONSTRUCTION SAFETY AND PHASING PLAN

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VERMONT

AGENCY OF TRANSPORTATION

Construct, Mark, Light, and Sign Partial Parallel Taxiway (Approximately 1,500 LF x 35 FT) and Relocate Fuel Farm Project No. AV-FY19-011 Re-Advertisement

at

Morrisville-Stowe State Airport
Morristown, Vermont

AIRPORT IMPROVEMENT PROGRAM

SAFETY/PHASING PLAN CHECKLIST

Prepared in accordance with
FAA AC 150/5370-2G

Prepared by:

JACOBS ENGINEERING GROUP INC.

Two Executive Park Drive
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June 2020

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1. GENERAL

The Morrisville-Stowe State Airport is owned and operated by the Vermont Agency of Transportations (VTrans) – Rail and Aviation Bureau. When the term "Airport Operator" is used herein it will be understood to mean the VTrans.

All construction will be accomplished in accordance with FAA Advisory Circular (AC) 150/5370-2G "Operational Safety on Airports During Construction".

2. PROJECT DESCRIPTION

The project consists of constructing a new parallel taxiway serving Runway 19. The new parallel taxiway will be 35 ft wide and approximately 1,500 ft long. The removal of Taxiway 'B', replacement of the existing drainage system, installation of new infiltration practices, installation of a new taxiway lighting system, relocation of the fuel farm, and regrading of turf areas will be included in this project. Miscellaneous associated work includes the removal of existing tie-downs, removal of pavement markings, and removal of the existing detention basin.

The project is anticipated to be constructed in eight phases. Refer to the Safety and Phasing Plans which are Sheets 6 – 16 of the contract plans.

3. COORDINATION

The Airport Operator will notify tenants, the FBO, local users, and any field operations personnel of the planned construction activity via the following methods or a combination thereof: public 'flyers', notification calls/emails/letters, local publication briefings, and project meetings.

a. Contractor progress meetings

Weekly progress meetings will be held with the Airport Operator, Contractor and Engineer. Safety is a required standing agenda item and will include both operational and personal safety.

In addition to progress meetings, the Airport Operator, Contractor and Engineer will meet prior to the start of work in order to coordinate the location, limits, NOTAMS, and notices required for the project.

b. Scope or Schedule Changes

Changes to the scope of work or construction schedule as detailed here-in may require portions of this document to be revised and submitted for approval by the Airport Operator and/or the FAA. Approval may take up to 45 working days.

c. FAA ATO Coordination

Refer to the section entitled 'AREAS AND OPERATIONS AFFECTED BY CONSTRUCTION ACTIVITY' of this document for additional information.

4. PHASING

This project is divided into eight (8) Phases. Phase 1 may be constructed concurrently with Phase 6. Phase 2 may be constructed concurrently with Phase 3. Refer to the Safety and Phasing Plans which are Sheets 6 – 16 of the contract plans.

A. Phase Elements

(1) Areas closed to aircraft operations

Phase	Runway Length Available (feet)	Duration (calendar days)	Closures
1	3,701	90	North-Eastern portion of Apron
2	Runway Closed	13	North-Eastern portion of Apron and Runway 1-19
3	Runway Closed	4	Taxiway 'B' and Runway 1-19
4	3,701	40	Taxiway 'B'
5	3,701	30	Taxiway 'A' and parallel Taxiway between old Taxiway 'B' and Taxiway 'A'. Taxiway 'B' removed
6	3,701	45	North-Eastern portion of Apron
7	3,701	3	North portion of Apron
8	3,701	3	South portion of Apron

*all durations are approximate and subject to change based upon production rates.

The runway lights will be switched off during work within RSA and lighted X runway closure markers will be installed over the 1-19 numerals. Taxiway lights not in use will be covered.

(2) Duration of closures

Refer to table above.

(3) Taxi routes

Phase	Taxi to Runway:	Via Taxiway:
1	1-19	Normal operations. Use existing Taxiway 'A' or 'B' to access/exit Runway 1-19.
2	1-19	Runway closed.
3	1-19	Runway closed.
4	1-19	Use existing Taxiway 'A' or newly constructed portion of Parallel Taxiway to access/exit Runway 1-19.
5	1-19	Use new Parallel Taxiway to access/exit Runway 1-19.
6	1-19	Normal operations. Use existing Taxiway 'A' or 'B' to access/exit Runway 1-19.
7	1-19	Use existing Taxiway 'A' or new Parallel Taxiway to access/exit Runway 1-19
8	1-19	Use existing Taxiway 'A' or new Parallel Taxiway to access/exit Runway 1-19

(4) Emergency access routes
Emergency response access routes will not be impeded during construction.

(5) Construction staging area
The construction staging area will be located near the northeast edge of the apron for phase 1, 2, 3, 4 and 6 and will be moved to the south of Taxiway 'A' for phase 5, 7 and 8. Both staging area locations are outside of all FAA Part 77 and Obstruction clearance surfaces. Equipment stationed within the staging area will not obstruct nor impede aircraft or airport vehicle movement. Equipment being used on a regular basis may be parked within the designated work areas provided the area is closed to Aircraft, and the equipment is parked outside of all active Runway and Taxiway Object Free Areas.

(6) Construction access and haul routes
Access to the airfield will be via the existing airport electric access gates as indicated on the Phasing Plans (Sheets 6 – 16 of the contract documents). The Contractor will disable the electronic gate operator and manually open and close the gate on a daily basis. The use of gate guards is required while Runway 1-19 is open and not required while Runway 1-19 is closed. During non-working hours the gate shall be restored to normal operation. Airport gates shall not be left unsecured at any time Runway 1-19 is open to aircraft operations.

No Contractor vehicles will be allowed on active runways or taxiways without prior permission by the Airport Operator. Contractor will provide authorized and designated escorts to guide construction vehicles on active taxiways and runways. The escort must monitor the airport frequency at all times.

(7) Impacts to NAVAIDs
The work to be performed does not directly impact the NAVAIDS. Runway and Taxiway lights, RW 19 PAPI, and both sets of REILS, will be disabled when Runway 1-19 is closed. The ASOS will not be affected by the project.

The Contractor will notify the Engineer 7-weeks prior to the anticipated closures of Runway 1-19. The Engineer will notify the Airport of the scheduled closures. The Airport will coordinate with the Atlantic Operations Control Center (AOCC) and Tech Ops. for disabling the NAVAIDS. It is understood this coordination must occur 45-days prior to the scheduled shutdown.

(8) Lighting and marking changes
For all runway closures, the runway lights will be deactivated by the Contractor and lighted runway closure markers will be placed on each

runway designation numeral by the Contractor. For all taxiway closures, the taxiway lights will be deactivated or covered and signs directing traffic to the closed taxiway will be covered. Refer to the Safety and Phasing Plans which are Sheets 6 – 16 of the contract plans.

Runway Closure markers will remain continuously operational for the duration of the runway closure (24/7). Contractor will inspect the operation of the closure markers daily at a minimum including non-work days.

(9) Available runway length
For work within runway safety areas, or runway approach/departure surfaces, the runway will be closed and the entire length will be unavailable for departures and arrivals during that period of time. For work outside the runway safety areas, while the runway is open, the full length of the runway will be available for departures and arrivals.

(10) Required hazard marking and lighting
Refer to the section entitled 'HAZARD MARKING AND LIGHTING' of this document.

(11) Lead times for required notifications
All runway and taxiway closures will be pre-approved by the Airport Operator one week in advance. The Contractor will submit weekly schedule(s) by the end of the work week preceding the week covered by the schedule. 45-days notice must be provided for Runway 1-19 closures in order to coordinate the shutdown of the NAVAIDS.

(12) Construction Safety Drawings
Detailed Construction Safety and Phasing Plan drawings are Sheets 6 – 16 of the contract plans.

5. AREAS AND OPERATIONS AFFECTED BY CONSTRUCTION ACTIVITY

A. Identification of Affected Areas

(1) Closing, or partial closing of runways, taxiways and aprons:
Refer to the section entitled 'Phase Elements'. Refer to the Safety and Phasing Plans which are Sheets 6 – 16 of the contract plans.

(2) Closing of Emergency access routes:
Emergency response access routes will not be impeded during construction. The work to be performed will occur in a manner that allows existing pavements to be accessible and traversable by emergency response crews at all times.

(3) Closing of access routes used by airport and FBO support vehicles:
Vehicular access routes used by the airport will not be closed. All will be advised to avoid work areas whenever possible.

(4) Interruption of utilities, including water supplies for firefighting:
Utilities, including water supplies for firefighting, will not be interrupted during construction.

(5) Approach/departure surfaces affected by heights of objects:
This project will not affect any approach/departure surfaces of an active runway.

(6) Construction areas:
Refer to the construction areas and storage areas as shown on Sheets 6 – 16 of the contract plans. No material or equipment may be stored within the approach, primary, and transitional surfaces defined by 14 CFR Part 77.19. All Contractor escorts will monitor radios when traversing active aircraft areas and ensure that construction equipment will give the right of way to aircraft. The Contractor will be responsible for maintaining pavements in the work areas and access routes free of foreign object debris (FOD) by sweeping any construction debris from the pavements.

B. Mitigation of Effects

(1) Temporary changes to runway and/or taxi operations:
Runway and taxiway operations will be impacted by the project. Refer to section 4.A above. The Contractor will give a minimum of 1-week advance notice to the Airport Operator for any phase that requires a runway or taxiway closure. The Airport Operator will coordinate all taxiway and runway restrictions with the appropriate FAA Airports Regional or District Office and issue NOTAMs as required.

Should there be a need for a temporary change of the Runway or adjacent taxiway condition, such as during an emergency, the Airport Operator will notify and coordinate with the Contractor. The Contractor will remove the barricades/closure markers as quickly as possible. The Contractor will re-activate the edge lights, and everyone will remain clear of the area until notified by the Airport Operator that work may resume.

(2) Detours for Emergency and other airport vehicles:
Emergency response access to areas of the airport will not be impeded during construction. When possible all vehicles will be advised to avoid work areas.

(3) Maintenance of essential utilities:
Essential utilities will not be interrupted during the construction activity.

(4) Temporary changes to air traffic control procedures:
Morrisville-Stowe State Airport does not have an Air Traffic Control Tower.

6. PROTECTION OF NAVIGATION AIDS (NAVAIDs)

The Contractor will not disturb the PAPI, REILS, ASOS or lights unless the Runway is closed and the appropriate NOTAMS have been issued.

7. CONTRACTOR ACCESS

The Contractor will not be provided with an escort by the Airport Operator. The Contractor will assign his/her own designated escorts and these escorts must be approved and provided Airfield Driver Training by the Airport Operator prior to the start of work. Refer to the Safety and Phasing General Plan of the contract plans.

a. Location of Stockpiled Construction Materials
All materials will be stored in the construction staging and material storage area. If there is any deviation from the planned areas, then the Contractor must obtain approval regarding the location of the stored materials from the Airport Operator. No materials will be stored within the TOFA, ROFA, OFZ or threshold approach surfaces. The TOFA, RSA, and ROFA are shown on the project drawings.

b. Vehicle and Pedestrian Operations
POV parking for the Contractor will be located outside the access gate. It is the Contractor's responsibility to safely transport work crews from this location to the construction site. When not in use, all construction equipment must be removed from the ROFA and TOFA, as shown on the Safety and Phasing Plans or as designated by the Engineer. All equipment will not exceed a height of 25-feet.

(1) Access and haul roads:
Access to the airfield will be via the existing airport access gates as indicated on the Safety and Phasing General Plan of the contract plans. The Contractor will coordinate access with the Airport Operator. In addition, if access to an active runway or taxiway is required, the Contractor will provide an authorized and designated escort to guide construction vehicles. Any personnel involved with the Project and needing to operate on an active taxiway or runway must be escorted by the Contractor's escort.

(2) Marking and lighting of vehicles:
All vehicles to be used on the airport will have the company logo or name visible and legibly identified on each side of the vehicle. Each construction vehicle intending to access the AOA will be equipped with an approved yellow rotating or flashing beacon light and this light must be

unobstructed from view. All equipment will have orange/white checkered flags attached to their highest point.

(3) Description of proper vehicle operations:
At all times, vehicles will give right of way to passing aircraft. When within the AOA, all construction vehicles must remain within the designated work areas and travel along the planned access routes. If a vehicle is inoperable due to a mechanical emergency, it must be moved to a safe area, away from aircraft and airport vehicles, for normal repairs that take less than 10 minutes or removed from within the AOA for complex repairs requiring extended time. Repairs involving the use of petrochemicals and other flammable fluids, flammable aerosols and powders, and small parts and accessories that can easily become FOD will not be conducted on the airfield.

(4) Required escorts:
The Contractor will designate his/her own escort who is approved by the Airport Operator. The Airport Operator will provide Airport Driver Training to all escorts. Training topics to include radio procedures and operational procedures. Employees or work crews intending to operate on an active taxiway, runway or maneuver outside of a delineated work area will be escorted by a designated escort.

(5) Training requirements for vehicle drivers:
The Airport Operator will brief the Contractor on the particular features of the airfield and areas affected by the construction activity. This includes but is not limited to: the location of airport runway and taxiway safety areas, airfield signage, NAVAIDs, special airport markers, fueling areas, and aircraft parking and transit areas, heavy pedestrian crossing areas, and areas with obstructed views. The Contractor should also be briefed on how to interpret the airport signage encountered along the access routes and within the work area.

(6) Situational awareness:
At all times, vehicles will give right of way to passing aircraft. Aircraft with their rotating beacons and/or strobe lights flashing are typical indications that the engine is running or that the engine start procedure has begun. The Contractor and Engineer will treat all aircraft with caution, regardless of whether they are occupied or not. All construction vehicles and work crews must remain within line of sight and as close as reasonably possible to the designated escort.

(7) Two-way radio communication procedures:
Prior to the start of work, The Airport Operator will inform the Contractor of the proper radio procedures including usage and appropriate phraseology and the appropriate radio frequencies at the airport.
The escort will maintain radio surveillance of the Common Traffic Advisory Frequency (CTAF) or UNICOM frequency for Morrisville-

Stowe State Airport when entering or operating within active aircraft operation areas. The CTAF/UNICOM frequency is 122.8. An escort with radio communication is required to operate on any active taxiway or runway.

(8) Maintenance of the secured area of the airport:
Only authorized persons and vehicles will have access on to the AOA. Prior to the start of the project and prior to accessing the AOA, the Contractor must understand airport procedures. The Contractor must prohibit "piggybacking" of unauthorized vehicles or persons that are not the project's Contractor or Subcontractor.

8. WILDLIFE MANAGEMENT

a. Trash
The Contractor will immediately secure and clean up all FOD upon observation of the objects. The Contractor will be required to keep the work areas clean of trash and food waste which might attract wildlife. If wildlife is observed in the vicinity of the worksite the Contractor or Engineer will notify the Airport Operator of the type and last known location of the sighting. The Airport Operator will determine the appropriate course of action if so required.

b. Standing Water
The creation of standing water due to construction activity is not anticipated.

c. Tall Grass and Seeds
Grass within the work area shall be maintained by the Contractor until project final acceptance to prevent tall grass and seeds from becoming a wildlife attractant.

d. Poorly Maintained Fencing and Gates
Access gates that are opened or utilized for the purpose of construction vehicle and work crew access must be closed and locked when not in use.

e. Disruption of Existing Wildlife Habitat
There are no anticipated disruptions to the local existing wildlife.

9. FOREIGN OBJECT DEBRIS (FOD) MANAGEMENT

The Contractor will implement the following FOD management procedures for the duration of the project. The work areas and adjacent airport areas will be kept free of unsecured paper, boxes, litter and other debris that could be blown onto the runways and taxiways or pose a hazard to aircraft.

Access roads and haul routes used by the Contractor will be maintained and kept clean during the course of the work to prevent the accumulation of dirt and mud

and the generation of dust by sweeping, washing or other methods approved by the Engineer.

Immediately prior to opening any runway, taxiway or apron pavements to aircraft the Contractor, Airport Operator and Engineer will inspect the area to ensure these areas are swept clean, free of FOD and that the pavement markings, signage and lights are unobstructed.

10. HAZARDOUS MATERIALS (HAZMAT) MANAGEMENT

The Contractor will comply with all Federal, State, and local laws and regulations controlling pollution of the environment and hazardous waste. The Contractor will have on hand and accessible at all times the MSDS sheets for all chemicals on site. All construction equipment will be serviced and refueled in the Contractor's staging area. Approved secondary containment will be used during servicing and refueling. Airport Operations and or the Engineer must be notified of any spills. The Airport Operator will notify the appropriate responders. The Contractor will have a HAZMAT management procedure manual in place. Copies will be available upon request and must be included with the Safety Plan Compliance Document (SPCD).

11. NOTIFICATION OF CONSTRUCTION ACTIVITIES

The Airport Operator will notify all users of the planned construction project involving the closures of Runway 1-19, Taxiway 'A' and Taxiway 'B' to aircraft operations. Meetings with the airport tenants will be scheduled prior to the start of work and notifications will be sent.

For notification of the construction activities, tenants will be sent periodic updates. These updates will outline areas of work completed and upcoming areas affected, identify areas hazardous to aircraft and vehicle movement, provide notification of schedule changes, and provide a forum for addressing questions and concerns that may arise due to the construction activity.

a. Maintenance of a List of Responsible Representatives/ Points of Contact
A list of responsible representatives and the associated contact numbers will be maintained in this document and will be distributed to the Contractor, Engineer, and Airport Operator. Any updates to the original list in this document must be made promptly and the full list reflecting those amendments will be redistributed separately. The Contractor will designate a representative to be available on a 24-hour basis, every day of the week for emergency maintenance of safety and phasing items, closure markings and coverings, signs and similar.

1. Contact 911
2. Morrisville-Stowe State Airport 802.272.3574
3. Stowe Aviation (FBO) 802.253.2332
4. Engineer's Office 603.666.7181
5. Engineer's on-site Inspector (TBD)

6. Contractor Office (TBD)
7. Contractor Site Superintendent (TBD)
8. FAA: (TBD)

b. Notices to Airmen (NOTAM)
NOTAMs must be issued to advise pilots and other airport users of the construction activity, closure period and other operational impacts. **Only the Airport Operator will initiate or cancel NOTAMs and is the only entity that can close or open a runway.** The Airport Operator must coordinate the issuance, maintenance and cancellation of NOTAMs about airport conditions resulting from the construction activities with tenants and the local air traffic facility, and must provide information on the closed or hazardous conditions on the airport movement areas to the FAA Flight Service Station (FSS) so that it can issue a NOTAM. Any person having reason to believe that a NOTAM is missing, incomplete, or inaccurate must notify the Airport Operator immediately. The RPR shall verify that NOTAMs are in place prior to allowing work to commence each morning.

c. Emergency Notification Procedures
The Airport Operator will be the first point of contact for any emergency involving the construction of the project after which the Engineer will be immediately contacted as well. For an emergency requiring immediate medical attention, 911 may be contacted prior the alerting the Airport Operator and the Engineer. Refer to Section 15 "Special Conditions" in the event of an emergency on the Airfield.

d. Coordination with Emergency Response Personnel
The Airport Operator will notify the Emergency Responders of proposed construction that may interfere with emergency response. The Emergency Responders will require access to all buildings throughout the project areas at all times. The Airport Operator and Engineer will be called for non-emergency incidents.

e. Notification to the FAA
The Construction Safety and Phasing Plan will be submitted by the Engineer to the FAA for review and approval.
FAA 7460-1 will be filed for the construction project.

In the event any conditions exist that adversely affect the operation of the airport, the Contractor will notify the Engineer or Airport Operator immediately by telephone and follow up in writing by email. The Engineer or Airport Operator will seek to remedy the situation. If no remedy is found, the Engineer or Airport Operator will immediately notify the FAA by telephone or in writing by email.

f. Notification of Severe Weather
The Contractor will be responsible for notifying all workers including subcontractors of severe weather in the vicinity of the Airport. During times of

severe weather, the Contractor will cease work and secure the jobsite to prevent damage to equipment and injury to personnel.

12. INSPECTION REQUIREMENTS

a. Daily (or More Frequent) Inspections

A safety and field preparedness inspection will be completed by the Airport Operator, Contractor and/or Engineer just prior to the end of the closure period to ensure the re-opened runways, taxiways, taxilanes, aprons, associated lighting systems and signage are in normal operating condition and that there are no obstructions to aircraft and vehicular movement and no FOD left on the airfield.

b. Final Inspections

When the Contractor determines that the work defined in the Contract is substantially completed, he/she will notify the Engineer in writing and the Engineer will schedule a final inspection of the work. Any work found to be unsatisfactory at the time of the final inspection will be noted and the Contractor given instructions on how to remedy the deficient areas. Upon completion of any "punch list" work, the Engineer and Airport Operator will review the areas again for acceptance.

13. UNDERGROUND UTILITIES

All known underground utilities are shown in the construction documents. It is the Contractor's responsibility to coordinate with dig-safe, utility owners, and locate all underground utilities prior to commencing excavation activities.

14. PENALTIES

Non-compliance with airport rules and regulations and violations of Airport Safety Plans including, but not limited to security breaches and vehicle/pedestrian deviations may lead to penalties. Penalties for non-compliance vary from verbal and written warnings to the suspension of the project until total compliance is met. Drivers who deviate from the assigned haul routes or work areas will have their airport access privileges revoked.

15. SPECIAL CONDITIONS

There are no special conditions in this project that affect airport operations other than the temporary closure of Runway 1-19, Taxiway 'A' and Taxiway 'B'.

In the event of an emergency involving an inbound aircraft in distress, the Contractor and Engineer must be alerted of the situation and must comply with all instructions issued by the Airport Operator and/or Emergency Responders.

In the event of an aircraft emergency or construction accident on the field, the Airport Operator will be notified immediately, and all work crews must meet at a pre-designated point, and all personnel will be accounted for.

If a security breach occurs on the airport, the Airport Operator will inform the Contractor of any action required, and all workers will remain within the work site until the issue is resolved.

If a potential security breach is noticed by any of the Contractor's staff, the Engineer and Airport Operator will be notified immediately.

In the event of a vehicle/pedestrian deviation by a member of the Contractor's staff, work will immediately cease, and all workers will be retrained regarding the airfield safety and operations. Upon investigation, the worker who caused the deviation may be penalized by being relieved of their duties for the day's work shift or for an extended period of time if so determined.

16. RUNWAY AND TAXIWAY VISUAL AIDS

For this section, also refer to the Safety and Phasing Plans, Sheets 6 – 16 of the contract plans. During runway closures lighted 'X' runway closure markers will be placed directly over the runway 1 & 19 designation numerals facing the approach. For all closures, a NOTAM will be issued and the applicable runway/taxiway edge lights will be disabled, signs directing traffic to the closed taxiways/runways will be covered.

Barricades will be used to delineate the boundaries of the work areas and the pavement areas open to aircraft and airport vehicle operations. Refer to section HAZARD MARKING AND LIGHTING of this document.

17. MARKING AND SIGNS FOR ACCESS ROUTES

No new pavement markings will be used to delineate access routes across the airfield. Construction signage along the haul routes to include "no construction vehicles beyond this point" and "stop wait for airport escort" signs will be installed as shown on the attached drawings.

18. HAZARD MARKING AND LIGHTING

Hazard marking and lighting prevents aircraft operators from breaching work areas and prevent construction crews and vehicles from inadvertently entering aircraft operation areas. At the start of each phase, construction barricades will be installed at the limits of the particular work area. The barricades will be outside of any active runway safety area. All barricade locations must be approved by the Airport Operator and/or Engineer prior to the commencement of the Work. The Contractor shall also place "no entry" and "construction ahead" signs as detailed on the Safety and Phasing Details, Sheets 6 – 16 of the contract plans.

19. WORK ZONE LIGHTING FOR NIGHT TIME CONSTRUCTION

When work is performed during hours of darkness the Contractor shall provide adequate site lighting to create a safe and efficient work environment. In general, site lighting shall not be positioned or aimed towards active runways or approaches.

20. PROTECTION

The work associated with this project will be phased such that there will be minimal construction activity in the vicinity of open and active runway. No work will occur within the associated runway and taxiway safety areas without closure of adjacent pavements. Prior permission must be attained from the Airport Operator and the Engineer must be notified before the Contractor is to perform any activities.

The Contractor shall coordinate his activities in such a manner to not interfere with the adjacent agricultural activities without prior permission from the Airport Operator.

The Contractor shall always wear proper personal protective equipment (PPE) when on project site.

21. OTHER LIMITATIONS ON CONSTRUCTION

a. Prohibitions

The Contractor will not perform any construction within the Runway Safety Area or Runway OFZ's while the Runway is open to aircraft operations.
The use of flare pots, flares, open flames or explosives are prohibited.

Smoking is prohibited within the AOA, on Airport property and construction work site at all times. Anyone caught smoking within the AOA, on Airport property and construction work site will be subject to fines and/or removal from the Project site.

b. Restrictions

Work hours shall be in accordance with the Town of Morristown Noise Ordinance (5:00 AM – 10:00 PM). The Contractor will provide 7 days prior notice for any work at night, on weekends or holidays.

ACRONYMS AND ABBREVIATIONS

ACSI	- Airport Certification Safety Inspector
AOA	- Airport Operations Area
ARFF	- Airport Rescue and Fire Fighting
ATO	- Air Traffic Office
CTAF	- Common Traffic Advisory Frequency
FAA	- Federal Aviation Administration
FOD	- Foreign Object Debris
HAZMAT	- Hazardous Materials
IMC	- Instrument Meteorological Conditions
LCA	- Localizer Critical Area
LOC	- Localizer
NAVAID	- Navigational Aid
NTP	- Notice to Proceed
OFA	- Object Free Area
OFZ	- Obstacle Free Zone
POV	- Privately Owned/Operated Vehicle
RSA	- Runway Safety Area
TOFA	- Taxiway Object Free Area

Item G-002 Record Documents

DESCRIPTION

002-1.1 General. The work included under this section of these specifications shall consist of preparing and submitting project record documents to the owner as specified here in.

The Contractor's attention is also directed to Section 90-11 *Project Closeout* of the General Provisions for additional project closeout documents and requirements.

ITEMS

002-2.1 As-built Plans and Final Survey. The Contractor shall maintain at the site a set of drawings on which shall be accurately recorded the actual as-built locations and dimensions of all his/her work. Changes and variations from the Contract Drawings should be clearly noted. The location an elevation of utilities and other items encountered during progress of the work shall be recorded. Notations on mechanical and electrical work shall include nameplate data for all installed equipment. The Contractor shall keep these drawings current as work progresses and available for review by the Engineer or RPR at all times. This record of as-built conditions shall include the work of all subcontractors.

Prior to final acceptance of the work, the Contractor shall have a final survey made by a Land Surveyor licensed in the State of Vermont. The final survey shall consist of taking shots at the same stations as the design cross sections with elevations recorded at every location where a proposed grade was shown on the design cross section, at all changes in grade, at the top and toes of slopes, and at the limits of work. It shall also include the location and elevation of all structures, lights, signs, installed utilities, pavement markings, and joints. For drainage items the survey shall include rim elevations, invert elevations, and sump elevations.

All survey shall be referenced to the National Geodetic Survey (NGS) Primary Airport Control Station (PAC) and/or Secondary Airport Control Stations (SACS). PAC and SAC locations and data may be obtained from http://www.ngs.noaa.gov/cgi-bin/airports.prl?TYPE=PACSAC. A copy of the Survey information shall be delivered to the Engineer in the appropriate vertical datum, in State Plane coordinate system, and in MicroStation format in accordance with VAOT CADD Standards and Procedure Manual. All elevations shall be to the nearest 0.01 foot with the exception of turf areas which may be to the nearest 0.1 foot.

All as-built information from the final survey shall be shown on the As-Built Drawings and submitted to the Engineer for review. Any errors shall be corrected by the Contractor as required. The As-Built Drawings and final survey shall be completed and accepted by the Engineer before final payment will be made.

002-2.2 Final DBE Participation Statement. The Contractor shall submit a statement showing the final accounting of all DBE participation actually used in accordance with Section 12.0 of the Supplemental Provisions.

002-2.3 Project Photographs. The Contractor shall furnish photographs of the project. The views shall be as directed or approved by the RPR. The photographs shall show the project site prior to construction, work, the work in progress and the project site at the completion of the work. A minimum of 24 color photographs will be taken during each 30-day period of the contract. A digital camera shall be used to take the photographs and they shall be delivered on cd or usb-drive. No separate payment shall be made

for the project photographs, but rather they shall be considered incidental to the project.

002-2.4 Aerial Photographs. The Contractor shall furnish the following sets of aerial imagery taken after the completion of all work. The Contractor shall inscribe on the reverse side of each photograph all pertinent information such as description, date, compass direction on which the picture was taken, AIP project number, photograph shall include all the airport boundaries. In addition to the required prints the Contractor shall turn over digital copies of all images along with the rights to reproduce and distribute the images.

1. The Contractor shall furnish four (4) color aerial photographs of the entire airport, including all airport boundaries. This photograph shall be taken with a mapping quality (cartographic) camera. The Contractor shall submit certification that the camera has been calibrated within the last three (3) years in accordance with USGS mapping standards. The photo shall be vertical and shall be enlarged to 1" = 400'. The 1"=400' enlargements shall be mounted on Gator Board (or approved equal) and shall be identified on the back of the Gator Board.

2. The Contractor shall furnish two (2) color aerial photographs of the entire airport, including all airport boundaries. This photograph shall be taken with a mapping quality (cartographic) camera. The contractor shall submit certification that the camera has been calibrated within the last three (3) years in accordance with USGS mapping standards. The photo shall be vertical and shall be enlarged to 1" = 200'. The 1"= 200' enlargements shall be mounted on 48" x 65" Gator Board (or approved equal) and shall be identified on the back of the Gator Board.

Snow cover will not be permitted. Cloud cover shall not obscure photos. The photos shall be taken at the time of day when shadows from the sun will be minimal. Photos shall be clear, in focus, with high resolution and sharpness. Color and tint shall be correct; washed out photos will not be accepted. The Contractor shall submit to the Engineer, contact prints of the photograph for approval prior to making enlargements. Enlargements shall be mounted on Gator Board as indicated above and shall be identified on the back of the Gator Board. Photos shall be suitable for photogrammetric mapping.

002-2.5 GIS Conversion. This item includes requirements for providing aeronautical data collection and conversion associated with work Tasks herein. This includes but is not limited to collection and GIS conversion of airfield features within the project limits in accordance with FAA criteria. This work shall be performed in addition to the Final Survey as required above. This work shall be performed by a **registered licensed surveyor or professional engineer** in the State of Vermont and in accordance with FAA AC 150/5300-18B, "General Guidance and Specifications for Aeronautical Surveys to NGS: Field Data Collection and Geographic Information System (GIS) Standards."

The Contractor shall submit all collected data (in Microstation format), and associated required deliverables specified in FAA AC 150/5300-18B, by VTrans, and herein. This includes, but is not limited to:

1. Survey Quality Control Plan (completed prior to the start of work)

2. Final Project Report

3. Documentation required for each feature as defined by Chapter 5 of FAA AC 150/5300-18B

4. All final processing, adjustment, or reduction files used to produce the final data. This includes the results of independent software files produced during the reduction of the final data, and any other product necessary to recreate the data.

In order to complete this task, the Contractor will be required to complete an as-built survey of the entire runway centerline profile in addition to the features located within the project limits.

METHOD OF MEASUREMENT

002-3.1 As-Built Plans and Final Survey. The As-built plans shall be measured as a single fixed lump sum item, complete and accepted by the Engineer.

002-3.2 Aerial Photographs. The Aerial Photographs shall be measured as a single fixed lump sum item, complete and accepted by the Engineer.

002-3.3 GIS Conversion. All work and costs involved in furnishing the GIS Conversion Data shall be measured as a single fixed lump sum item, complete and accepted by the Engineer.

002-3.4 Final DBE Participation Statement. All work and costs involved in furnishing the final DBE Participation statement shall not be measured separately for payment, but rather shall be considered incidental to the project items.

002-3.5 Project Photos. All work and costs involved in furnishing the project photos shall not be measured separately for payment, but rather shall be considered incidental to the project items.

BASIS OF PAYMENT

002-4.1 As-Built Plans. Payment shall be made at the fixed lump sum price specified in the bid proposal for furnishing a complete as-built plan set, measured as specified above, which price and payment thereof shall constitute full compensation for all labor, materials, equipment, expenses, survey, preparation, and incidentals to provide the required as-built plan set accepted by the Owner.

002-4.2 Aerial Photographs. Payment shall be made at the contract lump sum price for furnishing the complete aerial photograph sets, measured as specified above, which price and payment thereof shall constitute full compensation for all labor, materials, equipment, expenses, preparation, and incidentals to provide the aerial photographs accepted by the Owner. Payment will be made based in two parts based on the following schedule:

A. The first payment equal to 50% of the contract cost will be paid once the photos have been accepted by the Owner.
B. The second payment equal to the remaining 50% of the contract cost will be made upon approval of the photos by the FAA.

002-4.3 GIS Conversion. Payment shall be made at the fixed lump sum price specified in the bid proposal for the GIS Data collected, submitted and approved by the owner and FAA. This shall include compensation for all labor, equipment, and incidentals associated with collecting, analyzing, processing, reviewing and submitting this data.

Payment shall be made under:

900.645	(FAA G-002 AS-BUILT PLANS AND FINAL SURVEY) (N.A.B.I)	per Lump Sum
900.645	(FAA G-002 AERIAL PHOTOGRAPHS)	per Lump Sum
900.645	(FAA G-002 GIS CONVERSION) (N.A.B.I.)	per Lump Sum

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Item M-002 Contaminated Soil Removal and Replacement

DESCRIPTION

002-1.1 The work involved under this section of these specifications includes removing contaminated soil, if found within the project limits. The exact limits and quantity of contaminated soils will be determined in the field. Close coordination and notification to the Vermont Department of Environmental Conservation (VTDEC) will be required for the work involved. This work shall only be performed by qualified personnel. When excavation and backfill is incidental to unit pay items, such as with structures and pipe, refer to the specifications for those items for limitations on payment for contaminated soil removal and replacement.

CONSTRUCTION METHODS

002-2.1 General. The Contractor may use any method of excavation at his/her disposal, provided the requirements of these specifications and VTDEC regulations are satisfied.

002-2.2 Contaminated Soil Remediation. If, during the excavation operations, it is determined that contaminated soils are present, the Resident Project Representative (RPR) shall be notified immediately. The Contractor shall provide results of any field and/or laboratory analysis that determines the type and concentration of contamination to the RPR. The RPR shall notify the Owner and VTDEC.

The cost of laboratory soil tests and laboratory groundwater test for contamination shall be included in the Contractor's unit bid price for contaminated soil removal and replacement. All costs to collect, package, ship and manifest the soil samples shall be considered incidental.

Contaminated soil removal will be limited to soil within the excavation limits of the project, unless otherwise directed by the Owner or VTDEC. If contaminated soil extends below the groundwater table, personnel from the VTDEC shall direct the Contractor as to the proper removal procedures to follow.

The Contractor will remove the contaminated material from Airport property and legally dispose of it in conformance with VTDEC and all other applicable regulations.

The Contractor shall replace this material with suitable backfill material, free of organics and other objectionable materials such as vegetation, muck, peat, silt, sod, stumps or roots. Separate payment shall not be made for the backfill. Rather the suitable backfill material, placement, and compaction shall be included in the unit price for contaminated soil removal and replacement.

002-2.3 Suitable Backfill Material. The Contractor will be required to fill in the excavation created by the contaminated soil remediation operations. The material shall be clean granular readily compactable backfill material, placed and spread in 8-inch lifts. Compaction shall be in accordance with Specification Section *P-152 Excavation, Subgrade, and Embankment* of these specifications. The finished surface shall be to the elevation determined in the field by the RPR.

002-2.4 Site Restoration. Areas disturbed by the soil remediation work not within the limits of the work, shall be restored to their original or better condition. Work shall proceed as directed by the RPR. The area shall have a neat, smooth and pleasing appearance when completed.

METHOD OF MEASUREMENT

002-3.1 Contaminated Soil Removal and Replacement. The quantity of contaminated soil removal and replacement to be paid for shall be the number of cubic yards measured in its initial undisturbed, or final compacted position. Separate payment will not be made for testing, hauling, specialty contractors, permits, fees, disposal, or backfill. Rather the cost of such items and all incidentals required to complete the work shall be included in the unit price for contaminated soil removal and replacement.

BASIS OF PAYMENT

002-4.1 Contaminated Soil Removal and Replacement. Payment will be made at the contract unit price per cubic yard of contaminated soil removed and replaced. This price shall be full compensation for furnishing all materials; for all excavation, preparation, backfill, hauling, and placing of these materials; for all coordination, testing, stockpiling, permits, fees, legal disposal off site; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment shall be made under:

900.608 (FAA M-002 CONTAMINATED SOIL REMOVAL AND REPLACEMENT)
per Cubic Yard

END OF ITEM M-002

ITEM M-003 MAINTENANCE OF TRAFFIC

DESCRIPTION

003-1.1 This work shall consist of establishing and maintaining traffic control measures to protect the traveling public, including bicyclists and pedestrians, and construction operations. Particular attention shall be paid to the construction vehicles entering and exiting VT 100.

MATERIALS

003-2.1 Site Specific Traffic Control Plan. The Contractor shall prepare and submit a site-specific traffic control plan showing existing lane configurations, existing traffic control devices (signs, signals, and pavement markings), driveways, ramps, and intersections, and the location of all proposed temporary traffic control devices, Flaggers, and UTOs. All pertinent dimensions, such as taper lengths, sign spacing, temporary lane widths, and distances from existing traffic control devices shall be labeled.

003-2.2 Traffic Control Devices. All traffic control devices shall conform to the requirements of the Section 641.03 of the VAOT 2018 Standard Specifications for Construction and the latest edition of the MUTCD. Traffic control devices required in the performance of this work may include but are not limited to; signs with yielding posts or portable supports, reflectorized drums, traffic cones, delineators and Portable Changeable Message Signs

003-2.3 Flaggers. Flaggers shall be used to control and protect the traveling public and workers during construction operations. The use of flaggers is required whenever the Contractor is hauling materials in or out of the project site or when directed by the RPR. Flaggers shall meet the requirements of Section 630.04 of the VAOT 2018 Standard Specifications for Construction.

METHOD OF MEASUREMENT

003-4.1. The quantity of Maintenance of Traffic, All Inclusive to be measured for payment will be on a lump sum basis for providing traffic control in the complete and accepted work.

BASIS OF PAYMENT

003-5.1. The accepted quantity of Maintenance of Traffic, All Inclusive will be paid for at the Contract lump sum price.

(a) Partial payments for Maintenance of Traffic, All Inclusive will be made as follows:

(1) The first 50% of the Contract lump sum price will be paid upon the approval of the traffic control plan and complete installation of the traffic control devices.

(2) The remaining 50% of quantity payments will be paid on a prorated basis for the estimated duration of the Contract work remaining.

Payment will be full compensation for preparing, implementing, inspecting, maintaining, and removing the applicable traffic control plan and specified traffic control devices, and for furnishing all labor, including **flaggers**, tools, materials, equipment, and incidentals necessary to complete the work.

All items required to implement the applicable traffic control plan will not be paid for directly but will be considered incidental to Maintenance of Traffic.

Payment will be made under:

900.645	(FAA M-003 MAINTENANCE OF TRAFFIC)	per Lump Sum

END OF ITEM M-003

Item P-101 Preparation/Removal of Existing Pavements

DESCRIPTION

101-1 This item shall consist of preparation of existing pavement surfaces for overlay, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable plans.

EQUIPMENT AND MATERIALS

101-2 All equipment and materials shall be specified here and in the following paragraphs or approved by the Resident Project Representative (RPR). The equipment shall not cause damage to the pavement to remain in place.

CONSTRUCTION

101-3.1 Removal of existing pavement.

The Contractor's removal operation shall be controlled to not damage adjacent pavement structure, and base material, cables, utility ducts, pipelines, or drainage structures which are to remain under the pavement.

a. Concrete pavement removal. Full depth saw cuts shall be made perpendicular to the slab surface. The Contractor shall saw through the full depth of the slab including any dowels at the joint, removing the pavement and installing new dowels as shown on the plans and per the specifications. Where the perimeter of the removal limits is not located on the joint and there are no dowels present, the perimeter shall be saw cut the full depth of the pavement. The pavement inside the saw cut shall be removed by methods which will not cause distress in the pavement which is to remain in place. All material shall be removed and disposed off Airport property. Concrete slabs that are damaged by under breaking shall be repaired or removed and replaced as directed by the RPR.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Spall and underbreak repair shall be in accordance with the plans. Any underlaying material that is to remain in place, shall be recompacted and/or replaced as shown on the plans. Adjacent areas damaged during repair shall be repaired or replaced at the Contractor's expense.

b. Asphalt pavement removal. Asphalt pavement to be removed shall be cut to the full depth of the asphalt pavement around the perimeter of the area to be removed. If the material is to be incorporated into the embankment, it shall be pulverized to meet the gradation of *Item P-154 Subbase Course.*

c. Repair or removal of Base, Subbase, and/or Subgrade. All failed material including surface, base course, subbase course, and subgrade shall be removed and repaired as shown on the plans or as directed by the RPR. Materials and methods of construction shall comply with the applicable sections of these specifications. Any damage caused by Contractor's removal process shall be repaired at the Contractor's expense.

101-3.2 Preparation of joints and cracks prior to overlay/surface treatment. Not required for this project.

101-3.3 Removal of Foreign Substances/contaminates prior to overlay. Not required for this project.

101-3.4 Concrete spall or failed asphaltic concrete pavement repair. Not required for this project.

101-3.5 Cold milling. Milling shall be performed with a power-operated milling machine or grinder, capable of producing a uniform finished surface. The milling machine or grinder shall operate without tearing or gouging the underlaying surface. The milling machine or grinder shall be equipped with grade and slope controls, and a positive means of dust control. All millings shall be removed and disposed off Airport property. If the Contractor mills or grinds deeper or wider than the plans specify, the Contractor shall replace the material removed with new material at the Contractor's Expense.

a. Patching. The milling machine shall be capable of cutting a vertical edge without chipping or spalling the edges of the remaining pavement and it shall have a positive method of controlling the depth of cut. The RPR shall layout the area to be milled with a straightedge in increments of 1-foot (30 cm) widths. The area to be milled shall cover only the failed area. Any excessive area that is milled because the Contractor doesn't have the appropriate milling machine, or areas that are damaged because of his negligence, shall be repaired by the Contractor at the Contractor's Expense.

b. Profiling, grade correction, or surface correction. The milling machine shall have a minimum width of 7 feet and it shall be equipped with electronic grade control devices that will cut the surface to the grade specified. The tolerances shall be maintained within +0 inch and -1/4 inch (+0 mm and -6mm) of the specified grade. The machine must cut vertical edges and have a positive method of dust control. The machine must have the ability to remove the millings or cuttings from the pavement and load them into a truck. All millings shall be removed and disposed of off the airport.

c. Clean-up. The Contractor shall sweep the milled surface daily and immediately after the milling until all residual materials are removed from the pavement surface. Prior to paving, the Contractor shall wet down the milled pavement and thoroughly sweep and/or blow the surface to remove loose residual material. Waste materials shall be collected and removed from the pavement surface and adjacent areas by sweeping or vacuuming. Waste materials shall be removed and disposed off Airport property.

101-3.6. Preparation of asphalt pavement surfaces prior to surface treatment. Not required for this project.

101-3.7 Maintenance. The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the RPR. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor's expense.

101-3.8 Preparation of Joints in Rigid Pavement prior to resealing. Not required for this project.

101-3.8.1 Removal of Existing Joint Sealant. Not required for this project.

101-3.8.2 Cleaning prior to sealing. Refer to Specification Sections P-605, P-608 and M-004.

101-3.8.3 Joint sealant. Joint material and installation will be in accordance with P-605 and M-004.

101-3.9 Preparation of Cracks in Flexible Pavement prior to sealing. Not required for this project.

101-3.9.1 Preparation of Crack. Not required for this project.

101-3.9.2 Removal of Existing Crack Sealant. Not required for this project.

101-3.9.4 Removal of Pipe and other Buried Structures.

a. Removal of Existing Pipe Material. Remove the types of pipe as indicated on the plans. The pipe material shall be legally disposed of off-site in a timely manner following removal. Trenches shall be backfilled with material equal to or better in quality than adjacent embankment. Trenches under paved areas must be compacted to 95% of ASTM D698.

b. Removal of Catch Basins/Manholes. Where indicated on the plans or as directed by the RPR, inlets and/or manholes shall be removed and legally disposed of off-site in a timely fashion after removal. Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. When under paved areas must be compacted to 95% of ASTM D698, when outside of paved areas must be compacted to 95% of ASTM D698.

c. Removal of underdrain. Where indicated on the plans or as directed by the RPR, underdrain shall be removed and legally disposed of off-site in a timely fashion after removal. Trenches shall be backfilled with the materials as indicated on the plans or material equal to or better in quality than adjacent embankment. Trenches must be compacted to 95% of ASTM D698.

d. Removal of underdrain cleanouts. Where indicated on the plans or ad directed by the RPR, underdrain cleanouts shall be removed and legally disposed of off-site in a timely fashion after removal. Excavations after removal shall be backfilled with material as indicated on the plans or material equal to or better in quality than adjacent embankment. Excavations shall be compacted to 95% of ASTM D698.

d. **Removal of Tie-downs.** Remove the tie-downs as indicated on the plans. Any materials generated from the removal process shall be legally disposed off-site in a timely fashion after removal.

METHOD OF MEASUREMENT

101-4.1 Pavement removal. The unit of measurement for pavement removal shall be the number of square yards (square meters) removed by the Contractor. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. No direct measurement or payment shall be made for saw cutting. Saw cutting shall be incidental to pavement removal. Dowel bar installation shall be incidental to pavement removal.

101-4.6 Cold milling. Cold milling will not be measured for separate pavement rather it will be considered incidental to the item requiring the cold milling. Milling would only be required for this project to remove deficient material placed by the Contractor or to repair damage caused by the Contractor's operations.

101-4.7 Removal of Pipe. The quantity of pipe removal to be paid shall be the actual number of linear feet of pipe removed, regardless of diameter of the pipe, measured in place to the nearest foot along the centerline of the pipe. This item includes excavation, backfill, compaction, disposal off site, and all incidentals required to complete the item.

101-4.8 Removal of Catch Basins/Manholes. The unit of measurement for removal of other buried structures will be made at the contract unit price for each completed and accepted item. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.9.4.

101-4.8 Removal of Underdrains. The quantity of underdrain removal to be paid shall be the actual number of linear feet of underdrain removed, including all stone, fabric,

101-4.9 Removal of Underdrain Cleanouts. The quantity of underdrain cleanouts removed to be paid shall be the actual number of underdrain cleanouts removed, measured in place. This item includes excavation, backfill, hauling, disposing off site, and all incidentals required to complete the item.

101-5.0 Removal of Tie Downs. The quantity of tie downs removed to be paid shall be the actual number of tie downs removed, measured in place. This item includes all materials, labor, equipment, tools, saw cutting, disposal, CLSM backfill, and all incidentals required to complete the item.

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.

600.675	(FAA P-101 PAVEMENT REMOVAL)	per Square Yard
600.640	(FAA P-101 PIPE REMOVAL)	per Linear Foot
600.620	(FAA P-101 DRAINAGE STRUCTURE REMOVAL)	per Each
600.640	(FAA P-101 UNDERDRAIN REMOVAL)	per Linear Foot
600.620	(FAA P-101 UNDERDRAIN CLEANOUT REMOVAL)	per Each
600.620	(FAA P-101 TIE DOWN REMOVAL)	per Each

REFERENCES

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

Advisory Circulars (AC)

AC 150/5380-6 Guidelines and Procedures for Maintenance of Airport Pavements.

ASTM International (ASTM)

ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

END OF ITEM P-101

Item P-152 Excavation, Subgrade, and Embankment

DESCRIPTION

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

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

a. Unclassified excavation. Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature which is not otherwise classified and paid for under and paid for under Specification Section *P-101 Preparation and Removal of Existing Pavement*.

152-1.3 Unsuitable excavation. Unsuitable material shall be disposed in designated waste areas as shown on the plans. Materials 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 RPR.

CONSTRUCTION METHODS

152-2.1 General. Before beginning excavation, grading, and embankment operations in any area, the area shall be cleared or cleared and grubbed in accordance with Item P-151.

The suitability of material to be placed in embankments shall be subject to approval by the RPR. All unsuitable material shall be disposed of in waste areas as shown on the plans. All waste areas shall be graded to allow positive drainage of the area and adjacent areas. The surface elevation of waste areas shall be specified on the plans or approved by the RPR.

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

Areas outside the limits of the pavement areas where the top layer of soil has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4 inches (100 mm), to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade.

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

a. Blasting. Blasting will be permitted as directed by the RPR and in accordance with the following:

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

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

In each distinct blasting area, where pertinent factors affecting blast vibrations and their effects in the area remain the same, the Contractor shall submit a blasting plan of the initial blasts to the RPR for approval. This plan must consist of hole size, depth, spacing, burden, type of explosives, type of delay sequence, maximum amount of explosive on any one delay period, depth of rock, and depth of overburden if any. The maximum explosive charge weights per delay included in the plan shall not be increased without the approval of the RPR.

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

Blasting and explosive storage shall be in accordance with Section 70, paragraph 70-09 and all federal, state, and local safety regulations.

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

152-2.2 Excavation. No excavation shall be started until the work has been staked out by the Contractor and the RPR has obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface. The Contractor and RPR shall agree that the original ground lines shown on the original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

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

Volumetric quantities were calculated by comparing DTM files of the applicable design surfaces and generating Triangle Volume Reports. Electronic copies of DTM files and a paper copy of the original topographic map will be issued to the successful bidder**.**

Volumetric quantities were calculated using design cross sections which were created for this project using the DTM files of the applicable design surfaces and generating End Area Volume Reports. Paper copies of design cross sections and a paper copy of the original topographic map will be issued to the successful bidder.

Existing grades on the design cross sections or DTM's, where they do not match the locations of actual spot elevations shown on the topographic map, were developed by computer interpolation from those spot elevations. Prior to disturbing original grade, Contractor shall verify the accuracy of the existing ground surface by verifying spot elevations at the same locations where original field survey data was obtained as indicated on the topographic map. Contractor shall recognize that, due to the interpolation process, the actual ground surface at any particular location may differ somewhat from the interpolated surface shown on the design cross sections or obtained from the DTM's. Contractor's verification of original ground surface, however, shall be limited to verification of spot elevations as indicated herein, and no adjustments will be made to the original ground surface unless the Contractor demonstrates that spot elevations shown are incorrect. For this purpose, spot elevations which are within 0.1 foot (30 mm) of the

stated elevations for ground surfaces, or within 0.04 foot (12 mm) for hard surfaces (pavements, buildings, foundations, structures, etc.) shall be considered "no change". Only deviations in excess of these will be considered for adjustment of the original ground surface. If Contractor's verification identifies discrepancies in the topographic map, Contractor shall notify the RPR in writing at least two weeks before disturbance of existing grade to allow sufficient time to verify the submitted information and make adjustments to the design cross sections or DTM's. Disturbance of existing grade in any area shall constitute acceptance by the Contractor of the accuracy of the original elevations shown on the topographic map for that area**.**

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the RPR. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes **as** shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

The grade shall be maintained so that the surface is well drained at all times.

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

a. Selective grading. When selective grading is indicated on the plans, the more suitable material designated by the RPR shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas until it can be placed. The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved.

b. Undercutting. Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the RPR. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed off the airport. The cost is incidental to this item. This excavated material shall be paid for at the contract unit price per cubic yard (per cubic meter) for unclassified excavation. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities. The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans. Undercutting will be paid as unclassified excavation.

c. Over-break. Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the RPR. All over-break shall be graded or removed by the Contractor and disposed of as directed by the RPR. The RPR shall determine if the displacement of such material was unavoidable and their own decision shall be final. Payment will not be made for the removal and disposal of over-break that the RPR determines as avoidable. Unavoidable over-break will be classified as "Unclassified Excavation."

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

152-2.3 Borrow excavation. There are no borrow sources within the boundaries of the airport property. The Contractor shall locate and obtain borrow sources, subject to the approval of the RPR. All offsite

borrow sources will require an Offsite Activity Approval by the State of Vermont Agency of Natural Resources. The Contractor shall notify the RPR at least 15 days prior to beginning the excavation so necessary measurements and tests can be made by the RPR. All borrow pits shall be opened to expose the various strata of acceptable material to allow obtaining a uniform product. Borrow areas shall be drained and left in a neat, presentable condition with all slopes dressed uniformly. Borrow areas shall not create a hazardous wildlife attractant.

152-2.4 Drainage excavation. Drainage excavation shall consist of excavating drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. The work shall be performed in sequence with the other construction. Ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the RPR. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted.

152-2.5 Preparation of cut areas or areas where existing pavement has been removed. In those areas on which a subbase or base course is to be placed, the top 12 inches of subgrade shall be compacted to not less than 100 % of maximum density for non-cohesive soils, and 95**%** of maximum density for cohesive soils as determined by ASTM D698. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

152-2.6 Preparation of embankment area. All sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm) and shall then be compacted per paragraph 152-2.10.

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

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

152-2.7 Control Strip. The first half-day of construction of subgrade and/or embankment shall be considered as a control strip for the Contractor to demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the RPR.

152-2.8 Formation of embankments. The material shall be constructed in lifts as established in the control strip, but not less than 6 inches (150 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests

verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

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

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

The material in each lift shall be within ±2% of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The RPR will take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with ASTM D698. A new Proctor shall be developed for each soil type based on visual classification.

Density tests will be taken by the RPR for every 3,000 square yards of compacted embankment for each lift which is required to be compacted, or other appropriate frequencies as determined by the RPR.

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until the embankment is compacted to not less than 100% of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D698. Under all areas to be paved, the embankments shall be compacted to a depth of 12 inches and to a density of not less than 100 percent of the maximum density as determined by ASTM D698. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches (100 mm) which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with 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. The RPR shall perform all density tests. If the specified density is not attained, the area represented by the test or as designated by the RPR shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

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

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

When rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be incorporated into the outer portion of the embankment and the subgrade material shall be incorporated under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4 inches (100 mm) in their greatest dimensions will not be allowed in the top 12 inches (300 mm) of the subgrade. Rockfill shall be brought up in lifts as specified or as directed by the RPR and the finer material shall be used to fill the voids forming a dense, compact mass. Rock, cement concrete pavement, asphalt pavement, and other embankment material shall not be disposed of except at places and in the manner designated on the plans or by the RPR.

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

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

152-2.9 Proof rolling. The purpose of proof rolling the subgrade is to identify any weak areas in the subgrade and not for compaction of the subgrade. Before start of embankment, and after compaction is completed, the subgrade area shall be proof rolled with a 20 ton Tandem axle Dual Wheel Dump Truck loaded to the legal limit with tires inflated to 100 psi in the presence of the RPR. Apply a minimum of **1** coverage, or as specified by the RPR, under pavement areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be removed and replaced with suitable material or reworked to conform to the moisture content and compaction requirements in accordance with these specifications. Removal and replacement of soft areas is incidental to this item.

152-2.10 Compaction requirements. The subgrade under areas to be paved shall be compacted to a depth of 12 inches and to a density of not less than 100 percent of the maximum dry density as determined by ASTM D698. The subgrade in areas outside the limits of the pavement areas shall be compacted to a depth of 12 inches and to a density of not less than 95 percent of the maximum density as determined by ASTM 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). When the material has greater than 30 percent retained on the ¾ inch (19.0 mm) sieve, follow the methods in ASTM D698 for correction of maximum dry density and optimum moisture for oversized particles. Tests for moisture content and compaction will be taken at a minimum of 3,000 S.Y. of subgrade. All quality assurance testing shall be done by the RPR.

The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

If the specified density is not attained, the entire lot shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the RPR and the finished subgrade shall be maintained.

152-2.11 Finishing and protection of subgrade. Finishing and protection of the subgrade is incidental to this item. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low areas, holes or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been accepted by the RPR.

152-2.12 Haul. All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be made for any work or materials associated with providing, maintaining and removing haul roads or routes.

152-2.13 Surface Tolerances. In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

a. **Smoothness.** The finished surface shall not vary more than +/- ½ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

b. **Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/- 0.05 feet (15 mm) of the specified grade.

On safety areas, turfed areas and other designated areas within the grading limits where no subbase or base is to placed, grade shall not vary more than 0.10 feet (30 mm) from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

152-2.14 Topsoil. When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located as shown on the plans and the approved CSPP, and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the RPR, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further re-handling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

METHOD OF MEASUREMENT

152-3.1 Measurement for payment specified by the cubic yard shall be computed by the average end areas of design cross sections for computation of neat line design quantities. The end area is that bound by the original ground line established by field cross-sections and the final theoretical pay line established by cross-sections shown on the plans, subject to verification by the RPR.

152-3.2 The quantity of unclassified excavation to be paid for shall be the number of cubic yards 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.

152-3.3 The quantity of embankment in place shall be the number of cubic yards (cubic meters) measured in its final position.

BASIS OF PAYMENT

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

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

Payment will be made under:

900.608	(FAA P-152 UNCLASSIFIED EXCAVATION)	per Cubic Yard
900.608	(FAA P-152 EMBANKMENT IN PLACE)	per Cubic Yard

REFERENCES

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

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T-180	Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ASTM International (ASTM)

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/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 D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Advisory Circulars (AC)

AC 150/5370-2	Operational Safety on Airports During Construction Software

Software

FAARFIELD – FAA Rigid and Flexible Iterative Elastic Layered Design

U.S. Department of Transportation

FAA RD-76-66	Design and Construction of Airport Pavements on Expansive Soils

END OF ITEM P-152

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Item P-153 Controlled Low-Strength Material (CLSM)

DESCRIPTION

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

MATERIALS

153-2.1 Materials.

a. Cement. Cement shall conform to the requirements of ASTM C150 Type II.

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

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

Sieve Size	Percent Passing by weight
3/4 inch (19.0 mm)	100
No. 200 (75 µm)	0 - 12

d. Water. Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

MIX DESIGN

153-3.1 Proportions. The Contractor shall submit, to the RPR, a mix design including the proportions and source of aggregate, fly ash, cement, water, and approved admixtures. No CLSM mixture shall be produced for payment until the RPR has given written approval of the proportions. The proportions shall be prepared by a laboratory and shall remain in effect for the duration of the project. The proportions shall establish a single percentage or weight for aggregate, fly ash, cement, water, and any admixtures proposed. Laboratory costs are incidental to this item.

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

b. Consistency. Design CLSM to achieve a consistency that will produce an approximate 8-inch (200 mm) diameter circular-type spread without segregation. CLSM consistency shall be determined per ASTM D6103.

CONSTRUCTION METHODS

153-4.1 Placement.

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

b. Contractor Quality Control. The Contractor shall collect all batch tickets to verify the CLSM delivered to the project conforms to the mix design. The Contractor shall verify daily that the CLSM is consistent with 153-3.1a and 153-3.1b. Adjustments shall be made as necessary to the proportions and materials as needed. The Contractor shall provide all batch tickets to the RPR.

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

153-4.2 Curing and protection

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

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

153-4.3 Quality Assurance (QA) Acceptance. CLSM QA acceptance shall be based upon batch tickets provided by the Contractor to the RPR to confirm that the delivered material conforms to the mix design.

METHOD OF MEASUREMENT

153-5.1 Measurement.

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

BASIS OF PAYMENT

153-6.1 Payment.

No payment will be made separately or directly for controlled low strength material (CLSM). CLSM shall be considered necessary and incidental to the work of this Contract.

REFERENCES

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

ASTM International (ASTM)

ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low-Strength Material (CLSM) Test Cylinders
ASTM D6103	Flow Consistency of Controlled Low Strength Material (CLSM)

END OF ITEM P-153

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Item P-154 Subbase Course

DESCRIPTION

154-1.1 This item shall consist of a subbase course composed of granular materials constructed on a prepared subgrade or underlying course in accordance with these specifications, and in conformity with the dimensions and typical cross-section shown on the plans.

MATERIALS

154-2.1 Materials. The subbase material shall consist of hard durable particles or fragments of granular aggregates, recycled asphalt pavement (RAP), and/or recycled concrete pavement (RCO). The material may be obtained from gravel pits, stockpiles, or may be produced from a crushing and screening plant with proper blending. The materials from these sources shall meet the requirements for gradation, quality, and consistency. The material shall be free from vegetative matter, excessive amounts of clay, and other objectionable substances; uniformly blended; and be capable of being compacted into a dense, stable subbase.

The subbase material shall exhibit a California Bearing Ratio (CBR) value of at least 20 when tested in accordance with ASTM D1883. The subbase material shall meet the gradation specified in the table below.

Subbase Gradation Requirements

Sieve designation	Percentage by weight passing sieves		Contractor's Final Gradation	Job Control Grading Band Tolerances[1] (Percent)
	Subbase Aggregate	Recycled pavement (RAP or RCO)		
3 inch (75 mm)	100			0
1 1/2 inch (37.5 mm)		100		0
3/4 inch (19.0 mm)	70-100	70-100		±10
No. 10 (2.00 mm)	20-100	20-100		±10
No. 40 (425 µm)	5-60	5-60		±5
No. 200 (75 µm)	0-10	0-10		±5

[1]The "Job Control Grading Band Tolerances" shall be applied to "Contractor's Final Gradation" to establish the job control grading band.

The portion of the material passing the No. 40 (425 µm) sieve shall have a liquid limit of not more than 25 and a plasticity index of not more than six (6) when tested in accordance with ASTM D4318.

154-2.2 Sampling and testing.

a. Aggregate base materials. Samples shall be taken by the Contractor per ASTM D75 for initial aggregate subbase requirements and gradation. Material shall meet the requirements in paragraphs 154-2.1. The Contractor shall submit to the Resident Project Representative (RPR) certified test results showing that the aggregate meets the Material requirements of this section. Tests shall be representative of the material to be used for the project.

b. Gradation requirements. The Contractor shall take at least one aggregate subbase sample per day in the presence of the RPR to check the final gradation. Samples shall be taken from the in-place, un-compacted material at sampling locations determined by the RPR on a random basis per ASTM D3665. Sampling shall be per ASTM D75 and tested per ASTM C136 and ASTM C117. Results shall be furnished to the RPR by the Contractor each day during construction. Material shall meet the requirements in paragraph 154-2.1.

154-2.3 Separation Geotextile. Not used.

154-2.4 Geogrid. Not used.

CONSTRUCTION METHODS

154-3.1 General. The subbase course shall be placed where designated on the plans or as directed by the RPR. The material shall be shaped and thoroughly compacted within the tolerances specified.

Granular subbases which, due to grain sizes or shapes, are not sufficiently stable to support the construction equipment without movement, shall be mechanically modified to the depth necessary to provide stability as directed by the RPR. The mechanical modification shall include the addition of a fine-grained medium to bind the particles of the subbase material sufficiently to furnish a bearing strength, so the course will not deform under construction equipment traffic.

154-3.2 Preparing underlying course. Prior to constructing the subbase course, clean the underlying course or subgrade of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances in accordance with Item P-152. Correct ruts, soft yielding spots in the underlying courses, and subgrade areas having inadequate compaction and/or deviations of the surface from the specified requirements, by loosening and removing soft or unsatisfactory material, adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, the surface shall be stabilized prior to placement of the overlying course by mixing the overlying course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the overlying course is placed. The underlying course shall be checked and accepted by the RPR before placing and spreading operations are started.

To protect the subgrade and to ensure proper drainage, spreading of the subbase shall begin along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope.

154-3.3 Control Strip. The first half-day of subbase construction shall be considered as a control strip for the Contractor to demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration

that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the RPR.

154-3.4 Placement. The material shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the RPR, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted. The material shall not be placed when the underlying course is soft or yielding.

The material shall meet gradation and moisture requirements prior to compaction. Material may be free-draining and the minimum moisture content shall be established for placement and compaction of the material.

The material shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

154-3.5 Compaction. The subbase material shall be compacted, adjusting moisture as necessary, to be within ±2% of optimum moisture. The field density of the compacted material shall be at least 100% of the maximum density as specified in paragraph 154-3.9a. If the specified density is not attained, the area of the lift represented by the test shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

154-3.6 Weather limitation. Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on subbase course shall not be conducted when the subgrade is wet or frozen or the subbase material contains frozen material.

154-3.7 Maintenance. No base or surface course shall be placed on the subbase until the subbase has been accepted by the RPR. The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, the Contractor shall verify that materials still meet all specification requirements before placement of additional material. Equipment may be routed over completed sections of subbase course, provided the equipment does not damage the subbase course and the equipment is routed over the full width of the completed subbase course. Any damage to the subbase course from routing equipment over the subbase course shall be repaired by the Contractor at their expense.

154-3.8 Surface tolerance. In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

a. Smoothness. The finished surface shall not vary more than +/- ½ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

b. Grade. The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/- 0.05 feet (15 mm) of the specified grade.

154-3.9 Acceptance sampling and testing. The aggregate base course shall be accepted for density and thickness on an area basis. Two test shall be made for density and thickness for each 1,200 square yards. Sampling locations will be determined on a random basis per ASTM D3665.

a. Density. The RPR shall perform all density tests for acceptance.

Each area shall be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens compacted and tested per ASTM D698. The in-place field density shall be determined per ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the area represented by the failed test shall be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

When the material has greater than 30 percent retained on the ¾ inch (19.0 mm) sieve, use methods in ASTM D698 and the procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles.

b. Thickness. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the RPR for each area. Alternatively, the Contractor can perform a survey prior to an after placement of the subbase course to verify depth. Survey interval shall match the Cross Sections as shown on the Contract Plans and shall be performed in the presence of the RPR. Results of the survey shall be submitted to the RPR for acceptance.

Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

METHOD OF MEASUREMENT

154-4.1 Subbase course shall be measured by the number of cubic yards of subbase course material placed and compacted to specified density and plan thickness requirements in the completed course. The quantity of subbase course material shall be measured in final position based upon depth tests or cores taken as directed by the RPR, at the rate of two test per each 1200 square yards of subbase course. On individual depth measurements, thicknesses more than 1/2 inch (12 mm) in excess of that shown on the plans shall be considered as the specified thickness plus 1/2 inch (12 mm) in computing the yardage for payment. Subbase materials shall not be included in any other excavation quantities. Alternatively, if the quantity of subbase course material is to be measured in final position by survey, the pre and post placement elevation shall be measured to the nearest 0.01 feet.

BASIS OF PAYMENT

154-5.1 Payment shall be made at the contract unit price per cubic yard for subbase course. This price shall be full compensation for furnishing all materials; for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

900.608	(FAA P-154 SUBBASE COURSE)	per Cubic Yard

REFERENCES

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

ASTM International (ASTM)

ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4759	Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

American Association of State Highway and Transportation Officials (AASHTO)

M 288	Geotextile Specification for Highway Applications

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Item P-209 Crushed Aggregate Base Course

DESCRIPTION

209-1.1 This item consists of a base course composed of crushed aggregate base constructed on a prepared course in accordance with these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

MATERIALS

209-2.1 Crushed aggregate base. Crushed aggregate shall consist of clean, sound, durable particles of crushed stone, crushed gravel, and shall be free from coatings of clay, silt, organic material, clay lumps or balls or other deleterious materials or coatings. The method used to produce the crushed gravel shall result in the fractured particles in the finished product as consistent and uniform as practicable. Fine aggregate portion, defined as the portion passing the No. 4 (4.75 mm) sieve shall consist of fines from the coarse aggregate crushing operation. The fine aggregate shall be produced by crushing stone, gravel, that meet the coarse aggregate requirements for wear and soundness. Aggregate base material requirements are listed in the following table.

Crushed Aggregate Base Material Requirements

Material Test	Requirement	Standard
Coarse Aggregate		
Resistance to Degradation	Loss: 45% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Percentage of Fractured Particles	Minimum 90% by weight of particles with at least two fractured faces and 98% with at least one fractured face[1]	ASTM D5821
Flat Particles, Elongated Particles, or Flat and Elongated Particles	10% maximum, by weight, of flat, elongated, or flat and elongated particles [2]	ASTM D4791
Clay lumps and friable particles	Less than or equal to 3 percent	ASTM C142
Fine Aggregate		
Liquid limit	Less than or equal to 25	ASTM D4318
Plasticity Index	Not more than five (5)	ASTM D4318

[1] The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

[2] A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

209-2.2 Gradation requirements. The gradation of the aggregate base material shall meet the requirements of the gradation given in the following table when tested per ASTM C117 and ASTM C136. The gradation shall be well graded from coarse to fine and shall not vary from the lower limit on one sieve to the high limit on an adjacent sieve or vice versa.

Gradation of Aggregate Base

Sieve Size	Design Range Percentage by Weight passing	Contractor's Final Gradation	Job Control Grading Band Tolerances[1] (Percent)
2 inch (50 mm)	100		0
1-1/2 inch (37.5 mm)	95-100		±5
1 inch (25.0 mm)	70-95		±8
3/4 inch (19.0 mm)	55-85		±8
No. 4 (4.75 mm)	30-60		±8
No. 40[2] (425 µm)	10-30		±5
No. 200[2] (75 µm)	0-5		±3

[1] The "Job Control Grading Band Tolerances for Contractor's Final Gradation" in the table shall be applied to "Contractor's Final Gradation" to establish a job control grading band. The full tolerance still applies if application of the tolerances results in a job control grading band outside the design range.

[2] The fraction of material passing the No 200 (75 µm) sieve shall not exceed two-thirds the fraction passing the No 40 (425 µm) sieve.

209-2.3 Sampling and Testing.

a. Aggregate base materials. The Contractor shall take samples of the aggregate base in accordance with ASTM D75 to verify initial aggregate base requirements and gradation. Material shall meet the requirements in paragraph 209-2.1. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

b. Gradation requirements. The Contractor shall take at least two aggregate base samples per day in the presence of the Resident Project Representative (RPR) to check the final gradation. Sampling shall be per ASTM D75. Material shall meet the requirements in paragraph 209-2.2. The samples shall be taken from the in-place, un-compacted material at sampling points and intervals designated by the RPR.

209-2.4 Separation Geotextile. Not used**.**

CONSTRUCTION METHODS

209-3.1 Control strip. The first half-day of construction shall be considered the control strip. The Contractor shall demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of the specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be

increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly comact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted or removed and replaced at the Contractor's expense. Full operations shall not continue until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved by the RPR.

209-3.2 Preparing underlying subgrade and/or subbase. The underlying subgrade and/or subbase shall be checked and accepted by the RPR before base course placing and spreading operations begin. Re-proof rolling of the subgrade or proof rolling of the subbase in accordance with Item P-152, at the Contractor's expense, may be required by the RPR if the Contractor fails to ensure proper drainage or protect the subgrade and/or subbase. Any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, shall be corrected before the base course is placed. To ensure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

209-3.3 Production. The aggregate shall be uniformly blended and, when at a satisfactory moisture content per paragraph 209-3.5, the approved material may be transported directly to the placement.

209-3.4 Placement. The aggregate shall be placed and spread on the prepared underlying layer by spreader boxes or other devices as approved by the RPR, to a uniform thickness and width. The equipment shall have positive thickness controls to minimize the need for additional manipulation of the material. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

The aggregate shall meet gradation and moisture requirements prior to compaction. The base course shall be constructed in lifts as established in the control strip, but not less than 4 inches (100 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications at the Contractor's expense.

209-3.5 Compaction. Immediately after completion of the spreading operations, compact each layer of the base course, as specified, with approved compaction equipment. The number, type, and weight of rollers shall be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade.

The field density of each compacted lift of material shall be at least 100% of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. The laboratory specimens shall be compacted and tested in accordance with ASTM D698 The moisture content of the material during placing operations shall be within ±2 percentage points of the optimum moisture content as determined by ASTM D698. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

209-3.6 Weather limitations. Material shall not be placed unless the ambient air temperature is at least 40°F (4°C) and rising. Work on base course shall not be conducted when the subgrade or subbase is wet or frozen or the base material contains frozen material.

209-3.7 Maintenance. The base course shall be maintained in a condition that will meet all specification requirements. When material has been exposed to excessive rain, snow, or freeze-thaw conditions, prior to placement of additional material, the Contractor shall verify that materials still meet all specification

requirements. Equipment may be routed over completed sections of base course, provided that no damage results and the equipment is routed over the full width of the completed base course. Any damage resulting to the base course from routing equipment over the base course shall be repaired by the Contractor at the Contractor's expense.

209-3.8 Surface tolerances. After the course has been compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and recompacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense. The smoothness and accuracy requirements specified here apply only to the top layer when base course is constructed in more than one layer.

a. Smoothness. The finished surface shall not vary more than 3/8-inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

b. Grade. The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +0 and -1/2 inch (12 mm) of the specified grade.

209-3.9 Acceptance sampling and testing. Crushed aggregate base course shall be accepted for density and thickness on an area basis. Two tests shall be made for density and thickness for each 1,200 square yds. Sampling locations will be determined on a random basis per ASTM D3665

a. Density. The RPR shall perform all density tests for acceptance.

Each area shall be accepted for density when the field density is at least 100% of the maximum density of laboratory specimens compacted and tested per ASTM D698. The in-place field density shall be determined per ASTM D1556 or ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the area represented by the failed test must be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached. Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

b. Thickness. Depth tests shall be made by test holes at least 3 inches (75 mm) in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness as determined by depth tests taken by the Contractor in the presence of the RPR for each area. Alternatively, the Contractor can perform a survey prior to an after placement of the base course to verify depth. Survey interval shall match the Cross Sections as shown on the Contract Plans and shall performed in the presence of the RPR. Results of the survey shall be submitted to the RPR for acceptance.

Where the thickness is deficient by more than 1/2-inch (12 mm), the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches (75 mm), adding new material of proper gradation, and the material shall be blended and recompacted to grade. The Contractor shall replace, at his expense, base material where depth tests have been taken.

METHOD OF MEASUREMENT

209-4.1 The quantity of crushed aggregate base course will be determined by measurement of the number of cubic yards of material actually constructed and accepted by the RPR as complying with the plans and specifications. The quantify of crushed aggregate base course material shall be measured in final position based upon depth tests or cores taken as directed by the RPR, at the rate of two tests per each 1,200 SY of base course. On individual depth measurements, thicknesses more than 1/2 inch in excess of that shown on the plans shall be considered as the specified thickness plus 1/2 inch in computing the yardage for payment. Base materials shall not be included in any other excavation quantities. Alternatively, if the quantity of base course material is to be measured in final position by survey, the pre and post placement elevations shall be measured to the nearest 0.01 feet.

BASIS OF PAYMENT

209-5.1 Payment shall be made at the contract unit price per cubic yard for crushed aggregate base course. This price shall be full compensation for furnishing all materials, for preparing and placing these materials, and for all labor, equipment tools, and incidentals necessary to complete the item.

Payment will be made under:

900.608	(FAA P-209 CRUSHED AGGREGATE BASE COURSE)	per Cubic Yard

REFERENCES

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

ASTM International (ASTM)

ASTM C29	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2700 kN-m/m^3))

ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4643	Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM D4751	Standard Test Methods for Determining Apparent Opening Size of a Geotextile
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D7928	Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

American Association of State Highway and Transportation Officials (AASHTO)

M288	Standard Specification for Geosynthetic Specification for Highway Applications

END OF ITEM P-209

Item P-401 Asphalt Mix Pavement

DESCRIPTION

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

MATERIALS

401-2.1 Aggregate. Aggregates shall consist of crushed stone, crushed gravel, crushed slag, screenings, natural sand, and mineral filler, as required. The aggregates should have no known history of detrimental pavement staining due to ferrous sulfides, such as pyrite. Coarse aggregate is the material retained on the No. 4 (4.75 mm) sieve. Fine aggregate is the material passing the No. 4 (4.75 mm) sieve.

a. Coarse aggregate. Coarse aggregate shall consist of sound, tough, durable particles, free from films of matter that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. Coarse aggregate material requirements are given in the table below.

Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	0.3% maximum	ASTM C142
Percentage of Fractured Particles	Minimum 50% by weight of particles with at least two fractured faces and 65% with at least one fractured face[1]	ASTM D5821
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 [2]	ASTM D4791

[1] The area of each face shall be equal to at least 75% of the smallest mid-sectional area of the piece. When two fractured faces are contiguous, the angle between the planes of fractures shall be at least 30 degrees to count as two fractured faces.

[2] A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

b. Fine aggregate. Fine aggregate shall consist of clean, sound, tough, durable, angular shaped particles produced by crushing stone, slag, or gravel and shall be free from coatings of clay, silt, or other objectionable matter. Natural (non-manufactured) sand may be used to obtain the gradation of the fine

aggregate blend or to improve the workability of the mix. Fine aggregate material requirements are listed in the table below.

Fine Aggregate Material Requirements

Material Test	Requirement	Standard
Liquid limit	25 maximum	ASTM D4318
Plasticity Index	4 maximum	ASTM D4318
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Clay lumps and friable particles	0.3% maximum	ASTM C142
Sand equivalent	45 minimum	ASTM D2419
Natural Sand	0% to 15% maximum by weight of total aggregate	ASTM D1073

c. Sampling. ASTM D75 shall be used in sampling coarse and fine aggregate.

401-2.2 Mineral filler. Mineral filler (baghouse fines) may be added in addition to material naturally present in the aggregate. Mineral filler shall meet the requirements of ASTM D242.

Mineral Filler Requirements

Material Test	Requirement	Standard
Plasticity Index	4 maximum	ASTM D4318

401-2.3 Asphalt binder. Asphalt binder shall conform to ASTM D6373 Performance Grade (PG) **70-28.**

Asphalt Binder PG Plus Test Requirements

Material Test	Requirement	Standard
Elastic Recovery	75% minimum	ASTM D6084

401-2.4 Anti-stripping agent. Any anti-stripping agent or additive (anti-strip) shall be heat stable and shall not change the asphalt binder grade beyond specifications. Anti-strip shall be an approved material of the Department of Transportation of the State in which the project is located.

COMPOSITION

401-3.1 Composition of mixture(s). The asphalt mix shall be composed of a mixture of aggregates, filler and anti-strip agent if required, and asphalt binder. The aggregate fractions shall be sized, handled in separate size groups, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula (JMF).

401-3.2 Job mix formula (JMF) laboratory. The laboratory used to develop the JMF shall possess a current certificate of accreditation, listing D3666 from a national accrediting authority and all test methods required for developing the JMF; and be listed on the accrediting authority's website. A copy of

the laboratory's current accreditation and accredited test methods shall be submitted to the Resident Project Representative (RPR) prior to start of construction.

401-3.3 Job mix formula (JMF). No asphalt mixture shall be placed until an acceptable mix design has been submitted to the RPR for review and accepted in writing. The RPR's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

When the project requires asphalt mixtures of differing aggregate gradations and/or binders, a separate JMF shall be submitted for each mix. Add anti-stripping agent to meet tensile strength requirements.

The JMF shall be prepared by an accredited laboratory that meets the requirements of paragraph 401-3.2. The asphalt mixture shall be designed using procedures contained in Asphalt Institute MS-2 Mix Design Manual, 7th Edition**.** Samples shall be prepared and compacted using a Marshall compactor in accordance with ASTM D6926.

Should a change in sources of materials be made, a new JMF must be submitted to the RPR for review and accepted in writing before the new material is used. After the initial production JMF has been approved by the RPR and a new or modified JMF is required for whatever reason, the subsequent cost of the new or modified JMF, including a new control strip when required by the RPR, will be borne by the Contractor.

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

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

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

- Manufacturer's Certificate of Analysis (COA) for the asphalt binder used in the JMF in accordance with paragraph 401-2.3. Certificate of asphalt performance grade is with modifier already added, if used and must indicate compliance with ASTM D6373. For plant modified asphalt binder, certified test report indicating grade certification of modified asphalt binder.
- Manufacturer's Certificate of Analysis (COA) for the anti-stripping agent if used in the JMF in accordance with paragraph 401-2.4.
- Certified material test reports for the course and fine aggregate and mineral filler in accordance with paragraphs 401-2.1.
- Percent passing each sieve size for individual gradation of each aggregate cold feed and/or hot bin; percent by weight of each cold feed and/or hot bin used; and the total combined gradation in the JMF.
- Specific Gravity and absorption of each coarse and fine aggregate.
- Percent natural sand.
- Percent fractured faces.
- Percent by weight of flat particles, elongated particles, and flat and elongated particles (and criteria).
- Percent of asphalt.
- Number of blows.
- Laboratory mixing and compaction temperatures.

- Supplier-recommended field mixing and compaction temperatures.
- Plot of the combined gradation on a 0.45 power gradation curve.
- Graphical plots of air voids, voids in the mineral aggregate (VMA), and unit weight versus asphalt content. To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.
- Tensile Strength Ratio (TSR).
- Type and amount of Anti-strip agent when used.
- Asphalt Pavement Analyzer (APA) results.
- Date the JMF was developed. Mix designs that are not dated or which are from a prior construction season shall not be accepted.

Table 1. Asphalt Design Criteria

Test Property	Value	Test Method
Number of blows	50	ASTM D6926
Air voids (%)	3.5	ASTM D3203
Percent voids in mineral aggregate (VMA), minimum	See Table 2	ASTM D6995
Tensile Strength Ratio (TSR)[1]	not less than 80 at a saturation of 70-80%	ASTM D4867
Asphalt Pavement Analyzer (APA)[2]	Less than 10 mm @ 4000 passes	AASHTO T340 at 250 psi hose pressure at 64°C test temperature

[1] Test specimens for TSR shall be compacted at 7 ± 1.0 % air voids. In areas subject to freeze-thaw, use freeze-thaw conditioning in lieu of moisture conditioning per ASTM D4867.

[2] AASHTO T340 at 100 psi hose pressure at 64°C test temperature may be used in the interim. If this method is used the required Value shall be less than 5 mm @ 8000 passes

If APA is not available in the mix design laboratory, compacted mix design samples may be sent to a laboratory that has an APA or the Hamburg wheel test (AASHTO T 324) 10mm @ 20,000 passes may be used.

The mineral aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation or gradations specified in Table 2 when tested in accordance with ASTM C136 and ASTM C117.

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the sources of supply; be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa.

Table 2. Aggregate - Asphalt Pavements

Sieve Size	Percentage by Weight Passing Sieve
1 inch (25.0 mm)	-
3/4 inch (19.0 mm)	100
1/2 inch (12.5 mm)	90-100
3/8 inch (9.5 mm)	72-88
No. 4 (4.75 mm)	53-73
No. 8 (2.36 mm)	38-60
No. 16 (1.18 mm)	26-48
No. 30 (600 µm)	18-38
No. 50 (300 µm)	11-27
No. 100 (150 µm)	6-18
No. 200 (75 µm)	3-6
Minimum Voids in Mineral Aggregate (VMA)[1]	15.0
Asphalt Percent:	
Stone or gravel	5.0-7.5
Recommended Minimum Construction Lift Thickness	2 inch

[1]To achieve minimum VMA during production, the mix design needs to account for material breakdown during production.

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

401-3.4 Reclaimed asphalt pavement (RAP). RAP shall not be used.

401-3.5 Control Strip. Full production shall not begin until an acceptable control strip has been constructed and accepted in writing by the RPR**.** The Contractor shall prepare and place a quantity of asphalt according to the JMF. The underlying grade or pavement structure upon which the control strip is to be constructed shall be the same as the remainder of the course represented by the control strip.

The Contractor will not be allowed to place the control strip until the Contractor quality control program (CQCP), showing conformance with the requirements of paragraph 401-5.1, has been accepted, in writing, by the RPR.

The control strip will consist of at least 250 tons (227 metric tons) or 1/2 sublot, whichever is greater. The control strip shall be placed in two lanes of the same width and depth to be used in production with a longitudinal cold joint. The cold joint must be cut back in accordance with paragraph 401-4.14 using the same procedure that will be used during production. The cold joint for the control strip will be an exposed construction joint at least four (4) hours old or when the mat has cooled to less than 160°F (71°C). The equipment used in construction of the control strip shall be the same type, configuration and weight to be used on the project.

The control strip will be considered acceptable by the RPR if the gradation, asphalt content, and VMA are within the action limits specified in paragraph 401-5.5a; and Mat density greater than or equal to 94.5%, air voids 3.5% +/- 1%, and joint density greater than or equal to 92.5%.

If the control strip is unacceptable, necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made and another control strip shall be placed. Unacceptable control strips shall be removed at the Contractor's expense.

The control strip will be considered one lot for payment based upon the average of a minimum of 3 samples (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 401-8.1 using a lot pay factor equal to 100.

CONSTRUCTION METHODS

401-4.1 Weather limitations. The asphalt shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 4. The temperature requirements may be waived by the RPR, if requested; however, all other requirements including compaction shall be met.

Table 4. Surface Temperature Limitations of Underlying Course

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 inches (7.5 cm) or greater	40 [1]	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

401-4.2 Asphalt plant. Plants used for the preparation of asphalt shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 including the following items.

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

b. Storage bins and surge bins. The asphalt mixture stored in storage and/or surge bins shall meet the same requirements as asphalt mixture loaded directly into trucks. Asphalt mixture shall not be stored in storage and/or surge bins for a period greater than twelve (12) hours. If the RPR determines there is an excessive heat loss, segregation, or oxidation of the asphalt mixture due to temporary storage, temporary storage shall not be allowed.

401-4.3 Aggregate stockpile management. Aggregate stockpiles shall be constructed in a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the asphalt batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used.

A continuous supply of materials shall be provided to the work to ensure continuous placement.

401-4.4 Hauling equipment. Trucks used for hauling asphalt shall have tight, clean, and smooth metal beds. To prevent the asphalt from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the RPR. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the

mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

401-4.4.1 Material transfer vehicle (MTV). Material transfer vehicles used to transfer the material from the hauling equipment to the paver, shall use a self-propelled, material transfer vehicle with a swing conveyor that can deliver material to the paver without making contact with the paver. The MTV shall be able to move back and forth between the hauling equipment and the paver providing material transfer to the paver, while allowing the paver to operate at a constant speed. The Material Transfer Vehicle will have remixing and storage capability to prevent physical and thermal segregation.

401-4.5 Asphalt pavers. Asphalt pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of asphalt that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface. The asphalt paver shall be equipped with a control system capable of automatically maintaining the specified screed grade and elevation.

If the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued.

The paver shall be capable of paving to a minimum width specified in paragraph 401-4.12.

401-4.6 Rollers. The number, type, and weight of rollers shall be sufficient to compact the asphalt to the required density while it is still in a workable condition without crushing of the aggregate, depressions or other damage to the pavement surface. Rollers shall be in good condition, clean, and capable of operating at slow speeds to avoid displacement of the asphalt. All rollers shall be specifically designed and suitable for compacting asphalt concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used.

401-4.7 Density device. The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall supply a qualified technician during all paving operations to calibrate the gauge and obtain accurate density readings for all new asphalt. These densities shall be supplied to the RPR upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

401-4.8 Preparation of asphalt binder. The asphalt binder shall be heated in a manner that will avoid local overheating and provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. The temperature of unmodified asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles, but shall not exceed 325°F (160°C) when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F (175°C) when added to the aggregate.

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

401-4.10 Preparation of Asphalt mixture. The aggregates and the asphalt binder shall be weighed or metered and mixed in the amount specified by the JMF. The combined materials shall be mixed until the aggregate obtains a uniform coating of asphalt binder and is thoroughly distributed throughout the mixture. Wet mixing time shall be the shortest time that will produce a satisfactory mixture, but not less than 25 seconds for batch plants. The wet mixing time for all plants shall be established by the Contractor,

based on the procedure for determining the percentage of coated particles described in ASTM D2489, for each individual plant and for each type of aggregate used. The wet mixing time will be set to achieve 95% of coated particles. For continuous mix plants, the minimum mixing time shall be determined by dividing the weight of its contents at operating level by the weight of the mixture delivered per second by the mixer. The moisture content of all asphalt upon discharge shall not exceed 0.5%.

401-4.11 Application of Tack Coat. Immediately before placing the asphalt mixture, the underlying course shall be cleaned of all dust and debris.

A tack coat shall be applied in accordance with Item P-603 to all vertical and horizontal asphalt and concrete surfaces prior to placement of the first and each subsequent lift of asphalt mixture.

401-4.12 Laydown plan, transporting, placing, and finishing. Prior to the placement of the asphalt, the Contractor shall prepare a laydown plan with the sequence of paving lanes and width to minimize the number of cold joints; the location of any temporary ramps; laydown temperature; and estimated time of completion for each portion of the work (milling, paving, rolling, cooling, etc.). The laydown plan and any modifications shall be approved by the RPR.

Deliveries shall be scheduled so that placing and compacting of asphalt is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to approximately ambient temperature. The Contractor, at their expense, shall be responsible for repair of any damage to the pavement caused by hauling operations.

Contractor shall survey each lift of asphalt surface course and certify to RPR that every lot of each lift meets the grade tolerances of paragraph 401-6.2d before the next lift can be placed.

Edges of existing asphalt pavement abutting the new work shall be saw cut and the cut off material and laitance removed. Apply a tack coat in accordance with P-603 before new asphalt material is placed against it.

The speed of the paver shall be regulated to eliminate pulling and tearing of the asphalt mat. Placement of the asphalt mix shall begin along the centerline of a crowned section or on the high side of areas with a one way slope unless shown otherwise on the laydown plan as accepted by the RPR. The asphalt mix shall be placed in consecutive adjacent lanes having a minimum width of 12 feet (m) except where edge lanes require less width to complete the area. Additional screed sections attached to widen the paver to meet the minimum lane width requirements must include additional auger sections to move the asphalt mixture uniformly along the screed extension.

The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least one foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet (3 m) from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet (3 m).On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the asphalt may be spread and luted by hand tools.

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

Areas of segregation in the surface course, as determined by the RPR, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of the construction lift thickness as specified in paragraph 401-3.3, Table 2 for the approved mix design. The

area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet (3 m) long.

401-4.13 Compaction of asphalt mixture. After placing, the asphalt mixture shall be thoroughly and uniformly compacted by self-propelled rollers. The surface shall be compacted as soon as possible when the asphalt has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any surface defects and/or displacement occurring as a result of the roller, or from any other cause, shall be corrected at the Contractor's expense.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the asphalt to the roller, the wheels shall be equipped with a scraper and kept moistened with water as necessary.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power tampers.

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

401-4.14 Joints. The formation of all joints shall be made to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

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

Longitudinal joints which have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material and any laitance produced from cutting joints shall be removed from the project. Asphalt tack coat in accordance with P-603 shall be applied to the clean, dry joint prior to placing any additional fresh asphalt against the joint. The cost of this work shall be considered incidental to the cost of the asphalt.

401-4.15 Saw-cut grooving. Saw-cut grooving is not required.

401-4.16 Diamond grinding. Diamond grinding shall be completed prior to pavement grooving. Diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive.

Diamond grinding shall be performed with a machine designed specifically for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with a sufficient number of blades to create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Equipment or grinding procedures that cause ravels, aggregate fractures, spalls or disturbance to the pavement will not be permitted. Contractor shall demonstrate to the RPR that the grinding equipment will produce satisfactory results prior to making corrections to surfaces.Grinding will be tapered in all

directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. The Contractor shall apply a surface treatment per P-608 to all areas that have been subject to grinding.

401-4.17 Nighttime paving requirements. The Contractor shall provide adequate lighting during any nighttime construction. A lighting plan shall be submitted by the Contractor and approved by the RPR prior to the start of any nighttime work. All work shall be in accordance with the approved CSPP and lighting plan.

CONTRACTOR QUALITY CONTROL (CQC)

401-5.1 General. The Contractor shall develop a Contractor Quality Control Program (CQCP) in accordance with Item C-100. No partial payment will be made for materials without an approved CQCP.

401-5.2 Contractor quality control (QC) facilities. The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The RPR shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The RPR will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

401-5.3 Contractor QC testing. The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to these specifications and as set forth in the approved CQCP. The testing program shall include, but not necessarily be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, field compaction, and surface smoothness. A QC Testing Plan shall be developed as part of the CQCP**.**

a. Asphalt content. A minimum of two tests shall be performed per day in accordance with ASTM D6307 or ASTM D2172 for determination of asphalt content. When using ASTM D6307, the correction factor shall be determined as part of the first test performed at the beginning of plant production; and as part of every tenth test performed thereafter. The asphalt content for the day will be determined by averaging the test results.

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

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

d. Moisture content of asphalt. The moisture content shall be determined once per day in accordance with AASHTO T329 or ASTM D1461.

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

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

g. Smoothness for Contractor Quality Control.

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) "straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the RPR. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using either the FAA profile program, ProFAA, or FHWA ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

(1) Transverse measurements. Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the RPR. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

(2) Longitudinal measurements. Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 401-4.16 or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 401-6.1d(3). Areas that have been ground shall be sealed with a surface treatment in accordance with Item P-608. To avoid the surface treatment creating any conflict with runway or taxiway markings, it may be necessary to seal a larger area.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

h. Grade. Grade shall be evaluated daily to allow adjustments to paving operations when grade measurements do not meet specifications. As a minimum, grade shall be evaluated prior to and after the placement of the first lift and after placement of the surface lift.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch

(12 mm) vertically. The documentation will be provided by the Contractor to the RPR by the end of the following working day.

Areas with humps or depressions that exceed grade or smoothness criteria and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. Grinding shall be in accordance with paragraph 401-4.16.

The Contractor shall repair low areas or areas that cannot be corrected by grinding by removal of deficient areas to the depth of the final course plus ½ inch and replacing with new material. Skin patching is not allowed.

401-5.4 Sampling. When directed by the RPR, the Contractor shall sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

401-5.5 Control charts. The Contractor shall maintain linear control charts for both individual measurements and range (i.e. difference between highest and lowest measurements) for aggregate gradation, asphalt content, and VMA. The VMA for each day will be calculated and monitored by the QC laboratory.

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

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

Control Chart Limits for Individual Measurements

Sieve	Action Limit	Suspension Limit
3/4 inch (19.0 mm)	±6%	±9%
1/2 inch (12.5 mm)	±6%	±9%
3/8 inch (9.5 mm)	±6%	±9%
No. 4 (4.75 mm)	±6%	±9%
No. 16 (1.18 mm)	±5%	±7.5%
No. 50 (300 µm)	±3%	±4.5%
No. 200 (75 µm)	±2%	±3%
Asphalt Content	±0.45%	±0.70%
Minimum VMA	-0.5%	-1.0%

b. Range. Control charts shall be established to control gradation process variability. The range shall be plotted as the difference between the two test results for each control parameter. The Suspension Limits specified below are based on a sample size of n = 2. Should the Contractor elect to perform more

than two tests per lot, the Suspension Limits shall be adjusted by multiplying the Suspension Limit by 1.18 for n = 3 and by 1.27 for n = 4.

Control Chart Limits Based on Range

Sieve	Suspension Limit
1/2 inch (12.5 mm)	11%
3/8 inch (9.5 mm)	11%
No. 4 (4.75 mm)	11%
No. 16 (1.18 mm)	9%
No. 50 (300 µm)	6%
No. 200 (75 µm)	3.5%
Asphalt Content	0.8%

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

(1) One point falls outside the Suspension Limit line for individual measurements or range; or

(2) Two points in a row fall outside the Action Limit line for individual measurements.

401-5.6 QC reports. The Contractor shall maintain records and shall submit reports of QC activities daily, in accordance with Item C-100.

MATERIAL ACCEPTANCE

401-6.1 Acceptance sampling and testing. Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the RPR at no cost to the Contractor except that coring as required in this section shall be completed and paid for by the Contractor.

a. Quality assurance (QA) testing laboratory. The QA testing laboratory performing these acceptance tests will be accredited in accordance with ASTM D3666. The QA laboratory accreditation will be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing will be listed on the lab accreditation.

b. Lot size. A standard lot will be equal to one day's production divided into approximately equal sublots of between 400 to 600 tons. When only one or two sublots are produced in a day's production, the sublots will be combined with the production lot from the previous or next day.

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

c. Asphalt air voids. Plant-produced asphalt will be tested for air voids on a sublot basis.

(1) Sampling. Material from each sublot shall be sampled in accordance with ASTM D3665. Samples shall be taken from material deposited into trucks at the plant or at the job site in accordance with ASTM D979. The sample of asphalt may be put in a covered metal tin and placed in an oven for not less than 30 minutes nor more than 60 minutes to maintain the material at or above the compaction temperature as specified in the JMF.

(2) Testing. Air voids will be determined for each sublot in accordance with ASTM D3203 for a set of compacted specimens prepared in accordance with ASTM D6926.

d. In-place asphalt mat and joint density. Each sublot will be tested for in-place mat and joint density as a percentage of the theoretical maximum density (TMD).

(1) Sampling. The Contractor will cut minimum 5 inch (125 mm) diameter samples in accordance with ASTM D5361. The Contractor shall furnish all tools, labor, and materials for cleaning, and filling the cored pavement. Laitance produced by the coring operation shall be removed immediately after coring, and core holes shall be filled within one day after sampling in a manner acceptable to the RPR.

(2) Bond. Each lift of asphalt shall be bonded to the underlying layer. If cores reveal that the surface is not bonded, additional cores shall be taken as directed by the RPR to determine the extent of unbonded areas. Unbonded areas shall be removed by milling and replaced at no additional cost as directed by the RPR.

(3) Thickness. Thickness of each lift of surface course will be evaluated by the RPR for compliance to the requirements shown on the plans after any necessary corrections for grade. Measurements of thickness will be made using the cores extracted for each sublot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch (6 mm) less than the thickness indicated for the lift. Average thickness of lift, or combined lifts, will not be less than the indicated thickness. Where the thickness tolerances are not met, the lot or 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 RPR to circumscribe the deficient area.

(4) Mat density. One core shall be taken from each sublot. Core locations will be determined by the RPR in accordance with ASTM D3665. Cores for mat density shall not be taken closer than one foot (30 cm) from a transverse or longitudinal joint. The bulk specific gravity of each cored sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each sublot sample by the TMD for that sublot.

(5) Joint density. One core centered over the longitudinal joint shall be taken for each sublot that has a longitudinal joint. Core locations will be determined by the RPR in accordance with ASTM D3665. The bulk specific gravity of each core sample will be determined in accordance with ASTM D2726. The percent compaction (density) of each sample will be determined by dividing the bulk specific gravity of each joint density sample by the average TMD for the lot. The TMD used to determine the joint density at joints formed between lots will be the lower of the average TMD values from the adjacent lots.

401-6.2 Acceptance criteria.

a. General. Acceptance will be based on the implementation of the Contractor Quality Control Program (CQCP) and the following characteristics of the asphalt and completed pavements: air voids, mat density, joint density, grade**,** and Profilograph roughness**.**

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

c. Joint density. Acceptance of each lot of plant produced asphalt for joint density will be based on the PWL. If the PWL of the lot is equal to or exceeds 90%, the lot will be considered acceptable. If the PWL is less than 90%, the Contractor shall evaluate the reason and act accordingly. If the PWL is less than 80%, the Contractor shall cease operations and until the reason for poor compaction has been determined. If the PWL is less than 71%, the pay factor for the lot used to complete the joint will be

reduced by five (5) percentage points. This lot pay factor reduction will be incorporated and evaluated in accordance with paragraph 401-8.1.

d. Grade. The final finished surface of the pavement shall be surveyed to verify that the grade elevations and cross-sections shown on the plans do not deviate more than 1/2 inch (12 mm) vertically.

Cross-sections of the pavement shall be taken at a minimum 50-foot longitudinal spacing and at all longitudinal grade breaks. Minimum cross-section grade points shall include grade at centerline and edge of runway and/or taxiway pavement.

The survey and documentation shall be stamped and signed by a licensed surveyor. Payment for sublots that do not meet grade for over 25% of the sublot shall not be more than 95%.

e. Profilograph roughness for QA Acceptance. The final profilograph shall be the full length of the project to facilitate testing of roughness between lots. The Contractor, in the presence of the RPR shall perform a profilograph roughness test on the completed project with a profilograph meeting the requirements of ASTM E1274 or a Class I inertial profiler meeting ASTM E950. Data and results shall be provided within 48 hrs of profilograph roughness tests.

The pavement shall have an average profile index less than 15 inches per mile per 1/10 mile. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must grind" bumps and the Profile Index for the pavement using a 0.2-inch (5 mm) blanking band. The bump template must span one inch (25 mm) with an offset of 0.4 inches (10 mm). The profilograph must be calibrated prior to use and operated by a factory or State DOT approved, trained operator. Profilograms shall be recorded on a longitudinal scale of one inch (25 mm) equals 25 feet (7.5 m) and a vertical scale of one inch (25 mm) equals one inch (25 mm). Profilograph shall be performed one foot right and left of project centerline and 15 feet (4.5 m) right and left of project centerline. Any areas that indicate "must grind" shall be corrected with diamond grinding per paragraph 401-4.16 or by removing and replacing full depth of surface course. as directed by the RPR. Where corrections are necessary, a second profilograph run shall be performed to verify that the corrections produced an average profile index of 15 inches per mile per 1/10 mile or less.

401-6.3 Percentage of material within specification limits (PWL). The PWL will be determined in accordance with procedures specified in Item C-110. The specification tolerance limits (L) for lower and (U) for upper are contained in Table 5.

Table 5. Acceptance Limits for Air Voids and Density

Test Property	Pavements Specification Tolerance Limits	
	L	**U**
Air Voids Total Mix (%)	2.0	5.0
Surface Course Mat Density (%)	92.8	-
Base Course Mat Density (%)	92.0	-
Joint density (%)	90.5	--

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

The Contractor should note that (1) 90 PWL is achieved when consistently producing a surface course with an average mat density of at least 94.5% 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 94.0% with 1.55% or less variability, and (3) 90 PWL is achieved when consistently producing joints with an average joint density of at least 92.5% with 1.55% or less variability.

401-6.4 Resampling pavement for mat density.

a. General. Resampling of a lot of pavement will only be allowed for mat density, and then, only if the Contractor requests same, in writing, within 48 hours after receiving the written test results from the RPR. A retest will consist of all the sampling and testing procedures contained in paragraphs 401-6.1d and 401-6.2b. Only one resampling per lot will be permitted.

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

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

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

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

METHOD OF MEASUREMENT

401-7.1 Measurement. Asphalt shall be measured by the number of tons of asphalt used in the accepted work. Batch weights or truck scale weights will be used to determine the basis for the tonnage.

BASIS OF PAYMENT

401-8.1 Payment. Payment for a lot of asphalt meeting all acceptance criteria as specified in paragraph 401-6.2 shall be made based on results of tests for mat density and air voids. Payment for acceptable lots shall be adjusted according to paragraph 401-8.1c for mat density and air voids; and paragraph 401-6.2c for joint density, subject to the limitation that:

a. The total project payment for plant mix asphalt pavement shall not exceed 100 percent of the product of the contract unit price and the total number of tons (kg) of asphalt used in the accepted work.

b. The price shall be compensation for furnishing all materials, for all preparation, mixing, and placing of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

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

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

Payment for sublots which do not meet grade in accordance with paragraph 401-6.2d after correction for over 25% of the sublot shall be reduced by 5%.

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 401-8.1a.

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

d. Profilograph Roughness. The Contractor will receive full payment when the profilograph average profile index is in accordance with paragraph 401-6.2e. When the final average profile index for the entire length of pavement does not exceed 15 inches per mile per 1/10 mile, payment will be made at the contract unit price for the completed pavement.

401-8.1 Payment.

Payment will be made under:

900.680 (FAA P-401 ASPHALT SURFACE COURSE) per Ton

REFERENCES

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

ASTM International (ASTM)

ASTM C29	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C127	Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates

ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D242	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
ASTM D946	Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D979	Standard Practice for Sampling Asphalt Paving Mixtures
ASTM D1073	Standard Specification for Fine Aggregate for Asphalt Paving Mixtures
ASTM D1188	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
ASTM D2172	Standard Test Method for Quantitative Extraction of Bitumen from Asphalt Paving Mixtures
ASTM D1461	Standard Test Method for Moisture or Volatile Distillates in Asphalt Paving Mixtures
ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2489	Standard Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726	Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
ASTM D3381	Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4552	Standard Practice for Classifying Hot-Mix Recycling Agents
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D4867	Standard Test Method for Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5361	Standard Practice for Sampling Compacted Asphalt Mixtures for Laboratory Testing
ASTM D5444	Standard Test Method for Mechanical Size Analysis of Extracted Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6084	Standard Test Method for Elastic Recovery of Bituminous Materials by Ductilometer
ASTM D6307	Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6373	Standard Specification for Performance Graded Asphalt Binder
ASTM D6752	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method
ASTM D6925	Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the SuperPave Gyratory Compactor.
ASTM D6926	Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus
ASTM D6927	Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM D6995	Standard Test Method for Determining Field VMA based on the Maximum Specific Gravity of the Mix (Gmm)
ASTM E11	Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E950	Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
ASTM E2133	Standard Test Method for Using a Rolling Inclinometer to Measure Longitudinal and Transverse Profiles of a Traveled Surface

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
AASHTO T329	Standard Method of Test for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
AASHTO T324	Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Asphalt Mixtures

AASHTO T 340	Standard Method of Test for Determining the Rutting Susceptibility of Hot Mix Asphalt (APA) Using the Asphalt Pavement Analyzer (APA)

Asphalt Institute (AI)

Asphalt Institute Handbook MS-26, Asphalt Binder

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

AI State Binder Specification Database

Federal Highway Administration (FHWA)

Long Term Pavement Performance Binder Program

Advisory Circulars (AC)

AC 150/5320-6	Airport Pavement Design and Evaluation

FAA Orders

5300.1	Modifications to Agency Airport Design, Construction, and Equipment Standards

Software

FAARFIELD

END OF ITEM P-401

Item P-501 Cement Concrete Pavement

DESCRIPTION

501-1.1 This work shall consist of pavement composed of cement concrete 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. The terms cement concrete, hydraulic cement concrete, and concrete are interchangeable in this specification.

MATERIALS

501-2.1 Aggregates.

a. Reactivity. Fine and Coarse aggregates to be used in PCC on this project shall be tested and evaluated by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Tests must be representative of aggregate sources which will be providing material for production. ASTM C1260 and ASTM C1567 tests may be run concurrently.

(1) Coarse aggregate and fine aggregate shall be tested separately in accordance with ASTM C1260, however, the length of test shall be extended to 28 days (30 days from casting). Tests must have been completed within 6 months of the date of the concrete mix submittal.

(2) The 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 the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion 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.

(3) 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 in lieu of ASTM C1567. If lithium nitrate admixture is used, it shall be nominal 30% ±0.5% weight lithium nitrate in water. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

b. Fine aggregate. Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and the parameters identified in the fine aggregate material requirements below. Fine aggregate material requirements and deleterious limits are shown in the table below.

Fine Aggregate Material Requirements		
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Sand Equivalent	45 minimum	ASTM D2419
Fineness Modulus (FM)	$2.50 \leq FM \leq 3.40$	ASTM C136
Limits for Deleterious Substances in Fine Aggregate for Concrete		
Clay lumps and friable particles	1.0% maximum	ASTM C142
Coal and lignite	0.5% using a medium with a density of Sp. Gr. of 2.0	ASTM C123
Total Deleterious Material	1.0% maximum	

c. Coarse aggregate. The maximum size coarse aggregate shall be 1 inch.

Aggregates delivered to the mixer shall be clean, hard, uncoated aggregates consisting of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates shall have no known history of detrimental pavement staining. Steel blast furnace slag shall not be permitted. Coarse aggregate material requirements and deleterious limits are shown in the table below; washing may be required to meet aggregate requirements.

Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 for any size group coarser than 3/8 (9.5 mm) sieve [1]	ASTM D4791
Bulk density of slag [2]	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29
D-cracking (Freeze-Thaw)[3]	Durability factor ≥ 95	ASTM C666

[1] A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

[2] Only required if slag is specified.

[3] Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited

laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

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

Limits for Deleterious Substances in Coarse Aggregate

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (75 µm)	ASTM C117	1.0[1]
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert[2] (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	0.1

[1] The limit for material finer than 75-µm is allowed to be increased to 1.5% for crushed aggregates consisting of dust of fracture that is essentially free from clay or shale. Test results supporting acceptance of increasing limit to 1.5% with statement indicating material is dust of fracture must be submitted with Concrete mix. Acceptable techniques to characterizing these fines include methylene blue adsorption or X-ray diffraction analysis.

[2] Chert and aggregates with less than 2.4 specific gravity.

d. Combined aggregate gradation. This specification is targeted for a combined aggregate gradation developed following the guidance presented in United States Air Force Engineering Technical Letter (ETL) 97-5: Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements. Base the aggregate grading upon a combination of all the aggregates (coarse and fine) to be used for the mixture proportioning. Three aggregate sizes may be required to achieve an optimized combined gradation that will produce a workable concrete mixture for its intended use. Use aggregate gradations that produce concrete mixtures with well-graded or optimized aggregate combinations. The Contractor shall submit complete mixture information necessary to calculate the volumetric components of the mixture. The combined aggregate grading shall meet the following requirements:

(1) 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 paragraph 501-2.1d(4) below, the point thus determined shall fall within the parallelogram described therein.

(2) The CF shall be determined from the following equation:

CF = (cumulative percent retained on the 3/8 in. (9.5 mm) sieve)(100) / (cumulative percent retained on the No. 8 (2.36 mm) sieve)

(3) The 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).

(4) 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. The point determined by the plotting of the CF and WF may be adjusted during production ±3 WF and ±5 CF. Adjustments to gradation may not take the point outside of the parallelogram.

e. Contractors combined aggregate gradation. The Contractor shall submit their combined aggregate gradation using the following format:

Contractor's Combined Aggregate Gradation

Sieve Size	Contractor's Concrete mix Gradation (Percent passing by weight)
2 inch (50 mm)	
1-1/2 inch (37.5 mm)	
1 inch (25.0 mm)	
3/4 inch (19.0 mm)	
1/2 inch (12.5 mm)	
3/8 inch (9.5 mm)	
No. 4 (4.75 mm)	
No. 8 (2.36 mm)	
No. 16 (1.18 mm)	
No. 30 (600 µm)	
No. 50 (300 µm)	
No. 100 (150 µm)	

United States Air Force Engineering Technical Letter (ETL) 97-5: Proportioning Concrete Mixtures with Graded Aggregates for Airfield Pavements can be found at https://www.wbdg.org/ffc/dod/supplemental-technical-criteria/tspwg-m-3-250-04-97-05

501-2.2 Cement. Cement shall conform to the requirements of ASTM C150 Type II. Cement shall contain less than 0.6% equivalent alkali, or the mix must include additional measures such as fly ash, slag, or other approved admixtures.

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 shall have a Calcium Oxide (CaO) content of less than 15% and a total alkali content less than 3% per ASTM C311. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the Resident Project Representative (RPR).

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

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 D1751 or ASTM D1752 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 RPR. 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 RPR.

501-2.6 Steel reinforcement. Reinforcing shall conform to the requirements below as applicable:

Steel Reinforcement

Reinforcing Steel	**ASTM A615, ASTM A706, ASTM A775, ASTM A934**
Welded Steel Wire Fabric	**ASTM A1064, ASTM A884**
Welded Deformed Steel Fabric	**ASTM A1064**
Bar Mats	**ASTM A184 or ASTM A704**

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.

a. Dowel Bars. Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078, Type 1, with a coating thickness after curing greater than 10 mils. Patched ends are not required for Type 1 coated dowels. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

b. Tie Bars. 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. If water is taken from other sources considered non-potable, it shall meet 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 A, or Class B.

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 shall conform to the following specifications:

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-entraining 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.

c. Other admixtures. The use of set retarding and set-accelerating admixtures shall be approved by the RPR prior to developing the concrete mix. Retarding admixtures shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating admixtures 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:

Lithium Admixture

Constituent	Limit (Percent by Mass)
LiNO3 (Lithium Nitrate)	30 ±0.5
SO4 (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

The lithium nitrate admixture dispensing and mixing operations shall be verified and certified by the lithium manufacturer's representative.

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 Bond Breaker. Not required.

CONCRETE MIX

501-3.1. General. No concrete shall be placed until an acceptable concrete mix has been submitted to the RPR for review and the RPR has taken appropriate action. The RPR's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

501-3.2 Concrete Mix Laboratory. The laboratory used to develop the concrete mix 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 must be included in the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the RPR prior to start of construction.

501-3.3 Concrete Mix Proportions. Develop the mix using the procedures contained in Portland Cement Association (PCA) publication, "Design and Control of Concrete Mixtures." Concrete shall be proportioned to achieve a 28-day compressive strength that meets or exceeds the acceptance criteria contained in paragraph 501-6.6 for a compressive strength of 5,000 psi per ASTM C39.

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 517 pounds per cubic yard. The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall be between 0.38 – 0.45 by weight.

Compressive strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C39. At the start of the project, the Contractor shall determine an allowable slump as determined by ASTM C143 not to exceed 2 inches (50 mm) for slip-form placement. For fixed-form placement, the slump shall not exceed 3 inches (75 mm). For hand placement, the slump shall not exceed 4 inches (100 mm).

The results of the concrete mix 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.

If a change in source(s) is made, or admixtures added or deleted from the mix, a new concrete mix must be submitted to the RPR for approval.

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

501-3.4 Concrete Mix submittal. The concrete mix shall be submitted to the RPR at least 30 days prior to the start of operations. The submitted concrete mix shall not be more than 180 days old and must use the materials to be used for production for the project. Production shall not begin until the concrete mix is approved in writing by the RPR.

Each of the submitted concrete mixes (i.e, slip form, side form machine finish and side form hand finish) shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items and quantities as a minimum:

- Certified material test reports for aggregate in accordance with paragraph 501-2.1. Certified reports must include all tests required; reporting each test, test method, test result, and requirement specified (criteria).
- Combined aggregate gradations and analysis; and including plots of the fine aggregate fineness modulus.
- Reactivity Test Results.
- Coarse aggregate quality test results, including deleterious materials.
- Fine aggregate quality test results, including deleterious materials.
- Mill certificates for cement and supplemental cementitious materials.
- Certified test results for all admixtures, including Lithium Nitrate if applicable.
- Specified flexural strength, slump, and air content.
- Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.
- Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
- Correlation ratios for acceptance testing and Contractor QC testing, when applicable.
- Historical record of test results documenting production standard deviation, when applicable.

501-3.5 Cementitious materials.

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

b. Slag cement (ground granulated blast furnace (GGBF)). Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight.

c. Raw or calcined natural pozzolan. Natural pozzolan may be used in the concrete mix. 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.

501-3.6 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 6.0. 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 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 with the materials to be used in the work, in accordance with ASTM C494.

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.

CONSTRUCTION METHODS

501-4.1 Control Strip. The control strip(s) shall be to the next planned joint after the initial 250 feet (75 m) of each type of pavement construction (slip-form pilot lane, slip-form fill-in lane, or fixed form). The Contractor shall demonstrate, in the presence of the RPR, that the materials, concrete mix, equipment, construction processes, and quality control processes meet the requirements of the specifications. The concrete mixture shall be extruded from the paver meeting the edge slump tolerance and with little or no finishing. Pilot, fill-in, and fixed-form control strips will be accepted separately. Minor adjustments to the mix design may be required to place an acceptable control strip. The production mix will be the adjusted mix design used to place the acceptable control strip. Upon acceptance of the control strip by the RPR, the Contractor must use the same equipment, materials, and construction methods for the remainder of concrete paving. Any adjustments to processes or materials must be approved in advance by the RPR. Acceptable control strips will meet edge slump tolerance and surface acceptable with little or no finishing, air content within action limits, strength equal or greater than requirements of P501-3.3. The control strip will be considered one lot for payment (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 501-8.1 using a lot pay factor equal to 100.

501-4.2 Equipment. The Contractor is responsible for the proper operation and maintenance of all equipment necessary for handling materials and performing all parts of the work to meet this specification.

a. Plant and equipment. The plant and mixing equipment shall conform to the requirements of ASTM C94 and/or ASTM C685. Each truck 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. The truck mixers 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.

Equipment for transferring and spreading concrete from the transporting equipment to the paving lane in front of the finishing equipment shall be provided. The equipment shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will 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.

b. Finishing equipment.

(1) Slip-form. The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements.

(2) Fixed-form. On projects requiring less than 10,000 cubic yards of concrete pavement or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with equipment specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the RPR. Hand screeding and float finishing may only be used on small irregular areas as allowed by the RPR.

c. Vibrators. Vibrator shall be the internal type. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation or voids. 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) 309R, 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 RPR.

Hand held vibrators may only be used in irregular areas and shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

d. 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.

e. Fixed forms. Straight side fixed forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the RPR. 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 RPR. The forms shall extend the full depth of the pavement section.

501-4.3 Form setting. Forms shall be set to line and grade as shown on the plans, sufficiently in advance of the concrete placement, to ensure continuous paving operation. Forms shall be set to 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 concrete placement.

501-4.4 Base surface preparation prior to placement. Any damage to the prepared base, subbase, and subgrade shall be corrected full depth by the Contractor prior to concrete placement. The underlying surface shall be entirely free of frost when concrete is placed. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete.

501-4.5 Handling, measuring, and batching material. Aggregate stockpiles shall be constructed and managed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Store and maintain all aggregates at a uniform moisture content prior to use. A continuous supply of materials shall be provided to the work to ensure continuous placement.

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 are placed into the drum until the drum is emptied into the truck. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94 or ASTM C685.

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 discharged from the truck should not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. In no case shall the temperature of the concrete when placed exceed 90°F (32°C). 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 is not exceeded.

501-4.7 Weather 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 RPR, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

Curing during cold weather shall be in accordance with paragraph 501-4.13d.

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 concrete placement shall be protected from exceeding an evaporation rate 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. If the Contractor's measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

Curing during hot weather shall be in accordance with paragraph 501-4.13e.

c. Temperature management program. Prior to the start of paving operation for each day of paving, the Contractor shall provide the RPR with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. (Federal Highway Administration HIPERPAV 3 is one example of a temperature management program.) 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 19-9, PCA, Design and Control of Concrete Mixtures.

(3) Anticipated timing of initial sawing of joint.

(4) Anticipated number and type of saws to be used.

d. **Rain.** 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.

501-4.8 Concrete Placement. At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface 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 compressive strength of 3,100 psi, based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed. The Contractor must determine that the above minimum strengths are

adequate to protection the pavement from overloads due to the construction equipment proposed for the project.

The Contractor shall have available materials for the protection of the concrete during cold, hot and/or inclement weather in accordance with paragraph 501-4.7.

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 sufficient to consolidate the pavement without, segregation, voids, or vibrator trails 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 should be adjusted 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 will be removed the full width of the slip form lane and replaced at the expense of the Contractor as directed by the RPR.

b. Fixed-form construction. Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars / dowel 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 coated with a release agent each time they are used and before concrete is placed against them.

Concrete shall be spread, screed, 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. The equipment must be specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the RPR.

Concrete for the full paving width shall be effectively consolidated by internal vibrators. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation, voids, or leaving vibrator trails.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

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 2 inches (50 mm). Vibrators shall not be used to transport or spread the concrete. 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) or over-consolidation (vibrator trails, segregation, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the RPR.

If a lack of consolidation of the hardened concrete is suspected by the RPR, referee testing may be required. Referee testing of hardened concrete will be performed by the RPR by cutting cores from the finished pavement after a minimum of 24 hours curing. The RPR shall visually examine the cores for evidence of lack of consolidation. Density determinations will be made by the RPR 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 concrete mix density, with no cores having a density of less than 96% of the original concrete mix 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 screed. 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-foot (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. The filler shall be fastened uniformly along the hardened joint face with no buckling or debris between the filler and the concrete interface, including a temporary filler for the sealant reservoir at the top of the slab. The edges of the joint shall be finished and tooled while the concrete is still plastic

d. Dowels and Tie Bars for Joints

(1) 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 and within the tolerances in paragraph 501-4.10(f.). 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.

(2) Dowel bars. Dowel bars shall be placed across joints in the proper horizontal and vertical alignment as shown on the plans. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the RPR. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

(3) Placing dowels and tie bars. Horizontal spacing of dowels shall be within a tolerance of ±3/4 inch (19 mm). The vertical location on the face of the slab shall be within a tolerance of ±1/2 inch (12 mm). The method used to install dowels shall ensure that the horizontal and vertical alignment will not be greater than 1/4 inch per feet (6 mm per 0.3 m), 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 portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the following subparagraphs.

(a) Contraction joints. Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place 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, dowels and tie bars in contraction joints may be installed by insertion into the plastic concrete using approved equipment and procedures per the paver manufacturer's design. Approval of installation methods will be based on the results of the control strip showing that the dowels and tie bars are installed within specified tolerances as verified by cores or non-destructive rebar location devices approved by the RPR.

(b) 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.

(c) Joints in hardened concrete. Install dowels in hardened concrete by bonding the dowels into holes drilled into the concrete. The concrete shall have cured for seven (7) days or reached a minimum compressive strength of 3,100 psi before drilling begins. 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. Spalling beyond the limits of the grout retention ring will require modification of the equipment and operation. 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 by means of a suitable metal or plastic grout retention ring fitted around the dowel.

e. Sawing of joints. 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. 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 saw-cut and maintained for the remaining cure period.

Joints shall be cut in locations as shown on the plans. The initial joint cut shall be a minimum 1/8 inch (3 mm) wide and to the depth shown on the plans. Prior to placement of joint sealant or seals, the top of the joint shall be widened by sawing as shown on the plans.

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, edging of joints, and then texturing. 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. Equipment, mixture, and/or procedures which produce more than 1/4 inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. 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. Fog (mist) sprays or other surface applied finishing aids specified to prevent plastic shrinkage cracking, approved by the RPR, may be used in accordance with the manufacturers requirements.

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. Equipment, mixture, and/or procedures which produce more than 1/4 inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Remove excessive slurry from the surface with a cutting straightedge and wipe off the edge. 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 RPR'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.

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 12-foot (3.7-m) finishing straightedge swung from handles capable of spanning at least 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. 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.

501-4.12 Surface texture. The surface of the pavement shall be finished as designated below for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. The texture shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the RPR.

a. Brush or broom finish. Shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface.

b. Burlap drag finish. Burlap, at least 15 ounces per square yard (555 grams per square meter), will typically produce acceptable texture. 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.

c. Artificial turf finish. 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. Approval of the artificial turf 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.

501-4.13 Curing. Immediately after finishing operations are completed and bleed water is gone from the surface, all exposed surfaces of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

When a two-saw-cut method is used to construct the contraction joint, the curing compound shall be applied to the saw-cut 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. Curing with liquid membrane compounds should not occur until bleed and surface moisture has evaporated. All exposed surfaces 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 square feet (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 RPR, a double application rate shall be used to ensure coverage. 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.

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. Maintain the concrete at a temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the 7-day curing period. 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 RPR.

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 in accordance with paragraph 501-4.13.

If honeycombed areas are evident when the forms are removed, materials, placement, and consolidation methods must be reviewed and appropriate adjustments made to assure adequate consolidation at the edges of future concrete placements. Honeycombed areas that extend into the slab less than approximately 1 inch (25 mm), shall be repaired with an approved grout, as directed by the RPR. Honeycombed areas that extend into the slab greater than a depth of 1 inch (25 mm) shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-4.19.

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 RPR. 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 RPR.

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, the joints are protected, the concrete has attained a minimum field cured flexural strength of 450 psi (3100 kPa), and the slab edge is protected.

All new and existing pavement carrying construction traffic or equipment shall be kept clean and spillage of concrete and other materials shall be cleaned up immediately.

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 compressive strength of 3,100 pounds per square inch when tested in accordance with ASTM C39. 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. New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable as defined by acceptance criteria in paragraph 501-6.6 shall be removed and replaced or repaired, as directed by the RPR, at the Contractor's expense. 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 RPR 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 have a diameter of 2 inches (50 mm) to 4 inches (100 mm), 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 a bonding agent, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. Repair of cracks as described in this section shall not be allowed if in the opinion of the RPR 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.

a. Shrinkage cracks. Shrinkage cracks which do not exceed one-third of the pavement depth shall be cleaned and either high molecular weight methacrylate (HMWM) applied; or epoxy resin (Type IV, Grade 1) pressure injected using procedures recommended by the manufacturer and approved by the RPR. Sandblasting of the surface may be required following the application of HMWM to restore skid resistance. Care shall be taken to ensure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the RPR. Shrinkage cracks which exceed one-third the pavement depth shall be treated as full depth cracks in accordance with paragraphs 501-4.19b and 501-19c.

b. 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 one-third the pavement depth, that extend into the interior area.

c. Cracks close to and parallel to joints. All full-depth cracks within 6 inches (150 mm) either side of the joint and essentially parallel to the original joints, shall be treated as follows.

(1) Full depth cracks and original joint not cracked. The full-depth crack shall be treated as the new joint and the original joint filled with an epoxy resin.

i. Full-depth crack. The joint sealant reservoir for 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). The crack shall be sawed with equipment specially designed to follow random cracks. Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent raveling or spalling. The joint shall be sealed with sealant in accordance with P-605 or as directed by the RPR.

ii. Original joint. If the original 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.

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 and original joint cracked. 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.

d. Removal and replacement of full slabs. Make a full depth cut perpendicular to the slab surface along all edges of the slab with a concrete saw cutting any dowels or tie-bars. Remove damaged slab protecting adjacent pavement from damage. Damage to adjacent slabs may result in removal of additional slabs as directed by the RPR at the Contractor's expense.

The underlying material shall be repaired, re-compacted and shaped to grade.

Dowels of the size and spacing specified for other joints in similar pavement on the project shall be installed along all four (4) edges of the new slab in accordance with paragraph 501-4.10d.

Placement of concrete shall be as specified for original construction. The joints around the new slab shall be prepared and sealed as specified for original construction.

e. Spalls along joints.

(1) Spalls less than one inch wide and less than the depth of the joint sealant reservoir, shall be filled with joint sealant material.

(2) Spalls larger than one inch and/or deeper than the joint reservoir, but less than ½ the slab depth, and less than 25% of the length of the adjacent joint shall be repaired as follows:

i. Make a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inches (50 mm). Saw cuts shall be straight lines forming rectangular areas surrounding the spalled area.

ii. Remove unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete between the saw cut and the joint or crack with a light chipping hammer.

iii. Clean cavity with high-pressure water jets supplemented with compressed air as needed to remove all loose material.

iv. Apply a prime coat of epoxy resin, Type III, Grade I, to the dry, cleaned surface of all sides and bottom of the cavity, except any joint face.

v. Fill the cavity with low slump concrete or mortar or with epoxy resin concrete or mortar.

vi. An insert or other bond-breaking medium shall be used to prevent bond at all joint faces.

vii. 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.

(3) Spalls deeper than 1/2 of the slab depth or spalls longer than 25% of the adjacent joint require replacement of the entire slab.

f. Diamond grinding of Concrete surfaces. Diamond grinding shall be completed prior to pavement grooving. Diamond grinding of the hardened concrete should not be performed until the concrete is at least 14 days old and has achieved full minimum strength. Equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. 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.

Diamond grinding shall be performed with a machine specifically designed for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with sufficient number of flush cut blades that create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The Contractor shall determine the number and type of blades based on the hardness of the aggregate. Contractor shall demonstrate to the RPR that the grinding equipment will produce satisfactory results prior to making corrections to surfaces.

Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. All grinding shall be at the expense of the Contractor.

CONTRACTOR QUALITY CONTROL (CQC)

501-5.1 Quality control program. The Contractor shall develop a Quality Control Program in accordance with Item C-100. No partial payment will be made for materials that are subject to specific quality control requirements without an approved quality control program.

501-5.2 Contractor Quality Control (CQC). The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The RPR shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The RPR will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

501-5.3 Contractor QC testing. The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to this specification and as set forth in the CQCP. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content. A QC Testing Plan shall be developed and approved by the RPR as part of the CQCP.

The RPR 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 RPR, and if it can be demonstrated in the laboratory, in the presence of the RPR, that such material was erroneously rejected, payment will be made for the material at the contract unit pric**e.**

a. Fine aggregate.

(1) Gradation. A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

(3) Deleterious substances. Fine aggregate as delivered to the mixer shall be tested for deleterious substances in fine aggregate for concrete as specified in paragraph 501-2.1b, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

b. Coarse Aggregate.

(1) Gradation. A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

(3) Deleterious substances. Coarse aggregate as delivered to the mixer shall be tested for deleterious substances in coarse aggregate for concrete as specified in paragraph 501-2.1c, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

c. Slump. 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. 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. Unit weight and Yield. One test shall be made for each sublot. Unit weight and yield tests shall be 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.

f. Temperatures. Temperatures shall be checked at least four times per lot at the job site in accordance with ASTM C1064.

g. Smoothness for Contractor Quality Control.

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet,

identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) "straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the RPR. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high points. If the rolling inclinometer or external reference device is used, the data may be evaluated using either the FAA profile program, ProFAA, or FHWA profile program ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

(1) Transverse measurements. Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the RPR. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

(2) Longitudinal measurements. Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 501-4.19f or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 501-6.6.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

h. Grade. Grade will be evaluated prior to and after placement of the concrete surface.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch vertically and 0.1 feet laterally. The documentation will be provided by the Contractor to the RPR by the end of the following working day.

Areas with humps or depression that that exceed grade or smoothness and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. If these areas cannot be corrected with grinding then the slabs that are retaining water must be removed and replaced in accordance with paragraph 501-4.19d. Grinding shall be in accordance with paragraph 501-4.19f. All corrections will be at the Contractors expense.

501-5.4 Control charts. The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content. The Contractor shall also maintain a control chart plotting the coarseness factor/workability factor from the combined gradations in accordance with paragraph 501-2.1d.

Control charts shall be posted in a location satisfactory to the RPR 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 RPR 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. Superimposed on the control charts shall be the action and suspension limits. Gradation tests shall be performed by the Contractor per ASTM C136. The Contractor shall take at least two samples per lot to check the final gradation. Sampling shall be per ASTM D75 from the flowing aggregate stream or conveyor belt.

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.

c. Combined gradation. The Contractor shall maintain a control chart plotting the coarseness factor and workability factor on a chart in accordance with paragraph 501-2.1d.

Control Chart Limits[1]

Control Parameter	Individual Measurements	
	Action Limit	Suspension Limit
Gradation[2]	*[3]	*[3]
Coarseness Factor (CF)	±3.5	±5
Workability Factor (WF)	±2	±3
Slump	+0.5 to -1 inch (+13 to -25 mm)	+1 to -1.5 inch (+25 to -38 mm)
Air Content	±1.5%	±2.0%

[1] Control charts shall developed and maintained for each control parameter indicated.
[2] Control charts shall be developed and maintained for each sieve size.
[3] Action and suspension limits shall be determined by the Contractor.

501-5.5 Corrective action at Suspension Limit. The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of control. The CQCP 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 suspension limits, immediate steps, including a halt to production, shall be taken to correct the grading.

b. Coarseness and Workability factor. When the CF or WF reaches the applicable suspension limits, the Contractor, immediate steps, including a halt to production, shall be taken to correct the CF and WF.

c. 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.

d. Slump. The Contractor shall halt production and make appropriate adjustments whenever:

(1) one point falls outside the Suspension Limit line for individual measurements

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

(2) two points in a row fall outside the Action Limit line for individual measurements.

MATERIAL ACCEPTANCE

501-6.1 Quality Assurance (QA) 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 RPR. The Contractor shall provide adequate facilities for the initial curing of beams. The Contractor shall bear the cost of providing initial curing facilities and coring and filling operations, per paragraph 501-6.5b(1).

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. 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.

501-6.2 Quality Assurance (QA) testing laboratory. Quality assurance testing organizations performing these acceptance tests will be accredited in accordance with ASTM C1077. The quality assurance 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 will be submitted to the RPR prior to start of construction.

501-6.3 Lot size. Concrete will be accepted for strength and thickness on a lot basis. A lot will consist of a day's production not to exceed 2,000 square yards. Each lot will be divided into approximately equal sublots with individual sublots between 400 to 600 cubic yards. Where three sublots are produced, they will constitute a lot. Where one or two sublots are produced, they will be incorporated into the previous or next lot. Where more than one plant is simultaneously producing concrete for the job, the lot sizes will apply separately for each plant.

501-6.4 Partial lots. When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot or for overages or minor placements to be considered as partial lots, 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 will constitute a lot. Where one or two sublots have been produced, they will be incorporated into the next lot or the previous lot and the total number of sublots will be used in the acceptance criteria calculation, that is, n=5 or n=6.

501-6.5 Acceptance Sampling and Testing.

a. Strength.

(1) Sampling. One sample will be taken for each sublot from the concrete delivered to the job site. Sampling locations will be determined by the RPR in accordance with random sampling procedures contained in ASTM D3665. The concrete will be sampled in accordance with ASTM C172.

(2) Test Specimens. The RPR will be responsible for the casting, initial curing, transportation, and curing of specimens in accordance with ASTM C31. Two (2) specimens will be made from each sample and slump, air content, unit weight, and temperature tests will be conducted for each set of strength specimens. Within 24 to 48 hours, the samples will be transported from the field to the laboratory while in the molds. Samples will be cured in saturated lime water.

The strength of each specimen will be determined in accordance with ASTM C39. The strength for each sublot will be computed by averaging the results of the two test specimens representing that sublot.

(3) Acceptance. Acceptance of pavement for strength will be determined by the RPR in accordance with paragraph 501-6.6b(1). All individual strength tests within a lot will be checked for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded and the remaining test values will be used to determine acceptance in accordance with paragraph 501-6.5b.

b. Pavement thickness.

(1) Sampling. One core will be taken by the Contractor for each sublot in the presence of the RPR. Sampling locations will be determined by the RPR in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, will be excluded from sample locations.

Cores shall be a minimum 4 inch (100 mm) in diameter neatly cut with a core drill. The Contractor will furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes will be filled by the Contractor with a non-shrink grout approved by the RPR within one day after sampling.

(2) Testing. The thickness of the cores will be determined by the RPR by the average caliper measurement in accordance with ASTM C174. Each core shall be photographed and the photograph included with the test report.

(3) Acceptance. Acceptance of pavement for thickness will be determined by the RPR in accordance with paragraph 501-6.6.

501-6.6 Acceptance criteria.

a. General. Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-6.5b:

(1) Strength

(2) Thickness

(3) Grade

(4) Profilograph smoothness - **Not used**

(5) Adjustments for repairs

Acceptance for strength, thickness, and grade, will be based on the criteria contained in accordance with paragraph 501-6.6b(1), 501-6.6b(2), and 501-6.6b(3), respectively.

b. Acceptance criteria.

(1) **Strength.** The strength for each sublot shall be computed by averaging the results of that sublot. When sublot strength equals or exceeds the strength as specified in paragraph 501-3.3, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 501-8.1.

(2) Thickness. If sublot thickness is not be less than ½ inch (12 mm) from plan thickness, the lot will be acceptable. Acceptance and payment for the lot will be determined in accordance with paragraph 501-8.1.

(3) Grade. The final finished surface of the pavement of the completed project will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically or 0.1 feet laterally . The documentation, stamped and signed by a licensed surveyor shall be in accordance with paragraph 501-5.3h. Payment for sublots that do not meet grade for over 25% of the sublot shall reduced by 5% and not be more than 95%.

(4) Profilograph roughness for QA Acceptance. Not used.

(5) Adjustments for repair. Sublots with spall repairs, crack repairs, or partial panel replacement, will be limited to no more than 95% payment.

(6) Adjustment for grinding. For sublots with grinding over 25% of a sublot, payment will be reduced 5%.

METHOD OF MEASUREMENT

501-7.1 Concrete pavement shall be measured by the number of square yards of 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 501-6.6. 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; 501-8.1b for repairs; 501-8.1c for grinding; and 501-8.1d for smoothness, subject to the limitation that:

The total project payment for concrete pavement shall not exceed 100 percent of the product of the contract unit price and the total number of square yards of concrete pavement used in the accepted work (See Note 1 under the Price Adjustment Schedule table below).

Payment shall be full compensation for all labor, materials, tools, equipment, 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 strength and thickness. The lot pay factor shall be the higher of the two values when calculations for both 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 strength or thickness is 100% or higher. The lot pay factor shall be the lower of the two values when calculations for both 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 unless, after receipt of FAA concurrence, the Owner and Contractor agree in writing that the lot will remain; the lot paid at 50% of the contract unit price; and the total project payment limitation reduced by the amount withheld for that 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%; except for rejected lots which remain in place and/or sublots with adjustments for repairs.

b. Adjusted payment for repairs. The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots which contain repairs in accordance with paragraph 501-4.19 on more than 20% of the slabs within the sublot. Payment factors greater than 100 percent for the strength and thickness cannot be used to offset adjustments for repairs.

c. Adjusted payment for grinding. The PWL lot pay factor shall be reduced by 5% and be no higher than 95% for sublots with grinding over 25% of a sublot.

d. Profilograph Roughness. Not used.

e. Payment. Payment shall be made under:

900.675 (FAA P-501 PORTLAND CEMENT CONCRETE PAVEMENT) per Square Yard

REFERENCES

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

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1035	Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM C29	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064	Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E2133	Standard Test Method for Using a Rolling Inclinometer to Measure Longitudinal and Transverse Profiles of a Traveled Surface

American Concrete Institute (ACI)

ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete

Advisory Circulars (AC)

AC 150/5320-6	Airport Pavement Design and Evaluation

Federal Highway Administration (FHWA)

HIPERPAV 3, version 3.2

Portland Concrete Association (PCA)

PCA	Design and Control of Concrete Mixtures, 16th Edition

U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD)

CRD C662	Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

United States Air Force Engineering Technical Letter (ETL)

ETL 97-5	Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

END ITEM P-501

Item P-603 Emulsified Asphalt Tack Coat

DESCRIPTION

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

MATERIALS

603-2.1 Asphalt materials. The asphalt material shall be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions. The emulsified asphalt shall not be diluted. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt material to the Resident Project Representative (RPR) before the asphalt material is applied for review and acceptance. The furnishing of COA for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

CONSTRUCTION METHODS

603-3.1 Weather limitations. The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the RPR.

603-3.2 Equipment. The Contractor shall provide equipment for heating and applying the emulsified asphalt material. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute).

The equipment will be tested under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application, spray-bar height and pressure and pump speed, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

The distributor truck shall be equipped to effectively heat and mix the material to the required temperature prior to application as required. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Do not overheat or over mix the material.

The distributor shall be equipped with a hand sprayer.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the RPR.

A power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied shall be provided.

603-3.3 Application of emulsified asphalt material. The emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the RPR prior to application.

Emulsified Asphalt

Surface Type	Residual Rate, gal/SY (L/square meter)	Emulsion Application Bar Rate, gal/SY (L/square meter)
New asphalt	0.02-0.05 (0.09-0.23)	0.03-0.07 (0.13-0.32)
Existing asphalt	0.04-0.07 (0.18-0.32)	0.06-0.11 (0.27-0.50)
Milled Surface	0.04-0.08 (0.18-0.36)	.0.06-0.12 (0.27-0.54)
Concrete	0.03-0.05 (0.13-0.23)	0.05-0.08 (0.23-0.36)

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

603-3.4 Freight and waybills The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the RPR certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

METHOD OF MEASUREMENT

603-4.1 The emulsified asphalt material for tack coat shall be measured by the gallon. Volume shall be corrected to the volume at 60°F (16°C) in accordance with ASTM D1250. The emulsified asphalt material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10% over the specified application rate. Any amount of emulsified asphalt material more than 10% over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the emulsified asphalt material is necessary. Water added to emulsified asphalt will not be measured for payment.

BASIS OF PAYMENT

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

Payment will be made under:

900.625	(FAA P-603 EMULSIFIED ASPHALT TACK COAT)	per Gallon

REFERENCES

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

ASTM International (ASTM)

ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

END ITEM P-603

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Item P-605 Joint Sealants for 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 in pavement; joints between different types of pavements; and cracks in existing pavement.

MATERIALS

605-2.1 Joint sealants. Joint sealant materials shall meet the requirements of ASTM D6690 for Joint and Crack Sealants, Hot Applied for Concrete and Asphalt Pavements and ASTM D7116 for Joint Sealants, Hot Applied, Jet Fuel Resistant Types for Portland Cement Concrete Pavements.

Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer's certification stating that the sealant meets the requirements of this specification.

605-2.2 Backer rod. The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant in accordance with ASTM D5249. The backer-rod material shall be 25% ± 5 % larger in diameter than the nominal width of the joint.

605-2.3 Bond breaking tapes. Provide a bond breaking tape or separating material that is a flexible, non-shrinkable, non-absorbing, non-staining, and non-reacting adhesive-backed tape. The material shall have a melting point at least 5°F (3°C) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.

CONSTRUCTION METHODS

605-3.1 Time of application. Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be 50°F (10°C) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint.

605-3.2 Equipment. Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 7 days prior to use on the project.

a. 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.

b. Hand tools. Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces. Hand tools should be carefully evaluated for potential spalling effects prior to approval for use.

f. Hot-poured sealing equipment. The unit applicators used for heating and installing ASTM D6690 joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

605-3.3 Preparation of joints. Pavement joints for application of material in this specification must be dry, clean of all scale, dirt, dust, curing compound, and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method cleans the joint and does not damage the joint.

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 concrete saw or hand tools as specified in paragraph 605-3.2. 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 a backer rod in accordance with paragraph 605-2.2 to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backer rod is placed at the specified depth and is not stretched or twisted during installation.

d. Bond-breaking tape. Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-separating tape breaker in accordance with paragraph 605-2.3 to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

605-3.4 Installation of sealants. Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the RPR before sealing is allowed. Sealants shall be installed in accordance with the following requirements:

Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/4 inch ±1/16 inch below the top of pavement surface; or bottom of groove for grooved pavement. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. 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 RPR. 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 linear foot of sealant in place, completed, and accepted.

BASIS OF PAYMENT

605-5.1 Payment for joint sealing material shall be made at the contract unit price per linear foot. 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.

Payment will be made under:

900.640	(FAA P-605 JOINT SEALING FILLER)	per Linear Foot

REFERENCES

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

ASTM International (ASTM)

ASTM D789	Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)
ASTM D5249	Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt
ASTM D7116	Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types for Portland Cement Concrete Pavements

Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids

END ITEM P-605

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Item P-610 Concrete for Miscellaneous Structures

DESCRIPTION

610-1.1 This item shall consist of concrete and reinforcement, as shown on the plans, prepared and constructed in accordance with these specifications. This specification shall be used for all concrete other than airfield pavement which are cast-in-place.

MATERIALS

610-2.1 General. Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the Resident Project Representative (RPR) before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

a. Reactivity. Fine aggregate and coarse aggregates to be used in all concrete shall have been tested separately within six months of the project in accordance with ASTM C1260. Test results shall be submitted to the RPR. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion either or both test specimen is greater than 0.08% at 14 days, but less than 0.20%, a minimum of 25% of Type F fly ash, or between 40% and 55% of slag cement shall be used in the concrete mix.

If the expansion is greater than 0.20%, the aggregates shall not be used, and test results for other aggregates must be submitted for evaluation; or aggregates that meet P-501 reactivity test requirements may be utilized.

610-2.2 Coarse aggregate. The coarse aggregate for concrete shall meet the requirements of ASTM C33 and the requirements of Table 4, Class Designation 5S; and the grading requirements shown below, as required for the project.

Coarse Aggregate Grading Requirements

Maximum Aggregate Size	ASTM C33, Table 3 Grading Requirements (Size No.)
1 1/2 inch (37.5 mm)	467 or 4 and 67
1 inch (25 mm)	57
¾ inch (19 mm)	67
½ inch (12.5 mm)	7

610-2.2.1 Coarse Aggregate susceptibility to durability (D) cracking.

Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

Crushed granite, calcite cemented sandstone, quartzite, basalt, diabase, rhyolite or trap rock are considered to meet the D-cracking test requirements but must meet all other quality tests specified in Item P-501.

610-2.3 Fine aggregate. The fine aggregate for concrete shall meet all fine aggregate requirements of ASTM C33.

610-2.4 Cement. Cement shall conform to the requirements of **ASTM C150** Type **II or IIA**. Cement shall contain less than 0.6% equivalent alkalies, or the mix must include additional ASR mitigating measures such as additional fly ash, slag, or other approved admixtures.

610-2.5 Cementitious materials.

a. Fly ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the RPR.

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

610-2.6 Water. Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

610-2.7 Admixtures. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the RPR may require the Contractor to submit

complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the RPR from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

a. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

b. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

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

610-2.8 Premolded joint material. Premolded joint material for expansion joints shall meet the requirements of ASTM D1752.

610-2.9 Joint filler. The filler for joints shall meet the requirements of Item P-605, unless otherwise specified.

610-2.10 Steel reinforcement. Reinforcing shall conform to the requirements below as applicable:

Steel Reinforcement

Reinforcing Steel	ASTM A615, ASTM A706, ASTM A775, ASTM A934
Welded Steel Wire Fabric	ASTM A1064, ASTM A884
Welded Deformed Steel Fabric	ASTM A1064
Bar Mats	ASTM A184 or ASTM A704

610-2.11 Materials for curing concrete. Curing materials shall conform to one of the following:

Materials for Curing

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

CONSTRUCTION METHODS

610-3.1 General. The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the RPR.

610-3.2 Concrete Mixture. The concrete shall develop a compressive strength of 4,000 psi in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39. The concrete shall contain not less than 470 pounds of cementitious material per cubic yard (280 kg

per cubic meter). The water cementitious ratio shall not exceed 0.45 by weight. The air content of the concrete shall be 5% +/- 1.2% as determined by ASTM C231 and shall have a slump of not more than 4 inches (100 mm) as determined by ASTM C143.

610-3.3 Mixing. Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94 or ASTM C685.

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without the RPRs approval. If approval is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material is not permitted.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

610-3.4 Forms. Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the RPR. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.

The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface.

610-3.5 Placing reinforcement. All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

610-3.6 Embedded items. Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

610-3.7 Concrete Consistency. The Contractor shall monitor the consistency of the concrete delivered to the project site; collect each batch ticket; check temperature; and perform slump tests on each truck at the project site in accordance with ASTM C143.

610-3.8 Placing concrete. All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the RPR. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

610-3.9 Vibration. Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

610-3.10 Joints. Joints shall be constructed as indicated on the plans.

610-3.11 Finishing. All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated.

610-3.12 Curing and protection. All concrete shall be properly cured in accordance with the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. The concrete shall be protected from damage until project acceptance.

610-3.13 Cold weather placing. When concrete is placed at temperatures below 40°F (4°C), follow the cold weather concreting recommendations found in ACI 306R, Cold Weather Concreting.

610-3.14 Hot weather placing. When concrete is placed in hot weather greater than 85ºF (30 ºC), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

QUALITY ASSURANCE (QA)

610-4.1 Quality Assurance sampling and testing. Concrete for each day's placement will be accepted on the basis of the compressive strength specified in paragraph 610-3.2. The RPR will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231; make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

610-4.2 Defective work. Any defective work that cannot be satisfactorily repaired as determined by the RPR, shall be removed and replaced at the Contractor's expense. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

METHOD OF MEASUREMENT

610-5.1 Concrete under Item P-610 shall be considered incidental and no separate measurement shall be made.

BASIS OF PAYMENT

610-6.1 Concrete under Item P-610 shall be considered incidental and no separate payment shall be made.

REFERENCES

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

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing

ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

American Concrete Institute (ACI)

ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308R	Guide to External Curing of Concrete
ACI 309R	Guide for Consolidation of Concrete

END OF ITEM P-610

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Item P-620 Runway and Taxiway Marking

DESCRIPTION

620-1.1 This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the Resident Project Representative (RPR). The terms "paint" and "marking material" as well as "painting" and "application of markings" are interchangeable throughout this specification.

MATERIALS

620-2.1 Materials acceptance. The Contractor shall furnish manufacturer's certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer's surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the Resident Project Representative (RPR) prior to the initial application of markings. The reports can be used for material acceptance or the RPR may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the RPR upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the RPR.

620-2.2 Marking materials.

Table 1. Marking Materials

Paint				Glass Beads	
Type	**Color**	**Fed Std. 595 Number**	**Application Rate Maximum**	**Type**	**Application Rate Minimum**
Waterborne Type III	White	37925	90 ft^2/gal	III	8 lb/gal
Waterborne Type III	Yellow	33538 or 33655	90 ft^2/gal	III	8 lb/gal
Waterborne Type III	Red	31136	90 ft^2/gal	I	7 lb/gal
Waterborne Type II	Black	37038	115 ft^2/gal	-	

a. Paint. Paint shall be waterborne in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595Waterborne paint shall meet the requirements of Federal Specification TT-P-1952F, Type I or Type III as indicated above. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis. The acrylic resin used for Type III shall be 100% cross linking acrylic as evidenced by infrared peaks at wavelengths 1568, 1624, and 1672 cm-l with intensities equal to those produced by an acrylic resin known to be 100% cross linking.

b. Reflective media. Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type III.

Glass beads for red and pink paint shall meet the requirements for Type I, Gradation A.

Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

CONSTRUCTION METHODS

620-3.1 Weather limitations. Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations in accordance with paragraph 620-2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer's recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time.

620-3.2 Equipment. Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

620-3.3 Preparation of surfaces. Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminates that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the RPR. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

a. Preparation of new pavement surfaces. The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the RPR to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.

b. Preparation of pavement to remove existing markings. Existing pavement markings shall be removed by rotary grinding, water blasting, or by other methods approved by the RPR minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to 'block out' the removal area to eliminate 'ghost' markings.

c. Preparation of pavement markings prior to remarking. Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the RPR. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures

application and surface preparation requirements must be submitted to the RPR prior to the initial application of markings.

620-3.4 Layout of markings. The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans.

620-3.5 Application. A period of 30 days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the RPR.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

Marking Dimensions and Spacing Tolerance

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

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

620-3.6 Application--preformed thermoplastic airport pavement markings. Preformed thermoplastic pavement markings not used.

620-3.7 Control strip. Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the RPR. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

620-3.8 Retro-reflectance. Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 reading shall be taken over a 6 square foot area with 3 readings taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m^2/lux		
	White	**Yellow**	**Red**
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35
All materials, remark when less than[1]	100	75	10

[1] 'Prior to remarking determine if removal of contaminants on markings will restore retro-reflectance

620-3.9 Protection and cleanup. After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the RPR. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

METHOD OF MEASUREMENT

620-4.1a The quantity of surface preparation shall be measured by the number of square feet for each type of surface preparation specified in paragraph 620-3.3.

620-4.1b The quantity of markings shall be paid for shall be measured by the number of square feet of painting.

620-4.1c The quantity of reflective media shall not be measured for separate payment.

620-4.1d The quantity of temporary markings to be paid for shall be the number of square feet of painting performed in accordance with the specifications and accepted by the RPR. Temporary marking includes surface preparation, application and complete removal of the temporary marking.

BASIS OF PAYMENT

620-5.1 This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item complete in place and accepted by the RPR in accordance with these specifications.

620-5.1a Payment for surface preparation shall be made at the contract price for the number of square feet (square meters) for each type of surface preparation specified in paragraph 620-3.3.

620-5.2b Payment for markings shall be made at the contract price for the number of square feet of painting**.**

620-5.4c Payment for temporary markings shall be made at the contract price for the number of square feet of painting. This 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:

900.670	(FAA P-620 SURFACE PREPARATION)	per Square Foot
900.670	(FAA P-620 PERMANENT MARKING)	per Square Foot
900.670	(FAA P-620 TEMPORARY MARKING)	per Square Foot
900.670	(FAA P-620 BLACK PAINT)	per Square Foot

REFERENCES

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

ASTM International (ASTM)

ASTM D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1652	Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2074	Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D7585	Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments
ASTM E303	Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
ASTM E1710	Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
ASTM E2302	Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

Code of Federal Regulations (CFR)

40 CFR Part 60, Appendix A-7, Method 24
Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

29 CFR Part 1910.1200 Hazard Communication

Federal Specifications (FED SPEC)

FED SPEC TT-B-1325D	Beads (Glass Spheres) Retro-Reflective
FED SPEC TT-P-1952F	Paint, Traffic and Airfield Marking, Waterborne
FED STD 595	Colors used in Government Procurement

Commercial Item Description

A-A-2886B	Paint, Traffic, Solvent Based

Advisory Circulars (AC)

AC 150/5340-1	Standards for Airport Markings
AC 150/5320-12	Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces

END OF ITEM P-620

Item D-701 Pipe for Storm Drains and Culverts

DESCRIPTION

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

MATERIALS

701-2.1 Materials shall meet the requirements shown on the plans and specified below. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage shall be noncombustible and inert to fuel in accordance with National Fire Protection Association (NFPA) 415.

701-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
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.

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 ASTM C990.

701-2.8. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of P-153. When CLSM is used, all joints shall have gaskets.

701-2.9 Precast box culverts. Manufactured in accordance with and conforming to ASTM C1433.

701-2.10 Precast concrete pipe. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or American Concrete Pipe Association QCast Plant Certification program.

CONSTRUCTION METHODS

701-3.1 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 12 inches (300 mm) on each side. The trench walls shall be approximately vertical.

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

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

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

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

701-3.2 Bedding. The bedding surface for the pipe shall provide a foundation of uniform density to support the pipe throughout its entire length.

a. Rigid pipe. The pipe bedding shall be constructed uniformly for the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 in when the bedding thickness is less than 6 inches, and 1-1/2 in when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe.

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

Flexible Pipe Bedding

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

c. Other pipe materials. For PVC, polyethylene, polypropylene, or fiberglass pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075

mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

701-3.3 Geotextile. Geotextile fabric shall conform to the requirements of AASHTO M288 Class 2 or equivalent. The fabric shall meet the following requirements:

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

701-3.4 Laying pipe. The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

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

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

701-3.5 Joining pipe. Joints shall be made with (1) cement mortar, (2) 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. Pipe sections at joints shall be fully seated and the inner surfaces flush and even. Concrete pipe joints shall be sealed with rubber gaskets meeting ASTM C443 when leak resistant joints are required.

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

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

d. Fiberglass pipe. Joints and fittings shall be as detailed on the plans and in accordance with the manufacturers recommendations. Joints shall meet the requirements of ASTM D4161 for flexible elastomeric seals.

701-3.6 Embedment and Overfill. Pipes shall be inspected before any fill material is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced at the Contractor's expense.

701-3.6-1 Embedment Material Requirements

a. Concrete Pipe. Embedment material and compaction requirements shall be in accordance with the applicable Type of Standard Installation (Types 1, 2, 3, or 4) per ASTM C1479. If a concrete cradle or CLSM embedment material is used, it shall conform to the plan details.

b. Plastic and fiberglass Pipe. Embedment material shall meet the requirements of ASTM D3282, A-1, A-2-4, A-2-5, or A-3. Embedment material shall be free of organic material, stones larger than 1.5 inches in the greatest dimension, or frozen lumps. Embedment material shall extend to 12 inches above the top of the pipe.

c. Metal Pipe. Embedment material shall be granular as specified in the contract document and specifications, and shall be free of organic material, rock fragments larger than 1.5 inches in the greatest dimension and frozen lumps. As a minimum, backfill materials shall meet the requirements of ASTM D3282, A-1, A-2, or A-3. Embedment material shall extend to 12 inches above the top of the pipe.

701-3.6-2 Placement of Embedment Material

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

When the top of the pipe is above the top of the trench, the embedment material shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. All embedment material shall be compacted to a density required under P-152.

Concrete cradles and flowable fills, such as controlled low strength material (CLSM) or controlled density fill (CDF), may be used for embedment provided adequate flotation resistance can be achieved by restraints, weighing, or placement technique.

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

701-3.7 Overfill

Pipes shall be inspected before any overfill is in place. Any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be place and compacted in layers as required to achieve compaction to at least 95 percent standard proctor per ASTM D698**.** The soil shall contain no debris, organic matter, frozen material, or stones with a diameter greater than one half the thickness of the compacted layers being placed.

701-3.8 Inspection Requirements

An initial post installation inspection shall be performed by the Contractor in the presence of the RPR no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe interior. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe.

Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. The zoom ratio shall be provided for all still or video images that document any issues of concern by the inspection firm**.**

Flexible pipes shall be inspected for rips, tears, joint separations, soil migration, cracks, localized buckling, settlement, alignment, and deflection. Determine whether the allowable deflection has been exceeded by use of a laser profiler for internal pipe diameters of 48 inches or less, or direct measurement for internal pipe diameters greater than 48 inches. Laser profile equipment shall utilize low barrel distortion video equipment. Deflection of installed pipe shall not exceed the limits provided in the table below, as a percentage of the average inside diameter of the pipe.

Maximum Allowable Pipe Deflection

Type of Pipe	**Maximum Allowable Deflection (%)**
Corrugated Metal Pipe	5
Concrete Lined CMP	3
Thermoplastic Pipe	5
Fiberglass	5

If deflection readings in excess of the allowable deflection are obtained, remove the pipe with excessive deflection and replace with new pipe. Isolated areas may exceed allowable by 2.5% with concurrence of RPR. Repair or replace any pipe with cracks exhibiting displacement across the crack, bulges, creases, tears, spalls, or delaminations. The report for flexible pipe shall include as a minimum, the deflection results and final post installation inspection report. The inspection report shall include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design line and grade, and inspector's notes.

METHOD OF MEASUREMENT

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

701-4.2. The quantity of excavation, bedding, backfill, shoring, dewatering, coring of existing structure, or any other materials necessary to complete this item shall not be measured separately, but rather shall be considered included in the unit bid price for the pipe item. Select materials, such as P-154 Subbase Course or P-209 Crushed Aggregate Base Course will be paid for under their respective pay items.

701-4.3 The volume of rock shall be measured as per Specification Section P-152, no measurement for rock shall be made under this specification section.

BASIS OF PAYMENT

701-5.0 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, shoring, dewatering, bedding, backfill, coring and connecting to existing structures, and installation of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

900.640	(FAA D-701 6" HDPE PIPE)	per Linear Foot
900.640	(FAA D-701 12-INCH HDPE PIPE)	per Linear Foot
900.640	(FAA D-701 12-INCH RCP)	per Linear Foot
900.640	(FAA D-701 15-INCH HDPE PIPE)	per Linear Foot
900.640	(FAA D-701 15-INCH RCP)	per Linear Foot
900.640	(FAA D-701 24-INCH RCP)	per Linear Foot
900.640	(FAA D-701 18-INCH HDPE PIPE WITH STONE)	per Linear Foot
900.640	(FAA D-701 36-INCH HDPE PIPE WITH STONE)	per Linear Foot

REFERENCES

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

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter

ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C94	Standard Specification for Ready Mixed Concrete
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber

ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D3282	Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

National Fire Protection Association (NFPA)

NFPA 415	Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways

END OF 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.

AASHTO M252 Standard Specification for Corrugated Polyethylene Drainage Pipe

705-2.3 Joint mortar. Pipe joint mortar shall consist of one part by volume of Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

705-2.4 Elastomeric seals. Elastomeric seals shall conform to the requirements of ASTM F477.

705-2.5 Porous backfill. Porous backfill shall be free of clay, humus, or other objectionable matter, and shall conform to the gradation in Table 1 when tested in accordance with ASTM C136.

Table 1. Gradation of Porous Backfill

Sieve Designation (square openings)	Percentage by Weight Passing Sieves
	Porous Material No. *
1-1/2 inch (37.5 mm)	100
1 inch (25.0 mm)	90-100
3/8 inch (9.5 mm)	25-60
No. 4 (4.75 mm)	5-40
No. 8 (2.36 mm)	0-20
No. 16 (1.18 mm)	-
No. 50 (300 µm)	-
No. 100 (150 µm)	-

When two courses of porous backfill are specified in the plans, the finer of the materials shall conform to particle size tabulated herein for porous material No. 1. The coarser granular material shall meet the gradation given in the tabulation for porous material No. 2.

705-2.6 Granular material. Granular material used for backfilling shall conform to the requirements of ASTM D2321 for Class IA, IB, or II materials.

705-2.7 Filter fabric. The filter fabric shall conform to the requirements of AASHTO M288 Class 2 or equivalent.

Table 2. Fabric Properties

Fabric Property	Test Method	Test Requirement
Grab Tensile Strength, lbs	ASTM D4632	125 min
Grab Tensile Elongation %	ASTM D4632	50 min
Burst Strength, psi	ASTM D3785	125 min
Trapezoid Tear Strength, lbs	ASTM D4533	55 min
Puncture Strength, lbs	ASTM D4833	40 min
Abrasion, lbs	ASTM D4886	15 max loss
Equivalent Opening Size	ASTM D4751	70-100
Permittivity sec^{-1}	ASTM D4491	0.80
Accelerated Weathering (UV Stability) (Strength Retained - %)	ASTM D4355 *(500 hrs exposure)	70

705-2.8 Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153. All joints shall have elastomeric seals.

705-2.9 Cleanout Casting. Metal Castings shall conform to ASTM A48, Class 35B Gray Iron. Frames and covers shall be certified to carry a 250 psi load.

705-2.10 Concrete. Concrete shall meet the requirements of Specification P-610.

CONSTRUCTION METHODS

705-3.1 Equipment. All equipment required for the construction of pipe underdrains shall be on the project, in good working condition, and approved by the RPR before construction is permitted to start.

705-3.2 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but shall not be less than the external diameter of the pipe plus 6 inches (150 mm) on each side of the pipe. The trench walls shall be approximately vertical.

Where rock, hardpan, or other unyielding material is encountered, it shall be removed below the foundation grade for a depth of at least 4 inches (100 mm). The excavation below grade shall be backfilled with selected fine compressible material, such as silty clay or loam, and lightly compacted in layers not over 6 inches (150 mm) in uncompacted depth to form a uniform but yielding foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

Excavated material not required or acceptable for backfill shall be disposed of by the Contractor as directed by the RPR. The excavation shall not be carried below the required depth; if this occurs, the trench shall be backfilled at the Contractor's expense with material approved by the RPR and compacted to the density of the surrounding material.

The pipe bedding shall be constructed uniformly over the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 inch when the bedding thickness is less than 6 inches, and

1-1/2 inch when the bedding thickness is greater than 6 inches.Bedding shall be loosely placed, uncompacted material under the middle third of the pipe prior to placement of the pipe.

The Contractor shall do trench bracing, sheathing, or shoring necessary to perform and protect the excavation as required for safety and conformance to federal, state and local laws. Unless otherwise provided, the bracing, sheathing, or shoring shall be removed by the Contractor after the backfill has reached at least 12 inches (300 mm) over the top of the pipe. The sheathing or shoring shall be pulled as the granular backfill is placed and compacted to avoid any unfilled spaces between the trench wall and the backfill material. The cost of bracing, sheathing, or shoring, and the removal of same, shall be included in the unit price bid per foot (meter) for the pipe.

705-3.3 Laying and installing pipe.

a. Concrete pipe. The laying of the pipe in the finished trench shall be started at the lowest point and proceed upgrade. When bell and spigot pipe is used, the bells shall be laid upgrade. If tongue and groove pipe is used, the groove end shall be laid upgrade. Holes in perforated pipe shall be placed down, unless otherwise shown on the plans. The pipe shall be firmly and accurately set to line and grade so that the invert will be smooth and uniform. Pipe shall not be laid on frozen ground.

Pipe which is not true in alignment, or which shows any settlement after laying, shall be taken up and re-laid by the Contractor at no additional expense. Making adjustments in grade by exerting force on the barrel of the pipe with excavating equipment, by lifting and dropping the pipe, or by lifting the pipe and packing bedding material under it shall be prohibited. If the installed pipe section is not to grade, the pipe section shall be completely removed, the grade corrected, and the pipe rejoined."

b. Metal pipe. The metal pipe shall be laid with the separate sections joined firmly together with bands, with outside laps of circumferential joints pointing upgrade, and with longitudinal laps on the sides. Any metal in the pipe or bands that is not protected thoroughly by galvanizing shall be coated with a suitable asphaltum paint.

During installation, the asphalt-protected pipe shall be handled without damaging the asphalt coating. Any breaks in the bitumen or treatment of the pipe shall be refilled with the type and kind of bitumen used in coating the pipe originally.

c. PVC, fiberglass, or polyethylene pipe. PVC or polyethylene pipe shall be installed in accordance with the requirements of ASTM D2321. Perforations shall meet the requirements of AASHTO M252 or AASHTO M294 Class 2, unless otherwise indicated on the plans. The pipe shall be laid accurately to line and grade. Fiberglass per ASTM D3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe.

d. All types of pipe. The upgrade end of pipelines, not terminating in a structure, shall be plugged or capped as approved by the RPR.

Unless otherwise shown on the plans, a 4-inch (100 mm) bed of granular backfill material shall be spread in the bottom of the trench throughout the entire length under all perforated pipe underdrains.

Pipe outlets for the underdrains shall be constructed when required or shown on the plans. The pipe shall be laid with tight-fitting joints. Porous backfill is not required around or over pipe outlets for underdrains. All connections to other drainage pipes or structures shall be made as required and in a satisfactory manner. If connections are not made to other pipes or structures, the outlets shall be protected and constructed as shown on the plans.

e. Filter fabric. The filter fabric shall be installed in accordance with the manufacturer's recommendations, or in accordance with the AASHTO M288 Appendix, unless otherwise shown on the plans.

705-3.4 Mortar. The mortar shall be of the desired consistency for caulking and filling the joints of the pipe and for making connections to other pipes or to structures. Mortar that is not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted.

705-3.5 Joints in concrete pipe. When open or partly open joints are required or specified, they shall be constructed as indicated on the plans. The pipe shall be laid with the ends fitted together as designed. If bell and spigot pipe is used, mortar shall be placed along the inside bottom quarter of the bell to center the following section of pipe.

The open or partly open joints shall be surrounded with granular material meeting requirements of porous backfill No. 2 in Table 1 or as indicated on the plans. This backfill shall be placed so its thickness will be not less than 3 inches (75 mm) nor more than 6 inches (150 mm), unless otherwise shown on the plans.

When the original material excavated from the trench is impervious, commercial concrete sand or granular material meeting requirements of porous backfill No. 1 shall surround porous backfill No. 2 (Table 1), as shown on the plans or as directed by the RPR.

When the original material excavated from the trench is pervious and suitable, it may be used as backfill in lieu of porous backfill No. 1, when indicated on the plans or as directed by the RPR.

705-3.6 Embedment and Backfill

a. Earth. All trenches and excavations shall be backfilled soon after the pipes are installed, unless additional protection of the pipe is directed. The embedment material shall be select material from excavation or borrow and shall be approved by the RPR. The select material shall be placed on each side of the pipe out to a distance of the nominal pipe diameter and one foot (30 cm) over the top of the pipe and shall be readily compacted. It shall not contain stones 3 inches (75 mm) or larger in size, frozen lumps, chunks of highly plastic clay, or any other material that is objectionable to the RPR. The material shall be moistened or dried, as required to aid compaction. Placement of the embedment material shall not cause displacement of the pipe. Thorough compaction under the haunches and along the sides to the top of the pipe shall be obtained.

The embedment material shall be placed in loose layers not exceeding 6 inches (150 mm) in depth under and around the pipe. Backfill material over the pipe shall be placed in lifts not exceeding 8 inches (200 mm). Successive layers shall be added and thoroughly compacted by hand and pneumatic tampers, approved by the RPR, until the trench is completely filled and brought to the planned elevation. Embedment and backfilling shall be done to avoid damaging top or side of the pipe.

In embankments and other unpaved areas, the backfill shall be compacted per Item P-152 to the density required for embankments in unpaved areas. Under paved areas, the subgrade and any backfill shall be compacted per Item P-152 to the density required for embankments for paved areas.

b. Granular backfill. When granular backfill is required, placement in the trench and about the pipe shall be as shown on the plans. The granular backfill shall not contain an excessive amount of foreign matter, nor shall soil from the sides of the trench or from the soil excavated from the trench be allowed to filter into the granular backfill. When required by the RPR, a template shall be used to properly place and separate the two sizes of backfill. The backfill shall be placed in loose layers not exceeding 6 inches (150 mm) in depth. The granular backfill shall be compacted by hand and pneumatic tampers to the requirements as given for embankment. Backfilling shall be done to avoid damaging top or side pressure on the pipe. The granular backfill shall extend to the elevation of the trench or as shown on the plans.

When perforated pipe is specified, granular backfill material shall be placed along the full length of the pipe. The position of the granular material shall be as shown on the plans. If the original material excavated from the trench is pervious and suitable, it shall be used in lieu of porous backfill No. 1.

If porous backfill is placed in paved or adjacent to paved areas before grading or subgrade operations is completed, the backfill material shall be placed immediately after laying the pipe. The depth of the

granular backfill shall be not less than 12 inches (300 mm), measured from the top of the underdrain. During subsequent construction operations, a minimum depth of 12 inches (300 mm) of backfill shall be maintained over the underdrains. When the underdrains are to be completed, any unsuitable material shall be removed exposing the porous backfill. Porous backfill containing objectionable material shall be removed and replaced with suitable material. The cost of removing and replacing any unsuitable material shall be at the Contractor's expense.

If a granular subbase blanket course is used which extends several feet beyond the edge of paving to the outside edge of the underdrain trench, the granular backfill material over the underdrains shall be placed in the trench up to an elevation of 2 inches (50 mm) above the bottom surface of the granular subbase blanket course. Immediately prior to the placing of the granular subbase blanket course, the Contractor shall blade this excess trench backfill from the top of the trench onto the adjacent subgrade where it can be incorporated into the granular subbase blanket course. Any unsuitable material that remains over the underdrain trench shall be removed and replaced. The subbase material shall be placed to provide clean contact between the subbase material and the underdrain granular backfill material for the full width of the underdrain trench.

c. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153.

705-3.7 Flexible Pipe Ring Deflection. The flexible pipe shall be inspected by the Contractor during and after installation to ensure that the internal diameter of the pipe barrel has not been reduced by more than 5 percent. For guidance on properly sizing mandrels, refer to ASTM D3034 and ASTM F679 appendices.

705-3.8 Connections. When the plans call for connections to existing or proposed pipe or structures, these connections shall be watertight and made to obtain a smooth uniform flow line throughout the drainage system.

705-3.9 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, soil, and rubbish from the site. Surplus soil may be deposited in embankments, shoulders, or as directed by the RPR. Except for paved areas of the airport, the Contractor shall restore all disturbed areas to their original condition.

705-3.10 Installation of cleanout casting. All cast frames/covers shall be placed in the positions indicated on the plans, as detailed on the plans, or as directed by the RPR, and shall be set true to line and elevation. If frames are to be set in concrete, all anchors, sleeves 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. All units shall set firm and secure. After the frames have been set in their final position, the concrete shall be allowed to harden for seven (7) days before being subjected to traffic.

METHOD OF MEASUREMENT

705-4.1 The length of pipe shall be the number of linear feet (meters) of pipe underdrains in place, completed, and approved; measured along the centerline of the pipe from end or inside face of structure to the end or inside face of structure, whichever is applicable. The several classes, types, and sizes shall be measured separately. All fittings shall be included in the footage as typical pipe sections in the pipeline being measured.

705-4.2 The quantity of pipe underdrains shall be made at the contract unit price per linear foot (meter) complete, including porous backfill and filter fabric.

705-4.3 The quantity of underdrain cleanouts shall be measured per unit (per each) for each cleanout in place, completed and accepted. The quantity being measured shall include all fittings, riser pipes, castings, and concrete collards as incidental.

BASIS OF PAYMENT

705-5.1 Pipe underdrains, Complete. Pipe underdrains, complete (including porous backfill and filter fabric) shall be made at the contract unit price per linear foot (meter) complete (including porous backfill and filter fabric. These prices shall be full compensation for furnishing all materials and for all preparation, excavation, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

705-5.1 Cleanout, Complete. Payment will be made at the contract unit price per each cleanout completed and accepted. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfill, castings, concrete and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item as detailed in the contract drawings.

Payment will be made under:

900.640	(FAA D-705 6-INCH PIPE UNDERDRAIN, COMPLETE)	per Linear Foot
900.620	(FAA D-705 NEW UNDERDRAIN CLEANOUT, COMPLETE)	per Each

REFERENCES

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

ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C444	Standard Specification for Perforated Concrete Pipe
ASTM C654	Standard Specification for Porous Concrete Pipe
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F758	Standard Specification for Smooth Wall Poly (Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter

ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M190	Standard Specification for Bituminous - Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M288	Standard Specification for Geotextile Specification for Highway Applications
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel-Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) diameter
AASHTO	Standard Specifications for Highway Bridges

END OF ITEM D-705

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Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the RPR.

MATERIALS

751-2.1 Brick. The brick shall conform to the requirements of ASTM C32, Grade MS.

751-2.2 Mortar. Mortar shall consist of one part Portland cement and two parts sand. The cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

751-2.3 Concrete. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

751-2.4 Precast concrete pipe manhole rings. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

751-2.5 Corrugated metal. Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

751-2.6 Frames, covers, and grates. The castings shall conform to one of the following requirements:

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

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

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

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

751-2.7 Steps. The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of asphalt paint, when directed.

751-2.8 Precast Concrete structures. Precast concrete structures including but not limited to manholes, catch basins, and inlets shall conform to the requirements of ASTM C 478. Structures shall be designed in accordance with Appendix B of FAA Advisory Circular 150/5320-6F and shall be capable of supporting 25,000 pound wheel load with 250 psi tire pressure. Calculations shall be provided demonstrating supporting the wheel load at the center of the structure. Shop drawings and calculations shall be submitted to the Engineer with the signature and stamp of a registered professional engineer in the State of Vermont. Shop drawings shall include details of reinforcing, certification of load capacity, and state conformance with ASTM C 478.

751-2.9 Outlet Hoods. Outlet hoods shall be constructed from HDPE water tight flow control elbows manufactured by ADS or Round Snouts as manufactured by Best Management Products Inc. or approved equal.

751-2.10 Butyl Resin Sealant. The tongue and groove of precast concrete structures shall be formed so as to receive a butyl resin sealant, Conseal CS-102 or CS-202 as manufactured by Concrete Sealants, Inc., or approved equal. Butyl resin sealant shall conform to Federal Specification SS-S-210A and AASHTO M-198B.

751-2.11 Pipe Connectors. Entry pipe connectors for precast structures shall be A-Lok, Kor-N-Seal, or approved equal manufactured in accordance with ASTM C 923.

CONSTRUCTION METHODS

751-3.1 Unclassified excavation.

a. The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown on the plans, or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the RPR may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the RPR. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

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

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

e. After excavation is completed for each structure, the Contractor shall notify the RPR. No concrete or reinforcing steel shall be placed until the RPR has approved the depth of the excavation and the character of the foundation material.

751-3.2 Brick structures.

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

b. Laying brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it that can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and re-laid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

c. Joints. All joints shall be filled with mortar at every course Exterior faces shall be laid up in advance of backing. Exterior faces shall be plastered or parged with a coat of mortar not less than 3/8 inch (9 mm) thick before the backing is laid up. Prior to parging, all joints on the back of face courses shall be cut flush. Unless otherwise noted, joints shall be not less than 1/4 inch (6 mm) nor more than 1/2 inch (12 mm) wide and the selected joint width shall be maintained uniform throughout the work.

d. Pointing. Face joints shall be neatly struck, using the weather-struck joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

e. Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing with water. If necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of water.

f. Curing and cold weather protection. The brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost on the brick or when the air temperature is below 50°F (10°C) unless the Contractor has, on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60°F (16°C) for the duration of the curing period.

751-3.3 Concrete structures. Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the RPR before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

751-3.4 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall: (1) be smoothed to a uniform surface on both interior and exterior of the structure or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as

required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal or metal encapsulated steps that are embedded or built into the side walls shall be aligned and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 Corrugated metal structures. Corrugated metal structures shall be prefabricated. All standard or special fittings shall be furnished to provide pipe connections or branches with the correct dimensions and of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to allow the fastening of a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, the structures shall be placed on a reinforced concrete base.

751-3.6 Inlet and outlet pipes. Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

751-3.7 Placement and treatment of castings, frames, and fittings. All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the RPR, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the RPR. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

751-3.8 Installation of steps. The steps shall be installed as indicated on the plans or as directed by the RPR. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least seven (7) days. After seven (7) days, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete structures they shall meet the requirements of ASTM C478. The steps shall be cast into the side of the sections at the time the sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches (300 mm).

Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the RPR.

751-3.9 Backfilling.

a. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density

required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

b. Backfill shall not be placed against any structure until approved by the RPR. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

c. Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

751-3.10 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the RPR. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

751-3.11 Outlet Hoods. Outlet hoods shall be installed on all catch basin outlet pipes as shown on the contract drawings and in accordance with the manufacturer's requirements.

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; for all preparation, excavation, shoring, dewatering, bedding, fabric, precast components, pipe/manhole connectors, brick, mortar, concrete, rubber gaskets, butyl sealant, frames/covers, backfilling; design, shop drawings and certifications; 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:

900.620	(FAA D-751 4-FT DIAMETER CATCH BASIN)	per Each
900.620	(FAA D-751 4-FT DIAMETER DRAIN MANHOLE)	per Each
900.620	(FAA D-751 6-FT DIAMETER CATCH BASIN)	per Each
900.620	(FAA D-751 6-FT DIAMETER DRAIN MANHOLE)	per Each

REFERENCES

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

ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C32	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M36	Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

END OF ITEM D-751

Item L-108 Underground Power Cable for Airports

DESCRIPTION

108-1.1 This item shall consist of furnishing and installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the RPR. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities.

EQUIPMENT AND MATERIALS

108-2.1 General.

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

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

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

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

e. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format. The RPR reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner. The Contractor shall maintain a minimum insulation resistance in accordance with paragraph 108-3.10e with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period when tested in

accordance with AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

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

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Commercial Item Description A-A-59544A and shall be type THWN-2, 75°C for installation in conduit. Conductors for parallel (voltage) circuits shall be type and size and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, 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 grounding bond wire per ASTM B3 and ASTM B8, and shall be bare copper wire. For voltage powered circuits, the equipment grounding conductor shall comply with NEC Article 250.

Ground rods shall be copper-clad steel. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 10 feet long and 3/4 inch in diameter.

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

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

b. The field-attached plug-in splice. Field attached plug-in splices shall be installed as shown on the plans. The Contractor shall determine the outside diameter of the cable to be spliced and furnish appropriately sized connector kits and/or adapters. Tape or heat shrink tubing with integral sealant shall

be in accordance with the manufacturer's requirements. Primary Connector Kits manufactured by Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.

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

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

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

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

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

108-2.6 Cable identification tags. Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

108-2.7 Tape. Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

108-2.8 Electrical coating. Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

108-2.9 Existing circuits. Whenever the scope of work requires connection to an existing circuit, the existing circuit's insulation resistance shall be tested, in the presence of the RPR. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the RPR. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the RPR. The Contractor shall record the results on forms acceptable to the RPR. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the existing circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

108-2.11 Detectable warning tape. Plastic, detectable, American Public Works Association (APWA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables shall be orange. Detectable warning tape color code shall comply with the APWA Uniform Color Code.

CONSTRUCTION METHODS

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

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

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

Provide not less than 3 feet 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 vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the RPR.

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

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

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

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

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once

cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the RPR of any blockage in the existing ducts.

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

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

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

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

108-3.3 Splicing. Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

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

b. Field-attached plug-in splices. These shall be assembled per the manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches on each side of the joint or (3) On connector kits equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

c. Factory-molded plug-in splices. These shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) Wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches on each side of the joint. (2) Covered with heat shrinkable tubing

with integral sealant extending at least 1-1/2 inches on each side of the joint. or (3) On connector kits so equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

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

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch 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 on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. The manufacturer's recommendation for stretching tape during splicing shall be followed. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch 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.

e. Assembly. Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer's recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch 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.

108-3.4 Bare counterpoise wire installation for lightning protection and grounding. If shown on the plans or included in the job specifications, bare solid #6 AWG copper counterpoise wire shall be installed for lightning protection of the underground cables. The RPR shall select one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

a. Equipotential. Equipotential may be used by the RPR for areas that have high rates of lightning strikes. The counterpoise size is determined by the RPR. The equipotential method is applicable to all airfield lighting systems; i.e. runway, taxiway, apron – touchdown zone, centerline, edge, threshold and approach lighting systems. The equipotential method is also successfully applied to provide lightning protection for power, signal and communication systems. The light bases, counterpoise, etc – all components - are bonded together and bonded to the vault power system ground loop/electrode.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. The counterpoise is centered over the cable/conduit/duct to be protected.

The counterpoise conductor shall be installed no less than 8 inches minimum or 12 inches maximum above the raceway or cable to be protected, except as permitted below:

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

(2) The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90 degree angle).

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

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

All components rise and fall at the same potential; with no potential difference, no damaging arcing and no damaging current flow.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Equipotential Method of lightning protection.

Reference FAA STD-019E, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.

b. Isolation. Isolation used in areas where lightning strikes are not common. Counterpoise size is selected by the RPR. The isolation method is an alternate method for use only with edge lights installed in turf and stabilized soils and raceways installed parallel to and adjacent to the edge of the pavement. NFPA 780 uses 15 feet to define "adjacent to".

The counterpoise conductor shall be installed halfway between the pavement edge and the light base, mounting stake, raceway, or cable being protected.

The counterpoise conductor shall be installed 8 inches minimum below grade. The counterpoise is not connected to the light base or mounting stake. An additional grounding electrode is required at each light base or mounting stake. The grounding electrode is bonded to the light base or mounting stake with a 6 AWG solid copper conductor.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Isolation Method of lightning protection.

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

Grounding electrodes may be rods, ground dissipation plates, radials, or other electrodes listed in the NFPA 70 (NEC) or NFPA 780.

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

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to

the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

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

d. Parallel Voltage Systems. Provide grounding and bonding in accordance with NFPA 70, National Electrical Code.

108-3.5 Counterpoise installation above multiple conduits and duct banks. Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete area of protection measured 45 degrees each side of vertical.

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

108-3.6 Counterpoise installation at existing duct banks. When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

108-3.7 Exothermic bonding. Bonding of counterpoise wire shall be by the exothermic welding process or equivalent method accepted by the RPR. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

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

a. All slag shall be removed from welds.

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

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

108-3.8 Testing. The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the RPR. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the RPR. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

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

b. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance

ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The RPR shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

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

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

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

e. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than50 megohms. Verify continuity of all series airfield lighting circuits prior to energization.

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

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

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

i. That the impedance to ground of each ground rod does not exceed25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the RPR prior to performing the testing.

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

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

108-3.9 Cable Removal. The Contractor shall remove existing obsolete cabling as shown on the Contract Drawings.

METHOD OF MEASUREMENT

108-4.1 Cable or counterpoise wire installed in trench, duct bank or conduit shall be measured by the number of linear feet installed and grounding connectors, and trench marking tape ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable or counterpoise wire installed in trench, duct bank or conduit. The measurement for this item shall not include additional quantities required for slack.

108-4.2 No separate payment will be made for ground rods, they shall be considered incidental to the counterpoise or light base installation.

108-4.3 The quantity of cables removed from existing electrical ducts shall be measured by the linear foot along the length of each duct from which they are removed. Multiple cables in a duct shall be measured by the length of the duct, shall be removed in a single pull and shall be measured once for all cables

contained in the length of the duct. Cables removed from a duct shall not be measured individually. Any other removals required shall be considered incidental to the bid items provided.

BASIS OF PAYMENT

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

108-5.2 Payment for Cable Removal will be made at the contract until price per linear foot as accepted by the Engineer. This price shall be full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work. It shall also include the installation of a new pull wire.

Payment will be made under:

900.640	(FAA L-108 NO. 8 AWG, 5 KV, L-824, TYPE C CABLE, INSTALLED IN DUCT BANK OR CONDUIT)	
	Per Linear Foot	
900.640	(FAA L-108 NO. 6 AWG, SOLID, BARE COPPER COUNTERPOISE WIRE, INSTALLED IN TRENCH, INCLUDING CONNECTIONS/TERMINATIONS)	
	Per Linear Foot	
900.640	(FAA L-108 NO. 4/0 AWG, 600V CABLE, INSTALLED IN DUCT BANK OR CONDUIT)	
	Per Linear Foot	
900.640	(FAA L-108 NO. 2 AWG, 600V, INSULATED EQUIPMENT GROUND, INSTALLED IN DUCT BANK OR CONDUIT)	
	Per Linear Foot	
900.640	(FAA L-108 REMOVE CABLE)	Per Linear Foot

REFERENCES

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

Advisory Circulars (AC)

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description

A-A-59544A	Cable and Wire, Electrical (Power, Fixed Installation)
A-A-55809	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

ASTM International (ASTM)

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

Mil Spec

MIL-PRF-23586F	Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure Sensitive

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-780	Standard for the Installation of Lightning Protection Systems

American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

Federal Aviation Administration Standard

FAA STD-019E	Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment

END OF ITEM L-108

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Item L-109 Airport Transformer Vault and Vault Equipment

DESCRIPTION

109-1.1 This item shall consist of furnishing and installing of all vault equipment, wiring, electrical buses, cable, conduit, potheads, and grounding systems in an existing vault building. This work shall also include the painting of equipment and conduit; the marking and labeling of equipment and the labeling or tagging of wires; the testing of the installation; and the furnishing of all incidentals necessary to place it in operating condition as a completed unit to the satisfaction of the RPR. This work also includes providing a new electrical service to the proposed fuel farm as shown on the Contract Drawings.

EQUIPMENT AND MATERIALS

109-2.1 General.

a. Airport lighting equipment and materials covered by advisory circulars (AC) shall be certified in AC 150/5345-53, Airport Lighting Equipment Certification Program (ALECP) and listed in the ALECP Addendum.

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

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

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

e. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be provided in electronic pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

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

CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-3.1 Electrical vault building. Not Used.

109-3.2 Concrete. Note Used.

109-3.3 Precast concrete structures. Not Used.

109-3.4 Reinforcing steel. Not Used.

109-3.5 Brick. Not Used.

109-3.6 Rigid steel conduit. Rigid steel conduit and fittings shall be per Underwriters Laboratories Standards 6 and 514B.

109-3.7 Plastic Conduit and fittings. Plastic Conduit and fittings shall conform to the requirements of UL-651 and UL-654 schedule 40 polyvinyl chloride (PVC) suitable for use above or below ground.

109-3.8 Lighting. Not Used.

109-3.9 Outlets. Not Used.

109-3.10 Switches. Not Used.

109-3.11 Paint. Not Used.

109-3.12 Ground bus. Ground bus shall be 1/8 × 3/4 inch (3 × 19 mm) minimum copper bus bar.

109-3.13 Square duct. Not Used.

109-3.14 Ground rods. Ground rods shall be in accordance with Item L-108.

109-3.15 Vault prefabricated metal housing. Not Used.

109-3.16 FAA-approved equipment. Certain items of airport lighting equipment installed in vaults are covered by individual ACs listed below:

AC 150/5345-3	Specification for L-821, Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.
AC 150/5345-49	Specification for L-854, Radio Control Equipment
AC 150/5345-56	Specification for L-890 Airport Lighting Control and Monitoring System (ALCMS)

109-3.17 Other electrical equipment. Distribution transformers, oil switches, cutouts, relays, terminal blocks, transfer relays, circuit breakers, and all other regularly used commercial items of electrical equipment not covered by FAA equipment specifications and ACs shall conform to the applicable rulings and standards of the Institute of Electrical and Electronic Engineers (IEEE) or the National Electrical Manufacturers Association (NEMA). When specified, test reports from a testing laboratory indicating that the equipment meets the specifications shall be supplied. In all cases, equipment shall be new and a first-grade product. This equipment shall be supplied in the quantities required for the specific project and shall incorporate the electrical and mechanical characteristics specified in the proposal and plans.

Equipment selected and installed by the Contractor shall maintain the interrupting current rating of the existing systems or specified rating whichever is greater.

109-3.18 Wire. Wire (in conduit) rated up to 5,000 volts shall be per AC 150/5345-7, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits. For ratings up to 600 volts, moisture and heat resistant thermoplastic wire conforming to Commercial Item Description A-A-59544A Type THWN-2 shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

a. Control circuits. Unless otherwise indicated on the plans, wire shall be not less than No. 12 American wire gauge (AWG) and shall be insulated for 600 volts. If telephone control cable is specified, No. 19 AWG telephone cable per ANSI/Insulated Cable Engineers Association (ICEA) S-85-625 specifications shall be used.

b. Power circuits.

(1) 600 volts maximum – Wire shall be No. 6 AWG or larger and insulated for at least 600 volts.

(2) 3,000 volts maximum – Wire shall be No. 6 AWG or larger and insulated for at least 3,000 volts.

(3) Over 3,000 volts-Wire shall be No. 6 AWG or larger and insulated for at least the circuit voltage.

109-3.19 Short circuit / coordination / device evaluation / arc flash analysis. Not Used.

109-3.20 Fuel Farm Service. The Contractor shall provide a new 100A single phase electrical service for the proposed fuel farm. Power shall originate in the old lighting vault structure. Provide new circuit breaker and infrastructure to support the service as shown on the Contract Drawings.

The contractor shall install a new stand alone panelboard at the site of the new fuel farm. Panelboard shall be installed on support structure as shown on Contract Drawings. Coordinate exact location of panelboard with fuel farm contractor.

109-3.21 Temporary Generator. The contractor shall provide a temporary generator to support the new fuel farm once operational. The permanent electrical service is not scheduled to be operational until phase 4. It is expected that the generator will be operational during normal business hours. Contractor shall assume responsibility for all fuel and maintenance costs for the duration of installation. See phasing plans to calculate duration of requirement.

CONSTRUCTION METHODS

CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-4.1 General. Not used.

109-4.2 Foundation and walls. Not Used.

109-4.3 Roof. Not Used.

109-4.4 Floor. Not Used.

109-4.5 Floor drain. Not Used.

109-4.6 Conduits in floor and foundation. Not Used

109-4.7 Doors. Not Used.

109-4.8 Painting. Not Used.

109-4.9 Lights and switches. Not Used.

INSTALLATION OF EQUIPMENT IN VAULT OR PREFABRICATED METAL HOUSING

109-5.1 General. The Contractor shall furnish, install, and connect all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to ensure a complete and operable electrical distribution center for the airport lighting system as specified herein and shown in the plans. When specified, an emergency power supply and transfer switch shall be provided and installed.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction. All electrical work shall comply with the NEC and local code agency having jurisdiction including the separation of under 600V work from 5,000V work."

109-5.2 Power supply equipment. Transformers, regulators, booster transformers, and other power supply equipment items shall be furnished and installed at the location shown in the plans or as directed by the RPR. The power supply equipment shall be set on steel "H" sections, "I" beams, channels, or concrete blocks to provide a minimum space of 1-1/2 inch (38 mm) between the equipment and the floor. The equipment shall be placed so as not to obstruct the oil-sampling plugs of the oil-filled units; and name-plates shall, so far as possible, not be obscured.

If specified in the plans and specifications, equipment for an alternate power source or an emergency power generator shall be furnished and installed. The alternate power supply installation shall include all equipment, accessories, an automatic changeover switch, and all necessary wiring and connections. The emergency power generator set shall be the size and type specified.

109-5.3 Switchgear and panels. Oil switches, fused cutouts, relays, transfer switches, panels, panel boards, and other similar items shall be furnished and installed at the location shown in the plans or as directed by the RPR. Wall or ceiling mounted items shall be attached to the wall or ceiling with galvanized bolts of not less than 3/8-inch (9 mm) diameter engaging metal expansion shields or anchors in masonry or concrete vaults.

109-5.4 Duct and conduit. The Contractor shall furnish and install square-type exposed metallic ducts with hinged covers for the control circuits in the vault. These shall be mounted along the walls behind all floor-mounted equipment and immediately below all wall-mounted equipment. The hinged covers shall be placed to open from the front side with the hinges at the front bottom.

Wall brackets for square ducts shall be installed at all joints 2 feet (60 cm) or more apart with intermediate brackets as specified. Conduit shall be used between square ducts and equipment or between different items of equipment when the equipment is designed for conduit connection. When the equipment is not designed for conduit connection, conductors shall enter the square-type control duct through insulating bushings in the duct or on the conduit risers.

109-5.5 Wiring and connections. The Contractor shall make all necessary electrical connections in the vault per the wiring diagrams furnished and as directed by the RPR. In wiring to the terminal blocks, the Contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

109-5.6 Marking and labeling. All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

a. Wire identification. The Contractor shall furnish and install self-sticking wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks. Wire labels, if used, shall be of the self-sticking preprinted type and of the manufacturer's

recommended size for the wire involved. Identification -markings designated in the plans shall be followed. Tags, if used, shall be of fiber not less than 3/4 inch (19 mm) in diameter and not less than 1/32 inch (1 mm) thick. Identification markings designated in the plans shall be stamped on tags by means of small tool dies. Each tag shall be securely tied to the proper wire by a nonmetallic cord.

b. Labels. The Contractor shall stencil identifying labels on the cases of regulators, breakers, and distribution and control relay cases with white oil paint as designated by the RPR. The letters and numerals shall be not less than one inch (25 mm) in height and shall be of proportionate width. The Contractor shall also mark the correct circuit designations per the wiring diagram on the terminal marking strips, which are a part of each terminal block.

METHOD OF MEASUREMENT

109-6.1 Not used.

109-6.2 Not used.

109-6.3 The quantity of equipment to be paid for under 'Work in Lighting Vault' shall consist of all equipment installed, connected and accepted as a complete unit ready for operation within an existing vault or prefabricated metal housing.

109-6.4 The Contractor shall be compensated for 'Fuel Farm Service' on a lump sum basis. Measurement shall include furnishing and installing panelboard, enclosure, channel support, lightning protection, obstruction light, grounding, ground rod, foundation, excavation, backfill, crushed stone, frangible couplings, cable and conduit to the nearest handhole and all incidentals required to complete the installation as shown on the Contract Drawings.

Measurement shall also include all work within the old lighting vault to provide the fuel farm electrical service. This includes but not limited to circuit breakers, cable, conduit, cored holes, conduit supports, and expansion couplings and cable/conduit to the nearest handhole.

Measurement shall also include cost of temporary generator to support new fuel farm operation until phase 4 is complete. Work to include furnishing and installing generator as well as all fueling and maintenance costs associated with keeping the unit operational for the required duration.

BASIS OF PAYMENT

109-7.1 Payment will be made at the contract unit price for each completed and accepted vault or prefabricated metal housing equipment installation. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

109-7.2 Payment will be made at the contract lump sum price for each completed and accepted Fuel Farm installation. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

900.645	(FAA L-109 WORK IN LIGHTING VAULT)	Per Lump Sum
900.645	(FAA L-109 FUEL FARM SERVICE)	Per Lump Sum

REFERENCES

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

Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-3	Specification for L-821, Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13	Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
AC 150/5345-49	Specification L-854, Radio Control Equipment;
AC 150/5345-53	Airport Lighting Equipment Certification Program

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/ICEA S-85-625	Standard for Telecommunications Cable Aircore, Polyolefin Insulated, Copper Conductor Technical Requirements

ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C62	Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C90	Standard Specification for Loadbearing Concrete Masonry Units
ASTM D2823	Standard Specification for Asphalt Roof Coatings, Asbestos Containing
ASTM D4479	Standard Specification for Asphalt Roof Coatings – Asbestos-Free

Commercial Item Description (CID)

A-A 59544	Cable and Wire, Electrical (Power, Fixed Installation) Institute of Electrical and Electronic Engineers (IEEE)
IEEE 1584	Guide for Performing Arc-Flash Hazard Calculations

Master Painter's Institute (MPI)

MPI Reference #9	Alkyd, Exterior, Gloss (MPI Gloss Level 6)

Underwriters Laboratories (UL)

UL Standard 6	Electrical Rigid Metal Conduit – Steel
UL Standard 514B	Conduit, Tubing, and Cable Fittings
UL Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-70E	Standard for Electrical Safety in the Workplace
NFPA-780	Standard for the Installation of Lightning Protection Systems

END OF ITEM L-109

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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. 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 RPR.

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

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

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

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

110-2.2 Steel conduit. 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 mils 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. In lieu of PVC coated RGS, corrosion wrap tape shall be permitted to be used where RGS is in contact with direct earth."

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

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

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

a. Type I–Schedule 40 and Schedule 80 PVC suitable for underground use either direct-buried or encased in concrete.

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

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

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

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

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

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

110-2.6 Concrete. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

110-2.7 Precast concrete structures. Not used.

110-2.8 Flowable backfill. Not used.

110-2.9 Detectable warning tape. Plastic, detectable, American Public Works Association (APWA) red (electrical power lines, cables, conduit and lighting cable), orange (telephone/fiber optic cabling) with continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches wide. Detectable tape is incidental to the respective bid item.

CONSTRUCTION METHODS

110-3.1 General. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The RPR shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches 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 per 100 feet. On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. Under pavement, the top of the duct bank shall not be less than 18 inches below the subgrade; in other locations, the top of the duct bank or underground conduit shall be be not less than 18 inches below finished grade.

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

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

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200-pound 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.

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

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

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

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching

equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill may alternatively be used

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

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

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

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

All excavation shall be unclassified and shall be considered incidental to Item L-110. Dewatering necessary for duct installation, and erosion per federal, state, and local requirements is incidental to Item L-110.

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

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

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

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

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

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

110-3.2 Duct banks. Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches 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 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 beyond the edges of the pavement or 3 feet beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches thick prior to its initial set. 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 thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches 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 intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the RPR for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot 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 wide tape, 8 inches minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch wide tape only for single conduit runs. Utilize the 6-inch wide tape for multiple conduits and duct banks. For duct banks equal to or greater than 24 inches in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

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

110-3.3 Conduits without concrete encasement. Trenches for single-conduit lines shall be not less than 6 inches nor more than 12 inches 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 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 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 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 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 apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches 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 apart (measured from outside wall to outside wall) in a horizontal direction and lot less than 6 inches 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 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 intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the RPR for review prior to use.

110-3.4 Markers. The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet square and 4 - 6 inches thick extending approximately one inch 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 along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

The Contractor shall impress the word “DUCT” or “CONDUIT” on each marker slab. Impression of letters shall be done in a manner, approved by the RPR, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the RPR. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the RPR. The letters shall be 4 inches high and 3 inches wide with width of stroke 1/2 inch and 1/4 inch 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 of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 except that material used for back fill shall be select material not larger than 4 inches in diameter.

Flowable backfill may alternatively be used.

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

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

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

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

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

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

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

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

110-3.8 Removal of conduit. The contractor shall remove existing obsolete conduit as shown on the contract drawings.

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, trenching and backfill with designated material, and restoration, and for drain lines, the termination at the drainage structure, all measured in place, completed, and accepted. Separate measurement shall be made for the various types and sizes.

110-4.2 The quantity of conduits removed shall be measured by the linear foot. Separate measurement shall not be made for the various types and sizes.

BASIS OF PAYMENT

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

110-5.2 Payment for conduit removal will be made at the contract unit price per linear foot as accepted by the Engineer. This price shall be full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the work.

Payment will be made under:

900.640	(FAA L-110 NON-ENCASED ELECTRICAL CONDUIT, 1-WAY 2-INCH, PVC SCHEDULE 40)	Per Linear Foot
900.640	(FAA L-110 CONCRETE ENCASED ELECTRICAL CONDUIT, 1-WAY 2-INCH, PVC SCHEDULE 40)	Per Linear Foot
900.640	(FAA L-110 CONCRETE ENCASED ELECTRICAL DUCT BANK, 4-WAY 3-INCH, PVC SCHEDULE 40)	Per Linear Foot
900.640	(FAA L-110 REMOVE CONDUIT)	Per Linear Foot
900.640	(FAA L-110 GALVANIZED RIGID STEEL CONDUIT, 2-WAY 3-INCH) Per Linear Foot	

REFERENCES

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

Advisory Circular (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program

ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)

Underwriters Laboratories (UL)

UL Standard 6	Electrical Rigid Metal Conduit - Steel
UL Standard 514B	Conduit, Tubing, and Cable Fittings
UL Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL Standard 1242	Electrical Intermediate Metal Conduit Steel
UL Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit

END OF ITEM L-110

Item L-115 Electrical Manholes and Junction Structures

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 RPR. 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 RPR.

EQUIPMENT AND MATERIALS

115-2.1 General.

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

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

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

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications**.** The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

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

115-2.2 Concrete structures. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. Cast-in-place concrete structures shall be as shown on the plans.

115-2.3 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to withstand H20 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 on the plans.

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

115-2.4 Mortar. The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

115-2.5 Concrete. All concrete used in structures shall conform to the requirements of Item P-610, Concrete for Miscellaneous Structures.

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 an aircraft loading.

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).

115-2.8 Ladders. Not used.

115-2.9 Reinforcing steel. All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

115-2.10 Bedding/special backfill. Bedding or special backfill shall be as shown on the plans.

115-2.11 Flowable backfill. Not used.

115-2.12 Cable trays. Not used.

115-2.13 Plastic conduit. Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

115-2.14 Conduit terminators. Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

115-2.15 Pulling-in irons. Pulling-in irons shall be manufactured with 7/8-inch diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch diameter with an ultimate strength of 270,000 psi). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

115-2.16 Ground rods. Ground rods shall be one piece, copper clad steel**.** The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet long nor less than 5/8 inch in diameter.

CONSTRUCTION METHODS

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

The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item L-115. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item L-115.

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

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

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

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

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

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

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

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

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

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

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

115-3.5 Installation of ladders. Not used.

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 of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

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

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

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

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

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

115-3.9 Grounding. A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches above the floor. The ground rod shall be installed within one foot 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 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.

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

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

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

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

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

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

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

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

METHOD OF MEASUREMENT

115-4.1 Electrical manholes, handholes, and junction structures shall be measured by each unit completed in place and accepted. The following items shall be included in the price of each unit: All required excavation and dewatering; sheeting and bracing; all required backfilling with on-site materials; restoration of all surfaces and finished grading and turfing; all required connections; temporary cables and connections; and ground rod testing

115-4.2 Manhole elevation adjustments. Not Used.

115-4.3 Remove Electrical Handhole. Removal of structure shall be measured for payment by the quantity of units removed completely, and accepted. Measurement includes excavation disposal of structure, backfill and topsoil, seeding.

BASIS OF PAYMENT

115-5.1 The accepted quantity of electrical manholes, handholes, 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 The accepted quantity of electrical handholes removed 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 for all labor, equipment, tools and incidentals necessary to complete the work.

Payment will be made under:

900.620	(FAA L-115 REMOVE ELECTRICAL HANDHOLE)	Per Each
900.620	(FAA L-115 NEW AIRCRAFT RATED ELECTRICAL HANDHOLE (4'X4')) Per Each	

REFERENCES

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

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

Advisory Circular (AC)

AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5340-30	Design and Installation Details for Airport Visual Aids

AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description (CID)

A-A 59544	Cable and Wire, Electrical (Power, Fixed Installation)

ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C206	Standard Specification for Finishing Hydrated Lime

FAA Engineering Brief (EB)

EB #83	In Pavement Light Fixture Bolts

Mil Spec

MIL-P-21035	Paint High Zinc Dust Content, Galvanizing Repair

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)

END OF ITEM L-115

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Item L-125 Installation of Airport Lighting Systems

DESCRIPTION

125-1.1 This item shall consist of airport lighting systems furnished and installed in accordance with this specification, the referenced specifications, and the applicable advisory circulars (ACs). The systems shall be installed at the locations and in accordance with the dimensions, design, and details shown in the plans. This item shall include the furnishing of all equipment, materials, services, and incidentals necessary to place the systems in operation as completed units to the satisfaction of the RPR.

EQUIPMENT AND MATERIALS

125-2.1 General.

a. Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified under the Airport Lighting Equipment Certification Program in accordance with AC 150/5345-53, current version. FAA certified airfield lighting shall be compatible with each other to perform in compliance with FAA criteria and the intended operation. If the Contractor provides equipment that does not performs as intended because of incompatibility with the system, the Contractor assumes all costs to correct the system for to operate properly.

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

c. All materials and equipment used shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Clearly mark each copy to identify pertinent products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be clearly made with arrows or circles (highlighting is not acceptable). The Contractor shall be responsible for delays in the project accruing directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be submitted in electronic PDF format**.** The RPR reserves the right to reject any or all equipment, materials or procedures, which, in the RPR's opinion, does not meet the system design and the standards and codes, specified herein.

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

125-2.2 Conduit/Duct. Conduit shall conform to Specification Item L-110 Airport Underground Electrical Duct Banks and Conduits.

125-2.3 Cable and Counterpoise. Cable and Counterpoise shall conform to Item L-108 Underground Power Cable for Airports.

125-2.4 Tape. Rubber and plastic electrical tapes shall be Scotch Electrical Tape Numbers 23 and 88 respectively, as manufactured by 3M Company or an approved equal.

125-2.5 Cable Connections. Cable Connections shall conform to Item L-108 Installation of Underground Cable for Airports.

125-2.6 Retroreflective Markers. Not required.

125-2.7 Runway and Taxiway Lights. Runway and taxiway lights shall conform to the requirements of AC 150/5345-46. New runway and taxiway edge lights shall be medium intensity type conforming to the requirements of FAA specification L-861. Lamps shall be 45W Quartz, 6.6 amps. Filters shall be blue as indicated on the Contract Drawings.

125-2.8 Runway and Taxiway Signs. Runway and Taxiway Guidance Signs should conform to the requirements of AC 150/5345-44.

Signs

Type	Size	Style	Class	Mode	Notes
Location	**2**	**2**	**1**	**1**	
Directional	**2**	**2**	**1**	**1**	
Mandatory Hold	**2**	**2**	**1**	**1**	

125-2.9 Runway End Identifier Light (REIL). Not required.

125-2.10 Precision Approach Path Indicator (PAPI). Not required.

125-2.11 Light Base and Transformer Housings. Light Base and Transformer Housings should conform to the requirements of AC 150/5345-42. Light bases shall be Type L-867, Class 1A , steel bases, Size B as indicated on the Drawings. Steel cover shall be 3/8" thickness if required.

125-2.12 Isolation Transformers. Isolation Transformers shall be Type L-830 , 6.6A/6.6A, size per manufacturers recommendation. Transformer shall conform to AC 150/5345-47.

INSTALLATION

125-3.1 Installation. The Contractor shall furnish, install, connect and test all equipment, accessories, conduit, cables, wires, buses, grounds and support items necessary to ensure a complete and operable airport lighting system as specified here and shown in the plans.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and state and local code agencies having jurisdiction.

The Contractor shall install the specified equipment in accordance with the applicable advisory circulars and the details shown on the plans.

No light fixtures shall be installed without the approval of the RDR.

125-3.2 Testing. All lights shall be fully tested by continuous operation for not less than 24 hours as a completed system prior to acceptance. The test shall include operating the constant current regulator in each step not less than 10 times at the beginning and end of the 24-hour test. The fixtures shall illuminate properly during each portion of the test.

125-3.3 Shipping and Storage. Equipment shall be shipped in suitable packing material to prevent damage during shipping. Store and maintain equipment and materials in areas protected from weather and physical damage. Any equipment and materials, in the opinion of the RPR, damaged during construction or storage shall be replaced by the Contractor at no additional cost to the owner. Painted or galvanized surfaces that are damaged shall be repaired in accordance with the manufacturer's recommendations.

125-3.4 Elevated Lights. Water, debris, and other foreign substances shall be removed prior to installing fixture base and light.

A jig or holding device shall be used when installing each light fixture to ensure positioning to the proper elevation, alignment, level control, and azimuth control. Light fixtures shall be oriented with the light beams parallel to the runway or taxiway centerline and facing in the required direction. The outermost edge of fixture shall be level with the surrounding pavement. Surplus sealant or flexible embedding material shall be removed. The holding device shall remain in place until sealant has reached its initial set.

Prior to mounting the light fixture on the base, an L-823 connector kit is installed on the primary power cable ends and the appropriate L-830 isolation transformer is installed. Install heat shrink kits on the connector joints in the primary circuit as shown on the Contract Drawings. Plug the light disconnecting plug into the transformer secondary receptacle. Wrap the secondary connector joint with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one -half lapped, extending at least 12 inches on each side of the joint. Typical fixture details are shown in the plans.

125.3.5 Removal of Existing Fixtures. The Contractor shall carefully remove all existing base mounted fixtures, signs, markers, and isolation transformers where indicated and turn over to the airport.

METHOD OF MEASUREMENT

125-4.1 Runway and taxiway lights will be measured by the number of each type installed as completed units in place, ready for operation, and accepted by the RPR. Guidance signs will be measured by the number of each type and size installed on new foundations as completed units, in place, ready for operation, and accepted by the RPR.

125-4.2 Removed elevated lights, guidance signs or retroreflective marker will be measured by the number of units removed, including the light fixture, base, concrete encasement, foundation, isolation transformer, L-823 connections and heat shrink, and incidentals as applicable and shown on the Contract Drawings and as accepted by the RPR.

BASIS OF PAYMENT

125-5.1 Payment will be made at the Contract unit price for each complete runway or taxiway light, guidance sign, or retroreflective marker installed by the Contractor and accepted by the RPR. This payment will be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item.

125-5.2 Payment will be made at the Contract unit price for each complete taxiway light, guidance sign, or retroreflective marker removed by the Contractor and accepted by the RPR. This payment will be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item.

Payment will be made under:

900.620	(FAA L-125 REMOVED ELEVATED TAXIWAY EDGE LIGHT)	Per Each
900.620	(FAA L-125 REMOVE ELEVATED STAKE MOUNTED RETROREFLECTIVE MARKER) Per Each	
900.620	(FAA L-125 NEW L861T ELEVATED TAXIWAY EDGE LIGHT)	Per Each
900.620	(FAA L-125 NEW L861 BI-DIRECTIONAL RUNWAY EDGE LIGHT)	Per Each
900.620	(FAA L-125 NEW L858 LIGHTED AIRFIELD GUIDANCE SIGN, 1 MODULE)	Per Each
900.620	(FAA L-125 NEW L858 LIGHTED AIRFIELD GUIDANCE SIGN, 2 MODULE)	Per Each
900.620	(FAA L-125 NEW L858 LIGHTED AIRFIELD GUIDANCE SIGN, 3 MODULE)	Per Each
900.620	(FAA L-125 REMOVE LIGHTED AIRFIELD GUIDANCE SIGN AND FOUNDATION) Per Each	

REFERENCES

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

Advisory Circulars (AC)

AC 150/5340-18	Standards for Airport Sign Systems
AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	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 150/5345-44	Specification for Runway and Taxiway Signs
AC 150/5345-46	Specification for Runway and Taxiway Light Fixtures
AC 150/5345-47	Specification for Series to Series Isolation Transformers for Airport Lighting Systems
AC 150/5345-51	Specification for Discharge-Type Flashing Light Equipment
AC 150/5345-53	Airport Lighting Equipment Certification Program

Engineering Brief (EB)

EB No. 67	Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures

END OF ITEM L-125

Item T-901 Seeding

DESCRIPTION

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

MATERIALS

901-2.1 Seed. The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

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

Seeds shall be applied as follows:

Refer to Turf Establishment Detail located in the Contract Plan Set for Application Rates.

Seeding shall be performed during the period between April 15th and September 15 inclusive, unless otherwise approved by the RPR.

901-2.2 Lime. Refer to Turf Establishment Detail located in the Contract Plan Set.

901-2.3 Fertilizer. Refer to Turf Establishment Detail located in the Contract Plan Set.

901-2.4 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the RPR before being placed.

CONSTRUCTION METHODS

901-3.1 Advance preparation and cleanup. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

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

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

901-3.2 Dry application method.

a. Liming. Lime shall be applied separately and prior to the application of any fertilizer or seed and only on seedbeds that have previously been prepared as described above. The lime shall then be worked into the top 3 inches (75 mm) of soil after which the seedbed shall again be properly graded and dressed to a smooth finish**.**

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

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

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

901-3.3 Wet application method.

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

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

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

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the

recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

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

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

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

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

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

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

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

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

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

901-3.4 Maintenance of seeded areas. The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the RPR. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the

satisfaction of the RPR. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded.

METHOD OF MEASUREMENT

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

BASIS OF PAYMENT

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

Payment will be made under:

900.675	(FAA T-901 SEEDING)	per Square Yard

REFERENCES

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

ASTM International (ASTM)

ASTM C602	Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC	JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-901

Item T-905 Topsoil

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 RPR.

MATERIALS

905-2.1 Topsoil. Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (75 µm) 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 RPR shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

CONSTRUCTION METHODS

905-3.1 General. Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the RPR 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 RPR, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade

soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

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

905-3.3 Obtaining topsoil. Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the RPR. 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 RPR. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the RPR. 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 topsoil 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 RPR. The Contractor shall notify the RPR 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 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. after spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the RPR. 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 shall be measured by the square yard in-place, accepted and completed

905-4.2 When existing topsoil is obtained from the project work areas, such as areas to be regraded, the stripping/removal shall be paid for under P-152 Unclassified Excavation. Subsequent final placement of this material will be paid for per square yard under T-905-1 Topsoiling. There shall be no measurement of stockpiling and rehandling of the material if it cannot be immediately placed in it's final position.

905-4.3 When topsoil must be obtained from off the site, it shall be measured by the square yard in-place, accepted and completed and paid for under T-905-1 Topsoiling.

BASIS OF PAYMENT

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

Payment will be made under:

900.675	(FAA T-905 TOPSOILING 4" DEPTH)	per Square Yard

REFERENCES

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

ASTM International (ASTM)

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

Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-905

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Item T-908 Mulching

DESCRIPTION

908-1.1 This item shall consist of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or designated by the RPR.

MATERIALS

908-2.1 Mulch material. Acceptable mulch shall be the materials listed below or any approved locally available material that is similar to those specified. Mulch shall be free from noxious weeds, mold, and other deleterious materials. Mulch materials, which contain matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, will not be acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or which is in such an advanced stage of decomposition as to smother or retard the planted grass, will not be acceptable.

a. Hay. Hay shall not be used.

b. Straw. Straw shall not be used.

c. Hay mulch containing seed. Hay mulch containing seed shall not be used.

d. Manufactured mulch. Cellulose-fiber or wood-pulp mulch shall be products commercially available for use in spray applications**.**

e. Asphalt binder. Asphalt binder material shall conform to the requirements of ASTM D977, Type SS-1 or RS-1.

908-2.2 Inspection. The RPR shall be notified of sources and quantities of mulch materials available and the Contractor shall furnish him with representative samples of the materials to be used 30 days before delivery to the project. These samples may be used as standards with the approval of the RPR and any materials brought on the site that do not meet these standards shall be rejected.

CONSTRUCTION METHODS

908-3.1 Mulching. Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied simultaneously to seeding. The spreading of mulch shall be performed by the hydraulic method.

Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the RPR.

908-3.2 Securing mulch. The mulch shall be held in place by light discing, a very thin covering of topsoil, pins, stakes, wire mesh, asphalt binder, or other adhesive material approved by the RPR. Where mulches have been secured by either of the asphalt binder methods, it will not be permissible to walk on the slopes after the binder has been applied. When an application of asphalt binder material is used to secure the mulch, the Contractor must take every precaution to guard against damaging or disfiguring structures or property on or adjacent to the areas worked and will be held responsible for any such damage resulting from the operation.

908-3.3 Care and repair.

a. The Contractor shall care for the mulched areas until final acceptance of the project. Care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the RPR, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

b. The Contractor shall be required to repair or replace any mulch that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the RPR, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the Contractor.

c. If the "asphalt spray" method is used, all mulched surfaces shall be sprayed with asphalt binder material so that the surface has a uniform appearance. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m), or as directed by the RPR, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it. Asphalt binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. An approved spray nozzle shall be used. The nozzle shall be operated at a distance of not less than 4 feet (1.2 m) from the surface of the mulch and uniform distribution of the asphalt material shall be required. A pump or an air compressor of adequate capacity shall be used to ensure uniform distribution of the asphalt material.

d. If the "asphalt mix" method is used, the mulch shall be applied by blowing, and the asphalt binder material shall be sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m) or as directed by the RPR, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it.

METHOD OF MEASUREMENT

908-4.1 Mulching shall not be measured for separate payment rather it shall be considered incidental to Seeding or Erosion Control as applicable.

BASIS OF PAYMENT

908-5.1 No payment will be made for mulching.

REFERENCES

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

ASTM International (ASTM)

ASTM D977 Standard Specification for Emulsified Asphalt

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-908

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Item F-001 Fuel System

GENERAL

001-1.1 Description

This specification covers the removal of the existing underground fuel system and design and construction of the new above ground fuel system. This item also includes all supporting components and incidentals necessary to complete the removals and new installation.

001-2.1 General

A. The Contractor is responsible for performing all work in accordance with applicable laws, ordinances, codes, and regulations including but not limited to *NFPA 407 Standard for Aircraft Fuel Servicing* and *NFPA 30 Flammable and Combustible Liquid Code*.

B. The Contractor is responsible for the design of the new fuel system and associated foundation, anchorages, bollards, and any miscellaneous structures related to the fuel farm. The design shall be stamped by the responsible licensed professional engineer from the state of Vermont.

C. For the removal of the existing fuel system and installation of the new fuel system, the Contractor is responsible for all coordination, permits, paperwork, documentation, fees and disposals.

D. The Contractor is responsible for all dewatering.

E. The existing fuel system shall be removed and disposed of off site by the Contractor as part of this Contract.

F. A total of 4 tanks are required as part of the fuel system. One tank for Jet A, one tank for Jet A waste, one tank for AvGas, and one tank for AvGas waste.

G. Reference the following Specification Sections for more details on the new fuel system, fuel tank, material requirements, testing/inspections, etc:

13051 – Fuel System General Requirements
13053 – Identification of Fuel Piping and Equipment
13061 – Fuel System Pipe, Connections, and Installation
13063 – Fuel System Coatings for Corrosion Protection
13065 – Fuel System Valves
13067 – Fuel System Accessories
13069 – Fuel System Pumps
13071 – Fuel System Filtration
13075 – Inspection, Testing, Flushing
13201 – Fuel Storage Tank Packages

001-2.2 Materials

All materials included in the work shall meet all applicable codes and standards that govern the work and meet standard industry practice.

When a material or assembly is specified by "brand name or approved equal" and the Contractor elects to furnish the specified "or equal," the Contractor shall be required to furnish the manufacturer's certificate of compliance. Such certificate of compliance shall clearly identify each item delivered and shall certify conformance to the specified performance, testing, quality or dimensional requirements and suitability of the material or assembly for the use intended in the contract work. The Engineer shall be the sole judge as to whether the proposed "or equal" is suitable for use in the work.

001-2.3 Existing Conditions

The location of the existing fuel system is depicted in the Contract Drawings. Reference Sheet 16 Existing Conditions Plan 1 and Sheet 22 Site Preparation Plan. The two (2) existing underground fuel tanks are approximately 12,000 gallons each.

001-2.4 Demolition/Removal

A. The Contract shall install the new fuel system prior to demolition/removal of the existing fuel system. The new fuel system must be fully operational and accepted by the RPR and Owner.

B. The Contractor shall notify the Airport at least 2-weeks prior to beginning demolition of the existing fuel system.

C. Prior to the start of the removal work, the Contractor shall empty the existing fuel from the entire fuel system. The Contractor shall remove and dispose of all residual fuel, sludge, and other contaminants off site. All work and hauling must be performed by licensed individuals and/or licensed companies.

D. The Contractor must perform all soil sampling and testing. Included in this item is the removal and legal disposal of up to 5 Cubic Yards (CY) of contaminated soil. If removal and disposal of more than 5 CY of contaminated soil is required, the excess shall be paid for under the contaminated soil pay item called out in Specification Section M-002 Contaminated Soil Removal and Replacement.

D. The Contractor must submit all test results, assessments, and reports to the Vermont Department of Conservation (VTDEC) and Owner.

E. The Contractor must submit all paperwork to the VTDEC to document the permanent removal of the underground fuel tank.

F. The Contractor shall submit chain of custody, manifests, and related documents that document the legal disposal of all items.

G. The Contractor is responsible for all excavation, shoring, dewatering, and incidentals required to complete the work.

H. The Contractor is responsible for backfilling. Backfill shall be as called for in the plans and work shall be performed as specified in P-152.

I. The Contractor shall remove the existing pipe, tanks, conduits, vents, gauges, wires, filters, leak detection, and electronics associated with the existing fuel system.

001-2.5 Construction

A. Installation of the new above ground fuel system and supporting items shall meet the requirements of all applicable codes and regulations.

B. Preparation and submission of all permits, paperwork, and fees shall be included.

C. The Contractor is responsible for all required inspections.

D. All work shall be conducted under the supervision of a certified tank installer.

001-2.6 Commissioning and Testing

A. At the completion of the work, the Contractor shall test all components in the presence of the Engineer and Owner.

B. The Contractor shall provide user manuals, Owner's guides, product documents, etc. for all equipment.

C. The Contractor shall provide 2-hours of training on the operation and maintenance of the new fuel system and leak detection.

METHOD OF MEASUREMENT

001-3.1 All work and costs involved for removal of the existing underground fuel system and associated items and incidentals shall be measured as lump sum. If removal and disposal of contaminated soils more than 5 CY is required, the excess quantity shall be paid for under the contaminated soil pay item called out in Specification Section M-002 Contaminated Soil Removal and Replacement.

001-3.2 All work and costs involved for the design and construction of the fuel farm foundations, concrete pad and associated select materials, items, and incidentals shall be measured as a lump sum.

001-3.3 All work and costs involved for the design, procurement, and installation of the fuel farm system components and associated items and incidentals shall be measured as a lump sum.

BASIS OF PAYMENT

001-4.1 Payment shall be made at the contract lump sum price. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the items.

Payment will be made under:

900.645	(FAA F-001 EXISTING FUEL SYSTEM REMOVAL)	per Lump Sum
900.645	(FAA F-001 NEW FUEL SYSTEM – CONCRETE PAD AND SELECT MATERIALS)	per Lump Sum
900.645	(FAA F-001 NEW FUEL SYSTEM – SYSTEM COMPONENTS)	per Lump Sum

END OF ITEM F-001

ITEM 13051 - FUEL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY:

A. Furnish all labor, equipment and material for the complete installation of the aircraft system indicated and specified.

B. Contractor shall obtain and pay for all permits and water meters required by this Contract.

C. Related Work Specified Elsewhere:

1. Identification of Fuel Piping and Equipment: SECTION 13053.
2. Fuel System Pipe, Connections, and Installation: SECTION 13061.
3. Fuel System Coatings for Corrosion Protection: SECTION 13063.
4. Fuel System Valves: SECTION 13065.
5. Fuel System Accessories: SECTION 13067.
6. Fuel System Pumps: SECTION 13069.
7. Fuel System Filtration: SECTION 13071.
8. Inspection, Testing and Flushing: SECTION 13075.
9. Fuel System Aboveground Storage Tank Packages: SECTION 13201.

1.02 REFERENCES:

A. Refer to the individual Sections for fuel systems.

1.03 SUBMITTALS:

A. Submit as specified in *Section 17.0 of the Supplemental Provision*

B. Submittals shall constitute a representation to Owner and Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers and similar data or he assumes full responsibility for doing so, and that he has coordinated each Submittal with the requirements of the Work and the Contract Documents. Contractor certifies that the Material and Equipment shown and marked on the Submittals are in compliance with the Contract Documents and can be installed, operated, and maintained in the allocated space.

C. Include, but not limited to, the following:

1. Piping Fabrication Drawings:
   a. Include in-plan view of all systems piping 2-1/2 inches and larger. Provide isometrics for piping systems or tubing 2 inches in diameter and smaller.
   b. Show the actual Equipment furnished, Equipment location by dimension, and connections.
   c. Dimension pipelines in plan view and locate in elevation. Indicate support locations.
   d. Submit before fabrication is begun.
2. Motors and Drives:
   a. List all motor nameplate data on drawings including full load amps, locked rotor amps, and service factor for the motor at the voltage specified.
   b. List operating brake hp of the Equipment furnished.
   c. Furnish dimensioned motor drawing.
   d. Provide drawings for shop or field fabricated guards.
3. Hangers and supports.
4. Pumps, including performance curve and specified accessories.
5. Filter separators.
6. Manual valves.

7. Control valves.
8. Check valves.
9. Meters.
10. Coating materials.
11. Aboveground Storage Tanks: Indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.
12. Fuel dispensers.
13. Pipe, fittings, and accessories.
14. Instruction books and maintenance manuals include, but not limited to, the following:
    a. Aboveground Storage Tanks.
    b. Pumps.
    c. Filter Separators.
    d. Control Valves.
    f. Manual-Operated Valves.
    g. Meters.
    h. Controlling Instruments.
    i. Pressure Gauges.
    j. Fuel Dispensers.
    k. Sump Separators.
    l. Pipe Supports.
    m. Fittings and Specials.
    n. Installation and Erection Details.
    o. Welding qualification and procedures.
15. Bind all instruction books and manuals complete in three-ring binders with hard durable covers clearly and permanently identified with Contract name and number.
16. Each manual shall include the Equipment purchase order.

1.04 QUALITY ASSURANCE:

A. All Equipment and Materials shall be the latest design, new, undeteriorated, and the first quality standard product of manufacturers regularly engaged in the production of such Equipment and Materials for a minimum of 5 years.

B. When two or more units of the same class of Equipment are required, they shall be products of a single manufacturer.

C. Unless otherwise specified, all items, materials, and components specified herein shall be suitable for use within an aviation jet fuel or aviation gasoline system, as applicable, with maximum operating condition of 275 psig, within a temperature range of -40ºF to 100ºF, and having a specific gravity of 0.81 or 0.67, respectively.

D. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

E. Contractor or any Subcontractor or Supplier shall not supply, furnish, or install any pipe flanges, fittings, bolts, or nuts of foreign manufacture. All pipe flanges, fittings, bolts, and nuts shall be manufactured in the United States of America, and Contractor shall warrant the U.S.A. origin of all such items. Pipe flanges and fittings shall bear a stamp attesting to their place of origin. Contractor shall provide written certification from the manufacturer as to the origin of all flanges, fittings, bolts, and nuts installed on the Project. If at any time Owner determines that any flanges, fittings, bolts, or nuts are not of U.S.A. origin, Owner shall be entitled to replace all flanges, and/or fittings, and/or bolts and/or nuts (as the case may be) without the need for individual testing for

conformance to technical specifications, or for proof of non-U.S.A. origin of the other items. Contractor shall be responsible for all labor, materials, and consequential costs connected with such replacement.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Receive, unload, check, and store in suitable facilities all Equipment and Materials.
B. Examine all Equipment and Materials for concealed damage and report any damage to Owner.
C. Be responsible for the safety and protection from loss or damage of all Equipment and Materials received until the Work is complete.
D. Pay all demurrage charges and claims for damage to vehicles resulting from the unloading operation.
E. Protect all Equipment and Materials during storage and prior to start-up which shall include the coverings of all openings, protection against rust and other damage, and other similar measures. Equipment may be stored outdoors only when approved. Contractor shall protect all coated pipe and fittings from ultraviolet deterioration.
F. Furnish all labor, Materials, and Equipment necessary to make a complete installation as indicated and specified.
G. Provide all necessary supports, brackets, or foundations for properly installing all Equipment or temporary piping.
H. Coordinate with the other trades before installation of Materials. Extra charges shall not be approved for interferences due to lack of coordination.
I. All Equipment shall be properly aligned, adjusted, and lubricated before final acceptance.
J. Spot paint all equipment where shop paint has been damaged or flaked off. Painting of all exposed piping and mechanical equipment is specified in SECTION 13063 unless otherwise specified.
K. Furnish all bolts, studs, nuts, and gaskets for makeup of all connections to the Equipment and replace all gaskets damaged during storage, inspection, cleaning, or placing into service.
L. Retighten all threaded and bolted connections after installation.
M. Contractor shall be responsible for all added expenses due to their choice of Equipment.
N. All Materials shall be installed at times necessary to avoid delays in construction.
O. Provide vents and drains at high and low points as required for satisfactory draining and venting of fuel systems. For abovegrade piping systems, high point vents shall consist of a threadolet or weldolet, 3/4-inch ball valve and plug or cap, unless otherwise indicated. Low point drains for aboveground piping systems shall be similar except ball valve shall be 1-inch, unless otherwise indicated.
P. All connections to valves 3 inches and larger shall be made with flanges unless indicated otherwise; all connections to Equipment shall be made with unions or flanges.
Q. Installation shall equal or exceed the minimum requirements of the applicable codes and these Specifications; however, where local codes and ordinances are more stringent, they shall govern.

3.02 FIELD TESTS:

A. Service and Test Engineers:

1. Furnish the services of experienced factory service engineers for at least the minimum time specified and additional time as required to perform and/or supervise the erection, start-up, testing and placing into successful operation all piping systems and equipment and to instruct Owner's personnel in the operation of equipment.
2. Travel and living expenses shall be paid by Contractor.
3. The services of the service engineer shall be provided upon request at the times required by Owner.
4. The service engineer shall be directly responsible to Owner and when requested shall make daily reports to Owner.
5. The service engineer's performance shall be satisfactory and acceptable to Owner. Unsatisfactory performance time shall not be considered as qualified service time.
6. The service engineer shall be replaced at the request of Owner.
7. Upon arriving or leaving the site, the manufacturer's service engineer shall report to Owner's Resident Project Representative.
8. The service and test engineers required to conduct start-up and tests of the systems and Equipment furnished shall be called to the Site only after the installation is complete and ready, and Owner has been notified at least 24 hours in advance.

B. Testing:

1. Perform all tests as specified, recommended by the manufacturer, and required by the codes. Additional tests deemed necessary by Owner shall be performed to ensure proper operation and function of the Equipment furnished, and to certify that the furnished Equipment meets the performance specified.
2. Perform tests before Work is concealed and only after notifying Owner that items are ready. All tests shall be witnessed by Owner.
3. Conduct tests in a safe and orderly manner with qualified trained personnel in accordance with safety codes and local ordinances.
4. Obtain all necessary approvals, acceptances, and permits.
5. Correct all deficiencies resulting from tests.
6. Equipment and System Performance, and Acceptance Tests:
   a. Contractor shall coordinate and schedule all performance and acceptance tests and ensure that all required factory service engineers and test personnel will be present. The required test equipment and instruments will be available and calibrated for the tests.
   b. Contractor shall conduct all performance and acceptance tests and provide all test labor.
   c. Furnish all instruments, thermometers, and gauges required for testing. If the accuracy or completeness of installed instrumentation is not sufficient, Contractor shall provide additional instrumentation.
   d. Provide all pipeline connections, valves, temporary connections, and lines as specified or as required for testing.
   e. Make all performance tests as soon as practical after successful operation to determine if the Equipment furnished meets the Specifications and guarantees.
   f. Notify Owner at least one week in advance before the test. Contractor shall submit a written notice containing the test schedule, test procedure, and the personnel to be present at the test.

g. Contractor shall prepare a typewritten report of the test and submit six copies of all test log sheets and reports to Owner as specified.
h. Contractor shall furnish electrical power, water, and operating personnel for start-up, operating, and performance testing.
i. In the event of failure of any Equipment or systems specified in this Contract to operate and perform as specified, or if the Equipment fails to meet the performance guarantees provided for in this Contract, Owner shall have the right to operate the system or Equipment until such defects have been remedied by Contractor, and the guarantees complied with. In the event that defects necessitate the rejection of the system or Equipment, Owner shall have the right to operate the Equipment without additional cost until such time as new Equipment is provided to replace the rejected Equipment. Replacement of the Equipment shall be coordinated and scheduled with Owner.

7. Tests and Checks of Piping Systems for Acceptance:
   a. Inspection, Testing, and Flushing shall be as specified in SECTION 13075.

END OF ITEM 13051

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ITEM 13053 - IDENTIFICATION OF FUEL PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the identification of fuel piping and equipment.

B. Related Work Specified Elsewhere:

1. Protective Coatings: SECTION 13063.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A13.1 - Scheme for the Identification of Piping Systems.

B. American Petroleum Institute:

1. Bulletin No. 1542 - Airport Equipment Marking for Fuel Identification.
2. Recommended Practice 1637 - Using the API Color-Symbol System to Mark Equipment and Vehicles for Product Identification at Service Stations and Distribution Terminals.

C. Federal Aviation Administration:

1. Advisory Circular 150/5230-4 - Aircraft Fuel Storage, Handling and Dispensing on Airports.

D. National Fire Protection Association (NFPA):

1. 704 - Identification of the Hazards of Materials.

1.03 SUBMITTALS:

A. Submittals:

1. Submit as specified in *Section 17.0 of the Supplemental Provisions.*
2. Include, but not limited to, the following:
   a. Proposed identification scheme including plans identifying proposed piping and equipment label locations.
   b. Catalog cuts.
   c. Sample(s) representative of labels specified.
   d. Color chips.

1.04 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Comply with listed Codes and Standards for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products from one of the following:

1. W. H. Brady Company.
2. Seton Name Plate Corporation.
3. Gammon Technical Products.

2.02 IDENTIFICATION OF PIPING:

A. Materials: Pressure-sensitive type labels or paint/stencil as specified herein.

B. Sizing of Pipe Markers, Arrows:

1. Conform to ANSI A13.1 as a minimum for legend letter size and length of color field based upon outside diameter of pipe or covering if applicable.
2. Size of arrows shall be coordinated with pipe marker and letter size and also be based upon outside diameter of pipe, or covering if applicable.

C. Color Coding:

1. Jet-A and AVGAS Systems
   a. Label in accordance with API Bulletin 1542 and FAA Advisory circular 150/5230-4. Label or stencil flow direction on piping.
   b. Provide pressure sensitive type labels, Gammon Technical Products GTP-2135-5 (JET-A) and GTP-2135-4 (AVGAS 100 LL) or equal.
2. Miscellaneous Piping Systems:
   a. Label in accordance with ANSI A13.1.
   b. Use paint/stencils and decals as required.

D. Placards shall be installed on all sump separator inlet lines indicating the filter vessel type and mark number or storage tank number from which the inlet line emanates. Placards shall also indicate the line fill in gallons between the filter separator or tank and the sump separator inlet valve.

2.03 IDENTIFICATION OF FUEL EQUIPMENT:

A. Materials: Protective Coatings as specified in SECTION 13063.

B. General: Stencil equipment designation with black paint on tanks, filters, meters, and pumps. Marking scheme and arrangement shall be submitted for approval by Engineer.

C. All fuel system valves shall be painted black.

D. Nomenclature: Follow equipment designations used on mechanical flow diagram, and arrangement drawings.

1. Filter change dates shall be stenciled on filtration vessels.

E. Sizes:

1. Pumps - minimum 2-inch high letters.
2. Filters, vessels - minimum 2-inch high letters.
3. Storage tank - minimum 12-inch high letters, 2 places each (on ends).
4. Provide hazard identification markers (diamonds) for all storage tanks (on both ends). Markers shall be in accordance with NFPA 704.

2.04 VALVE IDENTIFICATION MARKERS:

A. Provide identification for all piping and valves as described below. Permanently install in easily visible locations.

B. Valves: Provide identification for load/unload selector valves. Letters shall be stenciled paint of as large a size as practical.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean area of surface to receive label or other pressure-sensitive item free of oil, grease, dust, dirt, or other substances which would affect adhesion.

B. On painted surface, install label only after coating system is complete and dry.

3.02 LOCATIONS:

A. Piping Labels:
   1. Use proper label type suitable for interior or exterior location as applicable.
   2. Locate labels on piping near connections to equipment, adjacent to valves or fittings, and at intervals not to exceed 25 feet.
   3. For piping with arrows, indicate direction of flow. Place arrows adjacent to or below labels, depending upon visibility. For dual-flow piping, indicate both directions.
   4. Locate legends to be visible from normal line of vision above floor finish or grade level.
   5. Replace labels which do not adhere properly.

B. Equipment Identification:
   1. Identification should be visible from normal operating position, platform, and control room.
   2. Location of identification shall be approved by Owner.

END OF ITEM 13053

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ITEM 13061 - FUEL SYSTEM PIPE, CONNECTIONS, AND INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers aircraft fueling system piping, fittings, welded and screwed connections, qualification procedures, welding procedures, materials, radiographing requirements, and construction requirements.

B. Aboveground piping shall be of conventional single-wall construction with pipe and fittings as specified herein for "CARRIER PIPE."

C. Related Work Specified Elsewhere:
   1. Fuel System General Requirements: SECTION 13051.
   2. Fuel System Coatings for Corrosion Protection: SECTION 13063.
   3. Identification of Fuel Piping and Equipment: SECTION 13053.
   4. Fuel System Valves: SECTION 13065.
   5. Fuel System Aboveground Storage Tank Packages: SECTION 13201.
   6. Inspection, Testing, and Flushing: SECTION 13075.

D. All materials, items, and components specified herein shall be suitable for use within an aviation jet fuel or aviation gasoline system, as applicable, with a maximum operating condition of 275 psig at 100°F and a specific gravity of 0.81 or 0.67, respectively.

E. All end connections on piping and fittings to be welded shall be prepared for butt welding, without backing ring. Butt welding end preparation shall conform to ANSI B16.25.

F. Contractor or any Subcontractor or Supplier shall not supply, furnish, or install any pipe flanges, fittings, bolts, or nuts of foreign manufacture. All pipe flanges, fittings, bolts, and nuts shall be manufactured in the United States of America and Contractor shall warrant the U.S.A. origin of all such items. Pipe flanges and fittings shall bear a stamp attesting to their place of origin. Contractor shall provide written certification from the manufacturer as to the origin of all flanges, fittings, bolts, and nuts installed on the Project. If at any time Owner determines that any flanges, fittings, bolts, or nuts are not of U.S.A. origin, Owner shall be entitled to replace all flanges, and/or fittings, and/or bolts and/or nuts (as the case may be) without the need for individual testing for conformance to technical specifications, or for proof of non-U.S.A. origin of the other items. Contractor shall be responsible for all labor, materials, and consequential costs connected with such replacement.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   2. A105 - Carbon Steel Forgings for Piping Applications.
   3. A193 - Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   4. A194 - Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
   5. A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
   6. A269 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

B. American National Standards Institute (ANSI):
   1. B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.

2. B16.11 - Forged Steel Fittings, Socket-Welding and Threaded.
3. B16.25 - Buttwelding Ends.
4. B16.5 - Pipe Flanges and Flanged Fittings.
5. B31.3 - Chemical Plant and Petroleum Refinery Piping.

C. American Petroleum Institute (API):
1. Spec 5L - Line Pipe.

D. American Society of Mechanical Engineers (ASME):
1. B16.20 - Metallic Gaskets for pipe Flanges-Ring-Joint, Spiral-Wound, and Jacketed.

E. American Welding Society (AWS).

1.03 QUALITY ASSURANCE:

A. All pipe and piping materials shall be produced by a manufacturer acceptable to Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturer: Subject to compliance with requirements, provide products from one of the listed manufacturers.
1. Flange Gaskets:
a. Flexitallic.
b. Furon.
c. Klinger.
2. Pipe Supports:
a. Blaw-Knox.
b. Basic Engineering.
c. Fee and Mason.
d. Grinnell.
e. Piping Technology.
3. Instrument Tubing and Fittings:
a. Parker.
b. Swagelok.
c. Hoke.
d. B-Line.

2.02 FUEL CARRIER PIPING MATERIALS:

A. Pipe shall be ASTM A53 Grade B or API 5L Grade B, seamless or electric resistance welded. Stamp all pipe with specification and grade. Shop-wrapped pipe shall be stamped within 3 inches of end. Submerged arc welded pipe is not acceptable. Material certificates and mill test reports shall be provided. All pipe 2-inches and smaller and located downstream of the fuel supply filter and/or filter/separator shall be stainless steel.

B. Pipe 2 inches and smaller shall be Schedule 80, pipe 2-1/2 inches through 10 inches shall be Schedule 40. Socket-weld connections shall be used for 2 inches and smaller pipe except for connections to threaded valves, unions, and other equipment.

C. Pipe or fittings in the fuel piping systems shall not be galvanized.

D. Mill Cleaning and Coating of Pipe:
1. Pipe and fittings 2-1/2 inches and larger shall be internally epoxy lined at the mill as specified in SECTION 13063.
2. All pipe and fittings shall be externally coated as specified in SECTION 13063.

3. Clean inside and outside of pipe and fittings by sand or grit blasting or pickling to remove all mill scale.
4. Apply in the mill an approved rust preventive coating to the interior and exterior of pipe and fittings immediately after cleaning. Rust preventive shall be approved by Owner and applied as recommended by the manufacturer. Rust preventive coating may be deleted from the pipe interior if pipe is internally epoxy lined immediately after cleaning. Rust preventive coating may be deleted from the pipe exterior if the pipe is externally epoxy coated immediately after cleaning.
5. The ends of the pipe shall be capped at the factory using suitable galvanized metal or plastic caps, secured with a double wrap of 2-inch-wide pressure sensitive tape.

2.03 FITTINGS FOR WELDED CARRIER PIPE:

A. Butt welding type carbon steel, ASTM A234 Grade WPB, ANSI B16.9 for sizes 2-1/2 inches and larger. Wall thicknesses shall match pipe.
B. Socket welding 3,000-pound forged steel, ASTM A105, conforming to ANSI B16.9 and B16.11.
C. Elbows shall be long radius unless noted otherwise.
D. Changes in direction of pipe of other than 45° or 90° shall be made as follows:
   1. With long radius weldells cut to the proper angle and shop beveled.
   2. Or, at the option of Contractor, with long radius pipe bends. Pipe roundness shall be maintained to factory tolerance for straight pipe lengths. Submit Shop Drawings of all bends and bending procedures for approval by Engineer.
   3. Bends of 2° or less may be miter joints.
E. Welded Branch Connections:
   1. Welded branch connections shall be butt welding tees except as described herein and with Engineer's approval.
   2. Fabricated tees shall be weldolets, elbolets, or vessolets. Fittings and connections shall provide a smooth and accessible surface suitable for 100% nondestructive examination of all welds.
   3. Standard weldolets may be used for welded branch connections.
   4. Fabricated branch connections for piping 2 inches and smaller shall be sockolets, elbolets, or threadolets. Field-fabricated half couplings shall not be used.

2.04 FITTINGS FOR THREADED FUEL PIPE:

A. 3,000-pound forged steel conforming to ANSI B16.11.
B. Threads of threaded jointed piping shall be full, clean, sharp, and true.
C. Bushings shall not be used except as noted on the Drawings.

2.05 FLANGES AND GASKETS:

A. Flanges shall be standard weldneck type 150-pound forged steel, ASTM A105, and conforming to ANSI B16.5, except where 300-pound, 600-pound, or API flanges are required to correspond to the equipment to which the piping is joined. Inside diameter of flanges shall be bored to match the inside diameter of the mating piping.
B. Flange facings shall correspond to the equipment to which the piping is joined, and unless otherwise required, shall be standard 1/16-inch raised face flanges.
C. Flange gaskets shall be "Flexitallic Type CG" using 304 stainless-steel windings with flexible graphite "fire rated" filler, or approved equal, conforming to B16.20.
D. Gaskets shall be resistant to the effects of aviation hydro-carbon fuels and manufactured of fire-resistant materials.

E. Full face gaskets shall be used for flat face steel flanged joints.
F. Ring gaskets shall be used for steel flanged joints with raised face flanges.
G. Gaskets shall be 1/8-inch in thickness.

2.06 FLANGE BOLTS AND NUTS:

A. Machine bolts shall be heavy hexagonal alloy carbon steel conforming to ASTM A193 Grade B7.
B. Nuts shall be heavy hexagon alloy carbon steel conforming to ASTM A194, Grade 2H.
C. Stud bolts may be used as required for corresponding equipment.

2.07 PIPE SUPPORTS:

A. Support design and location shall be as indicated and as otherwise required by the piping/equipment layout chosen. Refer to SECTION 13051.
B. Provide complete assemblies adequately rated for the applied loads.
C. Install all required inserts and anchors prior to concrete placement.
D. Expansion bolts shall be Hilti or equal.
E. Spacing and arrangements shall conform to ANSI B31.1.
F. Contractor shall locate and provide supports for piping in accordance with specified Codes and Standards.
G. Contractors shall provide additional supports as required due to changes in the pipe routing or equipment supplied.
H. Reduce spacing one-quarter where changes in direction occur.
I. Pipes run parallel in the same plane may be supported on gang supports.
J. Install to prevent sag or vibration and to adequately support the piping without interfering with inherent flexibility.
K. Make adjustments after systems are placed in operation.
L. Explosion or powder driven fasteners shall not be used.

2.08 WELDING FILLER MATERIALS:

A. Welding filler material shall be provided in accordance with the applicable welding procedure specification.
B. Filler materials shall be compatible with the base metal and shall be specified and purchased by ASME or AWS classification and chemical composition.
C. Welding electrodes and filler materials shall be properly stored in suitable regulated temperature enclosures in accordance with manufacturer's recommendations. The use of wet or moist electrodes will not be permitted.

2.09 THREADED PIPE JOINT SEALING:

A. Either of the two materials specified below may be used for sealing of threaded pipe joints unless specified. All threaded joints shall be sealed.
B. Screwed Pipe Joint Tape: TFE tape applied to male threads. Tape width, number of wraps, and use of additional paste sealant shall be in accordance with tape manufacturer's recommendations.
C. Screwed Pipe Joint Compound: Use compound which is resistant to the effects of aviation hydrocarbon fuels and Underwriters' Laboratories approved for the application intended.

2.10 INSTRUMENT TUBING AND FITTINGS:

A. Tubing:
   1. Material shall be ASTM A269 Type TP316 annealed, seamless stainless steel.
   2. Wall thickness shall be as required by the fittings, but not less than .049-inch.

B. Fittings: Stainless-steel compression type tube fittings for flareless tubes. Fitting connections shall be of four-piece construction including nut, front and back (double) ferrules, and fitting body.

PART 3 - EXECUTION

3.01 HAULING AND STRINGING PIPE:

A. Perform the hauling and stringing of pipe and other materials in such a manner as to prevent damage to pipe and material. If damage is sustained, Contractor shall be responsible for repair or replacement cost.
B. Galvanized metal or plastic caps covering the ends of the pipe shall remain in place until the welding of the pipe. If any caps are not in place, re-secure to the pipe ends to prevent dirt, water, and other foreign material from entering.
D. Contractor shall promptly repair, at his own expense, all roads, fences, building, or other property damaged by him in the progress of the Work.

3.02 INSTALLATION OF ABOVEGROUND PIPE:

A. Install complete with valves, fittings, and accessories and make all necessary connections.
B. Provide offsets, fittings, and accessories required to eliminate interferences and to match actual equipment connection locations and arrangements.
C. All fabrication and installation shall conform to ANSI B31.3.
D. Verify all measurements, and location of existing facilities and underground piping, before commencing work. Submit discrepancies for clarification before proceeding with the installations.
E. Arrange all piping with proper slopes, true to line, without sags, traps, or pockets, and pitched to drain at the lowest points so that entire systems can be emptied.
F. Provide high point vents, pump outs, and low point drains as required or indicated on the Drawings.
G. Provide threaded unions where indicated and as required elsewhere to permit satisfactory disassembly of small bore piping for threaded valve and equipment maintenance.

3.03 HANDLING COATED PIPE:

A. Storage Racks:
    1. Storage rack material shall be 4 to 6 inches in bearing width and placed not less than 10 feet apart.
    2. Do not rack pipe 10 inches in diameter and larger more than two sections in height; and pipe 8 inches and under not more than 4 sections in height.
    3. Protect all racked pipe by use of suitable padded material between sections.
B. Handling Operation:
    1. Pipe shall not be rolled off the truck but shall be carefully lowered onto the skids by mechanical equipment.

3.04 PIPE CLEANING:

A. Clean each joint before welding into the system, to remove all loose debris.
B. Remove materials such as welding rods, dirt, and similar materials, left inside after completion of the lines. Expense incurred by Owner for removal of such objects shall be reimbursed by Contractor.

3.05 GAS-FREE CONDITIONS:

A. All operations in the construction area that involve open flames or the possibility of arcing or sparking shall be conducted in a "Gas-Free" condition.

B. These operations shall include but not be limited to the following:

1. Use of internal combustion engines not equipped with Underwriters' approved spark and flame eliminators.
2. Use of electric motors or electric devices with arcing brushes or sliding contacts that could produce arcing or sparking.
3. Use of tools which may produce impact sparks.
4. Electric or gas welding.
5. Use of cutting or other torches or other open-flame equipment.
6. Holiday testing.
7. Use of equipment with hot surfaces or glowing elements.
8. Use of any other equipment or procedure that could create a fire hazard.

C. Contractor shall monitor the use and suitability of the equipment and procedures on the job and maintain a safe "Gas-Free" condition when necessary during construction.

D. Prior to commencing any phase of the Work requiring a gas-free condition, Contractor shall make the following provisions:

1. Empty pipes containing fuel and purge of all vapors.
2. Isolate, blank off, and adequately ventilate open piping sections so that no part of the pipe containing fuel or vapors is exposed.
3. Drain and ventilate fuel tanks prior to work inside tanks or on any of the tank connections.
4. Make certain that there are no open pools or reservoirs of fuel exposed in the vicinity of the Work.
5. Perform all other safety precautions necessary to ensure that these operations are conducted in a safe manner in accordance with all applicable codes.

E. Use a combustible gas analyzer to make certain no combustible gas concentrations exist in the construction area when performing these operations.

3.06 PERMITS:

A. Provide special permits required for any work under the various sections of this Section of the Specifications and pay all permit fees.

3.07 WELDED JOINTS:

A. Process: Welding shall be accomplished by the use of the shielded metallic arc process and shall be in strict accordance with ANSI B31.3.

B. Procedure: Upon award of the Contract, submit for review the welding procedures and qualifications that are intended to be used on the job in accordance with SECTION 13051.

1. Owner reserves the right to request qualification tests to be performed at the jobsite for each welder and welding operator on the job, such tests being made in strict compliance with the above code.

C. Costs: Costs incident to these procedures and the welder's qualification tests shall be assumed by Contractor.

D. Inspectors: Shop welding and fabrication shall be subject to the right of Owner to maintain one or more inspectors in the shop or to visit the shop at any time this work is in progress.

E. Identification:
   1. Each welder shall identify his weld with specific code marking signifying his name and assigned number.
   2. Contractor shall maintain a code listing assigned to each welder.
   3. Stamp on the pipe using "low stress" steel stamp, or other approved method, not closer than 4 inches to a weld.
F. Butt Welding End Preparation on all pipe:
   1. Conform to ANSI B16.25.
   2. Shop and field bevels shall be machine cut; manual flame cutting (without machine guide) shall not be permitted.
G. All welds shall have full penetration and fusion and shall conform to ANSI B31.3.
H. Backing rings shall not be used.
I. Align pipe joints with pipe clamps prior to welding. Clamps or other alignment devices shall not reduce the internal pipe diameter.
J. Defective welds shall be repaired in accordance with ANSI B31.3 at Contractor's expense.
K. Repairs to defective welds shall not be made prior to authorization. Owner will determine on the basis of the testing laboratory report if repairs may be made or if the entire joint must be cut out and welded again.
L. No weld metal shall project within the piping at completion of the welding.

3.08 RADIOGRAPHING:
A. Contractor shall coordinate and arrange for radiography by an approved testing laboratory of a minimum of 10% of selected welded joints.
B. Testing laboratory shall be selected by and employed by Contractor subject to Owner's approval.
C. The radiographing shall be coordinated by Manufacturer and conducted at the Manufacturer`s facility.
D. Reports for both factory and field welds shall be submitted throughout the progress of the Work as described below.
E. All radiographing and subsequent reports shall be in accordance with the requirements of ANSI B31.3.
F. Each weld shall be assigned a number. Contractor shall maintain a marked up copy of piping drawings identifying the location and number of each radiographed weld. Upon completion of the Work, these drawings shall be submitted with as-constructed drawings.
G. Radiograph exposure records shall be kept by the testing laboratory which show date, location, area, film number, serial number, film combination, time, source-film distance, angulation, weld number and other pertinent information for each weld radiographed.
H. A summary of this record and an expert interpretation by the testing laboratory shall be submitted in report form for each weld to Owner, Engineer, and Contractor.
I. All joints shall be left exposed until radiographing and other testing is completed.
J. Welds which do not meet the standards of acceptability as outlined in the above mentioned ANSI B31.3, will be judged unacceptable and shall be repaired or cut out and rewelded by Contractor as directed by the testing laboratory, all at no additional cost to Owner. Repaired and rewelded joints will then be reradiographed.
K. Inspection stamps, code symbol stamps, and other required information shall be stamped on the pipe by using "low stress" steel stamps, or other approved method.

L. All the costs of the radiographing at each weld and the accompanying reports and interpretation shall be paid by Contractor and shall be included in the Contract Price. Contractor shall be responsible for coordination and scheduling of the work.

END OF ITEM 13061

ITEM 13063 - FUEL SYSTEM COATINGS FOR CORROSION PROTECTION

PART 1 – GENERAL

1.01 SUMMARY:

A. This Section covers the field and shop-applied corrosion protection coatings of exterior and interior surfaces for fuel system piping, pipe supports, valves, fittings, aboveground tanks, equipment, and structural steel.

B. Coating includes surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat and finish coats to be shop applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.

1. Where surface preparation and first (prime) coat are specified in other Sections to be shop applied such as for structural steel, or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat.
2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.
3. Where equipment or materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.
4. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop applied.

C. Related Work Specified Elsewhere:

1. Fuel System General Requirements: SECTION 13051.
2. Fuel System Pipe, Connections, and Installation: SECTION 13061.
3. Identification of Fuel Piping and Equipment: SECTION 13053.
4. Fuel System Valves: SECTION13065.
5. Fuel System Accessories: SECTION 13067.
6. Fuel System Pumps: SECTION 13069.
7. Fuel System Filtration: SECTION 13071.
8. Fuel System Aboveground Storage Tanks Packages: SECTION 13201.
9. Inspection, Testing, and Flushing: SECTION 13075.

D. See Specification SECTION 13061 for special safety requirements for a "gas-free" condition during certain operations in the construction area.

1.02 REFERENCES:

A. Society for Protective Coatings (SSPC):

1. SP 1 - Solvent Cleaning. Removes oil, grease, soil, and other substances. Used with other methods to remove rust, paint, and mill scale.
2. SP 3 - Power Tool Cleaning. Removes loose material. Not intended to remove all scale or rust.
3. SP 5 - White Metal Blast Cleaning. Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
4. SP 6 - Commercial Blast Cleaning. Two-thirds of every 9 square inches free of all visible residues; remainder only light discoloration.
5. SP 7 - Brush-Off Blast Cleaning. Removes only loose material, remaining surface tight and abraded to give anchor pattern.
6. SP 10 - Near-White Blast Cleaning. At least 95% of every 9 square inches shall be free of all visible residues.
7. SP 11 - Power Tool Cleaning to Bare Metal.

1.03 SUBMITTALS:

A. Submit as specified in *Section 17.0 of the Supplemental Provisions.*

B. Includes, but not limited to, the following:

1. Schedule of products to be used. Schedule shall include the following information:
   a. Surfaces for system to be applied.
   b. Surface preparation method and degree of cleanliness.
   c. Product manufacturer, name, and number.
   d. Method of application.
   e. Dry film mil thickness per coat of coating to be applied.
2. Color charts for selection and acceptance.

C. Technical and material safety data sheets.

1.04 QUALITY ASSURANCE:

A. Include on label of container:

1. Manufacturer's name, product name, and number.
2. Type of paint and generic name.
3. Color name and number.
4. Storage and temperature limits.
5. Mixing and application instructions, including requirements for precautions which must be taken.
6. Drying or curing time.

B. Factory-Applied Pipe Coatings:

1. Coating applicator shall have a minimum of 5 years of certifiable experience in the type of coating Work required.
2. Certification of quality control procedures during application of internal and external coatings shall be submitted to Engineer for review. Certification to include: surface preparation, film thickness per coat, curing procedures, and holiday testing.

C. Stated VOC shall be unthinned maximum VOC certified by manufacturer. Maximum VOC allowable this area are 2.8 lb/gal for shop-applied coatings and 3.5 lbs/gal for field-applied coatings.

PART 2 - PRODUCTS

2.01 SHOP-APPLIED EXTERNAL PROTECTIVE COATING:

A. All fuel system tanks, pipe and fittings shall have an external coating system applied either in the manufacturer's shop or in the mill of an approved custom applicator.

B. Coating system shall meet the following specifications:

1. Surface preparation, material, application, testing, inspection, handling, storage and field installation shall be in accordance with the applicable requirements of AWWA C213, Fusion Bonded Epoxy Coating.
2. Coatings shall be applied in accordance with NAPCA Bulletin 12-78-83. Application Specifications Mill Applied Fusion Bonded Epoxy Coatings.
3. Surfaces shall be sandblasted in accordance with Steel Structures Painting Council Surface Preparation Specification No. 10, "near-white" metal blast.
4. Sandblasting shall be coordinated with coating application, which shall be applied as soon as possible after blasting. If blasted surface remains uncoated overnight, it shall be re-blasted.

5. Care shall be taken to prevent grease, oil, or other organic matter from contacting the blasted surface prior to application of the prime coat.
6. All burrs and rough protrusions on the outer surface of the pipe shall be ground smooth prior to coating.
7. Apply coating to produce a uniform dry film thickness of 15 mils.
8. Dry film thickness shall be spot checked at random on ten percent of the coated surfaces. If film thickness is not found to be uniform and to specification, the Contractor shall apply additional coats at no cost to the Owner until the specified film thickness has been obtained. Dry film thickness shall be checked by the Contractor at his expense.
9. Provide a 3 inch cut-back from each end.

C. The coating shall be holiday tested in the shop prior to shipment. Surfaces shall be checked for freedom from defects using a low-pulse electronic holiday detector at 125 volts per mil of coating thickness.

D. The Contractor shall secure the services of an independent testing and inspection laboratory to witness the coating application and testing and to certify that the pipe and fittings were prepared, cleaned, and coated using methods and materials conforming with these specifications.

E. Contractor shall perform final holiday test of all coatings prior to backfilling.

2.02 SHOP-APPLIED INTERNAL EPOXY LINING FOR PIPING:

A. All fuel supply, transfer, drain, and vent piping and pipe fittings 2-1/2 inches and larger in size shall be internally coated in the manufacturer's shop or in the mill of an approved internal epoxy applicator with a two coat high solids amine-cured epoxy system in accordance with Military Specification MIL-C-4556E and the following specifications. All materials used shall be lead-free, and shall not contain not more than VOC component quantities permitted by local regulatory authorities, as applied (in thinned state) unless noted otherwise.

1. Remove all grease or oil by thorough cleaning using an oil-free solvent.
2. Sandblast inside of pipe to "near-white" metal, confirming with Steel Structures Painting Council Surface Preparation Specification No. 10. No rust preventative coating material or other temporary coating shall be applied after sandblasting and before application of the internal epoxy coating. Care shall be taken to prevent grease, oil, or other organic matter from contacting the blasted surface prior to application of the prime coat. Blasting shall be coordinated with primer application, which shall be applied as soon as possible after blasting. If the blasted surface remains uncoated overnight, it shall be re-blasted.
3. The ends of the pipe and fittings shall have the paint wiped back 2-inches with cloth or other approved absorbent material. Masking the ends will not be acceptable as a thin film of paint is desired to prevent rust until installation of the material.
4. Apply one coat polyamide cured orange two-component epoxy resin primer. The thickness of the cured primer shall be not less than 3 mils, but shall not exceed 4 mils.
5. The prime coat shall be allowed to cure in accordance with manufacturer's recommendation for immersion service.
6. Apply one coat of polyamide-cured off-white two-component epoxy resin protective top coating. The cured thickness of the top coat shall be not less than 3mils, but shall not exceed 4 mils.
7. After the top coat has been cured in accordance with manufacturer's

recommendation for immersion service, the internal epoxy lining shall be tested electrically using an approved holiday detector and shall be free of missed spots, pinholes or holidays. Apply additional primer and finished coats to areas requiring touch-up.

8. Dry film thickness shall be spot checked at random on ten percent of the coated surfaces. If film thickness is not found to be uniform and to specification, the Contractor shall be required to apply additional coats at no cost to the Owner until the specified film thickness has been obtained. Dry film thickness is to be checked by the Contractor at his expense.
9. If, in the opinion of the Project Manager, the coatings show ridges, waves, runs or holidays indicating uneven coverage or improper application, the Contractor shall be required to remove and reapply the coating at no cost to the Owner.
10. Prior to shipping to the project site, the ends of the pipe shall be capped using suitable plastic caps secured with a double wrap of 2-inch wide pressure sensitive tape.

F. All applications shall be in accordance with the manufacturer's published instructions.

G. The Contractor shall secure the services of an independent testing and inspection laboratory to witness the lining application and testing and to certify that the pipe and fittings were prepared, cleaned and lined using methods and materials conforming with these specifications.

H. The coating system shall be Amercoat 395 manufactured by Ameron Protective Coatings Division, Diamond Vogel's Amerlock 400 FD or approved equal.

2.03 FIELD-APPLIED EXTERNAL COATING AND PROCEDURE:

A. All field welds of fuel system piping, including fittings and areas of thermit welding and where the shop coat has been damaged, valves and equipment in pits, shall receive a field-applied external protective coating using a two part liquid epoxy coating system in accordance with AWWA C-210.

1. Sandblast surfaces to "near-white" metal, conforming with Steel Structures Painting Council Surface Preparation Specification No. 10. No rust preventative coating material or other temporary coating shall be applied after sandblasting and before application of the epoxy coating. Care shall be taken to prevent grease, oil or other organic matter from contacting the blasted surface prior to application of the prime coat. Blasting shall be coordinated with primer application, which shall be applied as soon as possible after blasting. If the blasted surface remains uncoated overnight, it shall be re-blasted.
2. Grind smooth all burrs and sharp protrusions.
3. Surfaces must be dry before application of coating system.
4. Apply primer following manufacturer's recommendations. The thickness of the cured primer shall be not less than 1.5 mils.
5. Apply finish coat(s) of epoxy top coating in accordance with manufacturer's recommendations. The cured thickness of the total system shall be not less than 15 mils, but shall not exceed 25 mils.
6. After the top coat has been cured in accordance with manufacturer's recommendation, the epoxy coating shall be tested electrically using an approved holiday detector and shall be free of missed spots, pinholes or holidays. Apply additional primer and finished coats to areas requiring touch-up.

7. Coatings for piping to be pressure tested shall be applied after testing and acceptance.
8. Application, testing, and inspection shall be in accordance with AWWA C210.
9. Leave welds uncovered until after testing and acceptance.

B. Alternatives for Joint and Fitting Wrapping and Coating:
1. Thermofit pipe sleeves; Tapecoat CSS 1100 primer and CSS wrap around sleeve, or approved equal. Sleeve length shall overlap pipe coating four inches minimum on each side of joint.
2. Hot-applied tape; Tapecoat 20 with TC primecoat, or approved equal. Provide a two-layered, half-lapped, spiral wrap.

C. Do not coat manufacture's name tags, identification tags, instruction tag(s) or control mechanisms.

D. Holiday test all coatings prior to backfilling

2.04 SHOP APPLIED INTERNAL TANK LINING:

A. The interior surfaces of fuel storage tanks including all surfaces of structure and piping systems within the tank which will contact thefuel, shall be coated with a two coat high solids amine-cured epoxy in accordance with Military Specification MIL-C-4556E. All materials used shall be lead-free, and shall not contain not more than VOC component quantities permitted by local regulatory authorities, as applied (in thinned state) unless noted otherwise.

B. The interior surfaces of fuel storage tanks including [bottom of fixed roof, roof supports, tank bottom, side and] all surfaces of structure and piping systems within the tank which will contact the fuel, shall be coated with a polyurethane coating system, Corrocote II Petroliner as manufactured by Madison Chemical Industries, Inc., or approved equivalent. All materials used shall contain not more than VOC component quantities permitted by local regulatory authorities, as applied, unless noted otherwise.

C. Thoroughly examine surfaces scheduled to be coated prior to commencement of work. Report in writing, to the RPR, Engineer, and VTrans Project Manager, any condition that may potentially affect proper application. Do not commence until such defects have been corrected.

D. Protection:
1. Adequately protect other surfaces from paint and damage. Repair damage as a result of inadequate or unsuitable protection.
2. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and, in particular, surfaces within storage and preparation area.
3. Place cotton waste, cloths and material, which may constitute a fire hazard in closed metal containers and remove daily from site.

E. Preparation of Surfaces:
1. Surfaces shall be sandblasted in accordance with Steel Structures Painting Council Surface Preparation Specification No. 10, "near-white" metal blast.
2. Sandblasting shall be coordinated with primer application, which shall be applied as soon as possible after blasting. If blasted surface remains uncoated overnight, it shall be reblasted.
3. Care shall be taken to prevent grease, oil, or other organic matter from contacting the blasted surface prior to application of the prime coat.

F. Applications:
1. Apply coatings in accordance with manufacturer's recommendations.

2. Allow ample curing time in accordance with manufacturer's recommendations for immersion service.
3. Finished surfaces shall be free from runs, drips, ridges, brush marks and variation in color, texture and finish.
4. Do not paint when temperature is below 50 degrees F. or during periods of inclement weather.

G. Cleaning:
1. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered.
2. During progress of work, keep premises free from any unnecessary accumulation of tools, equipment, surplus material and debris. Remove waste materials from painting operations daily.
3. Upon completion of work, leave premises neat and clean, to the satisfaction of the Construction Manager.

H. The tank lining system shall be Corrocote II Petroliner as manufactured by Madison Chemical Industries, Inc., or approved equal.
1. Coating product shall be a plural component 100% solids polyurethane coating system for use as a lining in petroleum products storage tanks, consisting of a polyisocyanate resin and polyol resin which meets the following performance and properties requirements,

Property or Test	**Requirement**
Percent Solids	100
Mix Ratio	1 : 1
Elcometer Adhesion to Steel (white blast 2.5 mil/65 micron profile; no primer)	>1800 psi
Cathodic Disbondment per ASTM G-8 (28 day/20 degrees C/18 mils, near-white blast)	<10 mm radius
Flexibility (ASTM D522) over 1" mandrel	180 (minimum
Hardness (ASTM D543)	Shore D 80 " 5

2. Surface preparation shall be by sandblasting as specified in this section. Surfaces to be coated shall be completely dry and free of moisture, dust, grease, or any other deleterious substances at the time the coating or lining is applied.
3. Nominal coating thickness shall be 18 mils, with minimum acceptable thickness of 15 mils. Bolts, rivets, or other protrusions shall be coated to a thickness of 30 mils, using five passes from all directions.
4. A heated, plural-component airless spray pump shall be used to apply the coating in a one-coat, multi-pass operation. No primers shall be used; Contractor shall consult manufacturer for temperature and humidity restrictions.
5. Repair and field touch-up shall be compatible with the main coating system and shall be applied in accordance with manufacturer's recommendations.

6. Holiday inspection shall be conducted by using a wet sponge tester for thicknesses less than 20 mils and a low voltage spark tester (100 volts per mil) for coatings of 20 mils to greater thickness.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparations specifications listed.
   1. If grease or oils are present, SSPC-SP1 shall precede any other method specified.
   2. Remove surface irregularities such as weld spatter, burrs, or sharp edges, prior to specified surface preparation.
   3. Prepare surfaces of field welds, sears, or other damage, and touch up with coating as specified or recommended by manufacturer.

B. Depth of profile will be as specified for each system, but in no instance shall it exceed one-third of the coating dry film thickness per coat.

C. Prepare only those areas which will receive the first coat of the system on the same day.

3.02 APPLICATION:

A. Apply coatings in accordance with coating manufacturer's recommendations. Due to close proximity of aircraft and vehicle parking to painting area, all exterior painting shall be limited to brushes and rollers.

B. Use properly designed brushes and rollers for all applications.

C. Dry film thickness of each system shall meet the minimum specified but not exceed it more than 20% or coating manufacturer's requirements if less.

D. On unprimed surfaces apply first coat of the system the same day as surface preparation.

E. Field painting shall remain 3 inches away from unprepared surface of any substrate such as areas to be welded or bolted.

F. Environmental Conditions:
   1. Atmospheric temperature must be 50ºF or higher during application, unless approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating curing time requirements.
   2. Wind velocities for exterior applications shall be at a minimum and not greater than coating manufacturers limits.
   3. Relative humidity must be less than 85% and the temperature of the surface to be painted must be at least 5º above the dew point.
   4. Provide adequate ventilation equipment in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.

G. Protection:
   1. Cover or otherwise protect surfaces not being painted, areas not to be painted, and the work of other trades. Remove protective materials when appropriate.
   2. Provide signs to indicate fresh paint areas.
   3. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
   4. Provide cover to prevent paints from entering orifices in electrical or mechanical equipment.

5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, thinners, and related materials. Dispose of leftover containers, thinners, rags, brushes, rollers, and related materials in accordance with applicable regulations.
6. Do not remove or paint over equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 CLEANING:

A. Touch up and restore damaged finishes to original condition as required.
B. Remove spilled, dripped or splattered paint from all surfaces.

3.04 COATING REPAIRS:

A. Repair all damages to pipe coating systems.
B. This includes all cuts, breaks, voids, bruised or scarred spots, or other damage caused prior to delivery, or resulting from handling or installation of the pipe, or from any cause whatsoever.
C. Also repair the coating where welds are made and where damaged or broken by the installation of instrumentation or other accessories or appurtenances.
D. Repair coating where field welds are made or where otherwise damaged.
   1. Exposed Piping Systems: Use Protective Coating System materials and techniques.
   2. Complete all weld radiography for fuel piping joints prior to application of coatings.

END OF ITEM 13063

ITEM 13065 - FUEL SYSTEM VALVES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers valves applicable to the fuel system.

B. Related Work Specified Elsewhere:
   1. Fuel System General Requirements: SECTION 13051.
   2. Fuel System Coatings for Corrosion Protection: SECTION 13063.
   3. Fuel System Accessories: SECTION 13067.
   4. Fuel Storage Tank Packages: SECTION 13201.

C. Extent of Work shall be as follows:
   1. All special valves, pilots, fittings, equipment, and related items, shall meet the following requirements:
      a. Be furnished, installed, tested, and put into successful operation.
      b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and related items.
      c. Meet the requirements of applicable codes and standards as specified.
   2. Control Valves: Furnish complete with pilots, couplings, tubing, etc.
   4. Spare, Replacement, or Additional Parts:
      a. Where spare, replacement, or additional parts are required for the Equipment specified herein, these items shall be delivered to Owner immediately upon receipt at the Site.
      b. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.
      c. Contractor shall prepare an inventory list of the items delivered to Owner.

D. This Section covers valves related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation jet fuel system with a maximum operating condition of 275 psig, 0ºF to 100ºF, and having a specific gravity of 0.81 (Jet A) or 0.67 (Aviation Gasoline).

E. Supplier, Contractor or any Subcontractor or Supplier shall not supply, furnish, or install any flanges, fittings, bolts, or nuts of foreign manufacture. All flanges, fittings, bolts, and nuts shall be manufactured in the United States of America and Contractor shall warrant the U.S.A. origin of all such items. Flanges and fittings shall bear a stamp attesting to their place of origin. Supplier and Contractor shall provide written certification from the manufacturer as to the origin of all flanges, fittings, bolts, and nuts installed on the Project. If at any time Owner determines that any flanges, fittings, bolts, or nuts are not of U.S.A. origin, Owner shall be entitled to replace all flanges, and/or fittings, and/or bolts, and/or nuts (as the case may be) without the need for individual testing for conformance to technical specifications, or for proof of non-U.S.A. origin of the other items. Contractor shall be responsible for all labor, materials, and consequential costs connected with such replacement.

1.02 REFERENCES:

A. American Petroleum Institute (API):
   1. 6D - Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves).
   2. 6FA - Specification for Fire Test for Valves.
   3. 594 - Check Valves: Wafer, Wafer-Lug, and Double Flanged Type.
   4. 607 - Fire Test for Soft-Seated Quarter-Turn Valves.
   5. 609 - Butterfly Valves: Double Flanged, Lug- and Wafer-Type.

B. Military Specifications:
   1. MIL-PRF-4556 - Coating Kit, Epoxy, for Interior of Steel Fuel Tanks.
C. National Electrical Manufacturers Association (NEMA).

1.03 QUALITY ASSURANCE:
A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide products by one of the following:
   1. Ball Valves:
      a. Worcester Controls.
      b. Watts.
      c. MCF.
      d. Bray.
   2. Butterfly Valves:
      a. Bray.
      b. Keystone.
      c. WKM.
   3. Check Valves:
      a. Crane (Duo-Chek II).
      b. Goodwin (Type B).
      c. Jenkins (Figure B3674XUT).
      d. Walworth (Figure 5540S).
   4. Thermal Relief Valves:
      a. Hydroseal.
      b. Taylor Valve.
   5. Double Block and Bleed (DBB) Plug Valves:
      a. General Twin Seal (Model C811G).
      b. Orbit Truseal.
   6. Instrument Valves:
      a. Anderson, Greenwood & Co. (Model M9-VDC-44).
      b. Approved equal.
   7. Control Valves:
      a. Cla-Val.
      b. Brooks.
   8. Overfill Prevention Valves:
      a. OPW Fueling Components (61fSTOP-2000).
      b. Approved equal.
   9. Solenoid Valves:
      a. Magnatrol Valve Corp.
      b. Approved equal.
   10. Valve Limit Switches:
      a. Westlock Controls.
      b. Approved equal.

2.02 BALL VALVES:
A. Valve body shall be of carbon steel with 316 stainless steel ball and stem.

B. Valve shall be rated for 275-psig working pressure.
C. Valves 2-1/2-inch size and smaller shall be of three-piece bolted construction, with threaded end connections unless indicated or specified otherwise.
D. Valves 3-inch size and larger shall be of two-piece split body construction, with flanged end connections. Valves shall comply with API 6D.
E. Seals and/or seats shall be reinforced TFE.
F. Provide with a vinyl-coated, stainless steel locking handle suitable for padlocking.
G. Valves shall be certified "fire safe" per API-607.
H. Where noted, valves shall have quick closing spring return handle.

2.03 BUTTERFLY VALVES (MONOFLANGE):

A. Valves shall be metal-lined, single-flanged type, drilled and tapped full lug body.
B. Valves shall be certified "fire safe" per API-607.
C. Valve shall be suitable for 275-psig working pressure, bubble-tight at differential pressure of 275 psig, and a maximum shutoff pressure of 300 psig.
D. Valve body shall be compatible to ANSI Class 150 with a face-to-face dimension or laying length in accordance with API-609.
E. The disc shall be "double offset" and shall be capable of bi-directional flow and shall be suitable for dead-end service in both directions.
F. Valve body shall be carbon steel, shaft material of stainless steel, disc shall be 316 stainless steel, with 316 stainless steel pins for attachment to the shaft. Valve shall have adjustable top packing for the shaft. Top of shaft shall be keyed to allow installation of operator at two positions 90° apart. Valve seat shall be 316 stainless steel with TFE insert material.
G. Valves shall be suitable for installation between 150-pound raised-face flanges.
H. Operators shall be as follows:
   1. Valve sizes 4 inches and smaller shall have a 10-position, spring-loaded, squeeze-trigger handle with locking device.

2.04 CHECK VALVES:

A. Check valves 2-1/2-inch and smaller:
   1. Forged steel, Class 800, lift check.
   2. Elastomers shall be compatible with jet fuel.
   3. End connections shall be threaded.
B. Check valves 3-inch and larger:
   1. Valve shall be dual-plate wafer style suitable for 275 psig working pressure, designed and tested to API 594.
   2. Valve body and plate shall be carbon steel with resilient Viton seat and 316 SS pins, and springs. Each plate shall have an independent spring (two springs).
   3. Ends shall be suitable for installation between ANSI 150-lb raised-face flanges.

2.05 THERMAL RELIEF VALVES:

A. Carbon steel body, stainless steel internals, disc and seat type, Viton elastomers (seat, O-ring), closed cap (no lever).
B. Valves shall be set to relieve at 125 psi.
C. All set points shall be a nominal point within a "SET POINT" range, adjustable for field conditions.
D. Inlet and outlet connections shall be 3/4-inch and 1 inch, respectively, with threaded connections.

2.06 DOUBLE BLOCK AND BLEED (DBB) PLUG VALVES:

A. Valve body shall be steel with reduced port configuration and chrome-plated bore. Valve plug shall be chrome or nickel plated. Valve port openings shall be approximately 70% free area of pipe size installed in.
B. The valve assembly shall include a manual bleed valve and a thermal relief valve discharging upstream of valve throat.
C. Slip seals and valve O-rings shall be Viton.
D. Valve shall be fire tested and qualified to API 6FA. Valve shall be rated for 275-psig working pressure.

2.07 INSTRUMENT VALVES:

A. Shall have a replaceable seat insert of delrin and teflon stem packing.
B. Body shall be carbon steel, with working pressure of 3000 psi.
C. Shall have a needle type bleed valve.
D. End connections shall be screwed.

2.08 CONTROL VALVES:

A. General Requirements:
   1. All control valves provided shall be from same manufacturer.
   2. Diaphragm or balanced piston type valve designed for service as specified below.
   3. Valve and all components shall be suitable for turbine jet fuel or aviation gasoline and a working pressure of 275 psig.
B. Construction:
   1. Body shall be cast steel or ductile iron suitable for a working pressure of 275 psig.
   2. Piping connection shall be 150-pound ANSI raised-face flanges (or flat-face for ductile iron). Size shall be as indicated on Drawings.
   3. Main valve trim, seats, guides, control pilots and tubing systems shall be stainless steel.
   4. Elastomers shall be suitable for service in Jet A turbine fuel or aviation gasoline.
   5. For cast steel valves, wettable main valve body surfaces shall be epoxy coated conforming to MIL-PRF-4556 to a dry film thickness of 3 mils.
   6. Ductile iron valves shall be nickel plated.
   7. Provide one or more in-line strainers in valve pilot tubing to prevent potential fouling of pilot controls.
   8. Performance characteristics and accessories shall be as noted in the following paragraphs.
C. Manufacturer's Service Engineer:
   1. Furnish the services of a manufacturer authorized service engineer to verify proper installation and assist in start-up, check-out, and calibration. Service engineer shall provide all final adjustments prior to commissioning of system. Allow for separate trips to the Site if required by the construction schedule or Owner's operations.
   2. Furnish the services of service engineer for a minimum of one day to instruct Owner's operating personnel on proper operation, maintenance and repair of equipment. This instruction time and trip to the Site shall be in addition to the requirements of "1." above.
   3. Provide certification from manufacturer of authorized service engineer.

D. Specific Requirements:
   1. Water slug valve - Shall be located downstream of filter/separator and close by either electric signal upon detection of water by the water detection probe contained within the filter/separator, or hydraulically by actuation of a water float valve located within the filter/separator. Valve shall be normally closed, flow to open. Valve shall close within 30 seconds, from an 80% open position, with no pressure differential. Valve shall limit flow rate as applicable. Provide the following trim and accessories:
      a. Explosion proof, 120Vac control solenoid, with maintained position type manual override.
      b. Rate of flow pilot with orifice plate at valve entrance and sensing lines completely piped and self-contained on valve.
      c. Opening speed adjustment.
      d. Integral check feature.
   2. Air Eliminator Block Valve – Solenoid enabled, hydraulically actuated diaphragm type valve located downstream of receipt air eliminator. Valve closes on hydraulic signal on detection of excess air in the eliminator head. Provide the following trim/accessories:
      a. Integral check feature.
      b. Opening and closing speed adjustment.
      c. Explosion proof 120-VAC control solenoid with manual override.

2.09 OVERFILL PREVENTION VALVES:
A. Tank shall be provided with float operated, poppet-type overfill prevention valves with drop tubes in accordance with Section 13201.
B. Valve sizes shall be as listed in Section 13201.
C. Valves shall be rated for 150 psi.
D. Valves shall have an integrated anti-siphon feature.
E. Valves shall be OPW 61fSTOP or approved equal.

2.10 SOLENOID VALVES:
A. Two-way pilot operated. Normally closed, energize to open.
B. NPT ends, stainless steel body, 0 psi minimum differential pressure to open, 275 psi maximum operating pressure differential.
C. Combination explosion proof/watertight, 120Vac.
D. Provide with maintained-position manual operator.
E. Valve shall be Magnatrol Type K or approved equal.
F. Provide y-strainer on solenoid valve inlets.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Inspect valve for cleanliness, corrosion and operability. Remove special packing materials, such as blocks used to prevent disc movement during shipping and handling.
B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve's closure member to the shipping position.
C. Examine threads or flanges on both the valve and the mating pipe for form (i.e., out-of-round or indentation) and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, defects, and damage.
E. Prior to valve installation, examine the pipe for cleanliness and proper alignment.
F. Replace defective valves with new valves.

3.02 VALVE ENDS SELECTION:
A. Unless indicated otherwise, select valves with the following end connections.
1. Sizes 2-1/2-inch and smaller: Threaded.
2. Sizes 3 inch and larger: Flanged.

3.03 ADJUSTMENTS AND CALIBRATION:
A. Contractor shall adjust all valves for the travel limits, torque settings, flows, level settings, pressure settings, and other settings specified or required.
B. Set rate of closure of control valves to eliminate surges and shocks in the systems as installed.
C. Final adjustments shall be made with system in operation during system commissioning. Contractor shall frequently check all valve settings following final adjustment to monitor for potential drift. Adjustments back to original setting shall be performed immediately if drift occurs.
D. Modify adjustments during start-up, including flow rates, pressure settings, meter settings, and other variables as required by Owner's representative on the job.

3.04 TUBING INSTALLATIONS:
A. Assemble and tighten fittings as recommended by the manufacturer.
B. Route as required to interconnect the instrumentation provided.
C. Provide an instrument valve and threadolet for all "root" valve locations where instrumentation tubing connections are made to the piping system.

3.05 VALVE AND EQUIPMENT INSTALLATION:
A. Install in accordance with manufacturer's recommendations.
B. Replace any and all valves and equipment that prove defective during testing. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for Owner's operation.
C. Install all butterfly valves with the disc shaft in the horizontal axis.
D. Provide spool pieces or spacers in the piping as necessary to ensure valve parts, operators, and butterfly discs have sufficient operating clearances.
E. For adapters with integral screens; remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.06 CLEANING AND PROTECTION:
A. Clean all fabricated assemblies and all equipment items thoroughly before operating or testing.
B. Protect equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.07 EQUIPMENT TEST AND CHECKOUT:
A. Before equipment installations will be accepted, the equipment shall be tested and demonstrated to be correctly connected and installed.
B. All testing and checkout procedures of the manufacturer shall be carried out completely.

C. All tested equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.
D. Any operating difficulty or defective item as a result of Contractor's work shall be repaired or replaced and put into proper operation by Contractor immediately.
E. Protect all equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF ITEM 13065

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ITEM 13067 - FUEL SYSTEM ACCESSORIES

PART 1 – GENERAL

1.01 SUMMARY:

A. This Section covers special Equipment and mechanical accessories applicable to the fuel system.

B. Related Work Specified Elsewhere:
   1. Fuel System General Requirements: SECTION 13051.
   2. Fuel System Coatings for Corrosion Protection: SECTION 13063.
   3. Fuel Storage Tank Packages: SECTION 13201.

C. Extent of Work shall be as follows:
   1. All special valves, pilots, fittings, equipment, and related items shall meet the following requirements:
      a. Be furnished, installed, tested, and put into successful operation.
      b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and other items, whether shown on the Drawings or not, but required.
      c. Meet the requirements of applicable codes and standards as specified.
   2. Piping connected to Equipment shall be furnished and installed as required to make a complete and workable installation without additional cost to Owner.
   3. Spare, Replacement, or Additional Parts:
      a. Where spare, replacement, or additional parts are required for the equipment specified herein, these items shall be delivered to the Owner at time of system acceptance.
      b. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.
      c. Contractor shall prepare an inventory list of the items delivered to Owner.

D. This Section covers fittings, meters, and accessories related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation fuel system with a maximum operating condition of 275 psig, 0ºF to 100ºF, and having a specific gravity of 0.81 (Jet A) or 0.67 (Aviation Gasoline).

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):
   1. Section VIII of the ASME Boiler and Pressure Vessel Code.

B. American Petroleum Institute (API):
   1. 1529 - Aviation Fueling Hose.
   2. 1584 - Four-Inch Hydrant System Components and Arrangements.

C. Military Specifications:
   1. MIL-R-6855 - Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes.

D. Local governing code.

1.03 QUALITY ASSURANCE:

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves and Equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Strainers:
      a. Hayward
      b. Muessco
      c. Weamco.
      d. Approved equal.
   2. Quick Couplings:
      a. OPW. (Model 633 Coupler, Model 733 Adaptor, Model 634 dust cap).
      b. Approved equal.
   3. Sight Flow Indicators:
      a. OPW ("Visi-Flo," Type 1471).
      b. Approved equal.
   4. Fuel Sampling Connections:
      a. Gammon Technical Products, Inc. (Kit No. 7).
      b. Approved equal.
   5. Pressure Gauges:
      a. Ashcroft (Model 1009).
      b. Wika.
      c. Approved equal.
   6. Jet Fuel/Avgas Hose:
      a. B.F. Goodrich.
      b. Approved equal.
   7. Jet Fuel/Avgas Hose Swivel Joint:
      a. Emco Wheaton (Style 40).
      b. Approved equal.
   8. Jet Fuel/Avgas Unloading Hose Dry Break Coupler:
      a. Emco Wheaton (J451).
      b. Approved equal.
   9. Avgas Vapor Recovery Adapter:
      a. OPW Environmental Systems (1611AV-1605).
      b. Approved equal.
   10. Meters:
      a. Smith Meter.
      b. Brooks.
   11. Sump Separators:
      a. Gammon Technical Products.
      b. Facet.
   12. Automatic Air Vents:
      a. Armstrong.
      b. Approved equal.
   13. Hand Pumps:
      a. Blackmer (828B).
      b. Approved equal.

14. Mechanical Gauges:
    a. Morrison Brothers (818 Series).
    b. Approved equal.
15. Aircraft Single Point Connection Nozzle:
    a. Cla-Val (347GF).
    b. Approved equal.

2.02 STRAINERS:

A. Provide with quick opening cover.
B. Body shall be basket style with threaded drain.
C. Body shall be carbon steel with a 275-pound working pressure.
D. Piping connections shall be ANSI 150-pound raised-face flanged. Connections shall be in-line.
E. Basket shall be stainless steel with 3/16-inch-diameter holes lined with 40-mesh stainless steel screen.
F. Differential Pressure Gauge:
    1. Provide (2) 3/4" NPT connections in strainer body for differential pressure gauge tubing.
    2. Provide (2) instrument valves in accordance with SECTION 13065 - FUEL SYSTEM VALVES.
    3. Provide pressure gauge in accordance with this Section. Gauge shall be graduated 0 to 15 psi.
    4. Provide gauge tubing in accordance with SECTION 13061 - FUEL SYSTEM PIPING.

2.03 QUICK COUPLINGS:

A. Shall be a cam-locking type coupling adaptor and dust cap, size as indicated.
B. Construction of adaptor and cap shall be aluminum.

2.04 SIGHT FLOW INDICATORS:

A. Indicators shall have two high strength tempered viewing windows and Teflon window gaskets. Indicator shall have a propeller.
B. Cast-steel body shall be suitable for 275-psi working pressure.
C. End connections shall be screwed for 2-inch and smaller, 150-pound ANSI raised face flanged for sizes 2-1/2-inch and larger.

2.05 FUEL SAMPLING CONNECTIONS:

A. Kit shall include stainless steel probe, ball valve and dry break quick coupler with chain-affixed dust plug of aluminum.
B. Shall be suitable for sampling aviation fuel from piping systems or Equipment. Sampling connection shall be installed on side of pipe, not top or bottom.

2.06 PRESSURE GAUGES:

A. All pressure gauges shall be silicon-filled type and shall have all internal parts immersed.
B. Gauges shall have 4-1/2-inch dials, 1/2-inch NPT lower stem, 316SS tube/socket and stainless steel case, and shall be mounted to the pipe by means of the instrument valves specified.
C. Gauges shall be graduated as follows:
    1. Pump suction: Compound, 30"-0-30 psi.

2. All other locations: 0 to 150 psi.

2.07 JET FUEL/AVGAS HOSE:

A. Hose shall be 4-inch or 3-inch diameter as required and capable of 300 psi working pressure to full vacuum.
B. Tube shall be nitrile with single ply, high-tensile nylon cord reinforcement interwoven hardwall construction. Cover shall be black neoprene.
C. Hose shall be API 1529 Grade 2 Type C and meet NFPA 407 requirements.

2.08 JET FUEL/AVGAS HOSE SWIVEL JOINT:

A. Swivel Joint shall match piping diameter.
B. Swivel joint shall be capable of 275 psi working pressure.
C. End connections shall be flanged body with female threaded sleeve.

2.09 AVGAS VAPOR RECOVERY ADAPTER:

A. Adapter shall be rated at 10 psi maximum working pressure.
B. Elbow end and FNPT end shall be 3-inch size.
C. Adapter shall be hard coated aluminum.
D. Provide with dust cap OPW 1711T-7085-EVR or equal.

2.10 METERS:

A. General Requirements: Positive displacement temperature compensated meters shall be designed to meter aviation fuel, Jet A or 100LL Aviation Gasoline at the supply flow rate.
B. Manufacturer's Service Engineer:
   1. Furnish the services of a manufacturer certified service engineer to verify proper installation and assist in start-up, checkout, calibration, and meter proving.

2.11 SUMP SEPARATORS:

A. General Requirements: 50-gallon tank with self-contained pump, valves, and piping used to separate water from fuel tank and filter sump samples.
B. Construction:
   1. Tank capacity shall be 50 gallons.
   2. Unit shall be internally epoxy coated.
   3. Provide self-contained centrifugal pump with check valve and piping for sending fuel through receipt filtration back to the storage tank, and water/waste fuel to waste tank. Pump shall be 5 gpm, 30-foot head with starter in explosionproof box. Motor shall be 120 volts, 60 hertz, 1/2 hp, single-phase explosionproof.
   4. Provide sight glass and ball stop with stainless steel fittings.

2.13 AUTOMATIC AIR VENTS:

A. Automatic air vents shall be all stainless steel construction including float and body. Seat shall be Buna-N for Jet A and Viton for aviation gasoline.
B. Connections shall be 1-inch FNPT inlet and outlet.
C. Provide with a tee with manual air vent between vessel or pipe and automatic air vent.

2.14 HAND PUMPS:

A. Hand pumps shall be sliding vane design and shall be suitable for handling jet fuel and avgas.

B. Pumping capacity shall be a minimum of 28 gallons per 115 revolutions.

2.15 MECHANICAL TANK LEVEL GAUGES:

A. 12-hour clock face with standard units shown with feet and inches hands.
B. Aluminum body.
C. 2-inch FNPT end.
D. Stainless steel float and cable with 2-inch aluminum guide pipe for float.

2.16 AIRCRAFT SINGLE POINT CONNECTION NOZZLE

A. Provide with swivel connection
B. Provide with stowage bar.
C. 2-inch NPT end.

PART 3 - EXECUTION

3.01 SETTING AND ALIGNING EQUIPMENT:

A. Set and align all Equipment supplied under this Section in accordance with manufacturer's recommendations.
B. Set true and level all Equipment at the locations shown. Demonstrate adequate leveling of installed Equipment.
C. Provide coupling alignment records indicating parallel and angular dial indicator readings as well as coupling manufacturer's tolerances. Alignment for pumps, couplings, and drivers requiring "cold" and "hot" settings shall be checked in both conditions and so indicated on the alignment record.
D. Retighten all bolted and threaded connections after installation.

3.02 INSPECTIONS:

A. The Work will be inspected by Owner or Owner's Representative at intervals appropriate to the stage of construction during the course of construction.
B. Provide for inspection by all others having jurisdiction over the work performed under the various Sections of these Specifications during the proper phase.
C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction.

3.03 START-UP, MOTORS AND DRIVES:

A. Check all motors and drives carefully for correct rotation and alignment before placing Equipment into operation.
B. Disconnect and realign couplings before placing into service or testing.

3.04 ADJUSTMENTS AND CALIBRATION:

A. Contractor shall adjust all valves for the flows, level settings, and pressure settings indicated and specified.
B. Set rate of closure of control valves to eliminate surges and shocks in the systems as installed.
C. Final adjustments shall be made during system operation prior to final start-up.
D. Adjust all items at start-up, including flow rates, pressure settings, meter settings, and other variables as required by Owner's representative on the job.

3.05 TUBING INSTALLATIONS:

A. Assemble using Hy-Fer-Set presetting device as recommended by manufacturer.
B. Route as required to interconnect the instrumentation provided.

C. Provide an instrument valve and threadolet for all "root" valve locations where instrumentation tubing connections are made to the piping system.

3.06 GAUGES:

A. Install where indicated on the Drawings.

3.07 VALVE AND EQUIPMENT INSTALLATION:

A. Replace any and all valves and Equipment that prove defective during testing.
B. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for Owner's operation.
C. Install all butterfly valves with the disc shaft in the horizontal axis.
D. Provide spool pieces or spacers in the piping as necessary to ensure valve parts, operators, and butterfly discs have sufficient operating clearances.
E. For adapters with integral screens; remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.08 CLEANING AND PROTECTION:

A. Clean all fabricated assemblies and all Equipment items thoroughly before operating or testing.
B. Protect Equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.09 EQUIPMENT TEST AND CHECKOUT:

A. Before Equipment installations will be accepted, Contractor-furnished Equipment shall be tested and demonstrated to be correctly connected and installed.
B. All testing and checkout procedures of manufacturer shall be carried out completely.
C. All tested equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.
D. Any operating difficulty or defective item as a result of Contractor's Work shall be repaired or replaced and put into proper operation by Contractor immediately.
E. Protect all Equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF ITEM 13067

ITEM 13069 - FUEL SYSTEM PUMPS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes pumps applicable to the fuel system.

B. Related Work Specified Elsewhere:

1. Fuel System General Requirements: SECTION 13051.
2. Fuel System Coatings for Corrosion Protection: SECTION 13063.
3. Fuel Storage Tank Packages: SECTION 13201.

1.02 REFERENCES:

A. American Bearing Manufacturers Association (ABMA).

B. National Electrical Manufacturers Association (NEMA):

1. MG1 - Motors and Generators.

C. National Fire Protection Association (NFPA):

1. 70 - National Electrical Code (NEC).

1.03 SUBMITTALS:

A. General: Submit each item in this Article in accordance with the Conditions of the Contract and DIVISION 4 Section 60.

1. Product data including certified performance curves and rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate pump's operating point on curves.
2. Shop Drawings showing pump and motor layout and connections. Include setting drawings with templates, directions for installation of foundation and anchor bolts, and other anchorages.
3. Wiring diagrams detailing wiring for power, signal, and control systems and differentiating between manufacturer-installed wiring and field-installed wiring.
4. Maintenance data for pumps to include in the operation and maintenance manual specified in DIVISION 4 Section 60. Include startup instructions.

1.04 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with provisions of the following:

1. NEMA MG 1 for electric motors. Include NEMA listing and labeling.
2. NFPA 70 for electrical components and installation.

B. Single-Source Responsibility: Obtain each category of pumps from one source and by a single manufacturer. Include responsibility and accountability to answer questions and resolve problems regarding compatibility, installation, performance, and acceptance of pumps.

C. Manufacturer's Qualification: Firms regularly engaged in manufacture of equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Store pumps in dry location.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

D. Comply with pump manufacturer's rigging instructions.

E. Connect and operate motor space heaters during storage as recommended by motor manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Self-Priming Centrifugal Pumps:
      a. Gorman-Rupp.
      b. Approved Equal.

2.02 SELF-PRIMING CENTRIFUGAL PUMPS:

A. General Requirements: Horizontal self-priming centrifugal pumps, manufactured to .handle jet fuel or aviation gasoline. Receipt Pump: Gorman-Rupp Roto-Prime RD Series with optional air release valve or approved equal. Provide pumps as a complete assembly with pump, motor, couplings, optional air release device and all materials necessary for a complete installation. Maximum total dynamic head shall be the highest at no flow and decrease continually from no flow to design flow for the provided packaged system. Furnish with mechanical seals.

B. Performance: Pumps shall be designed for both continuous and intermittent service. Provide certified performance curves of head, horsepower and efficiency at all flow rates for each pump.

C. Operating Conditions:

Pump	**Jet A Receipt**	**Jet A Over Wing Supply**	**Jet A Single Point Supply**	**Avgas**
Capacity (GPM)	**200**	**22**	**50**	**22**
Specific Gravity	**0.81**	**0.81**	**0.81**	**0.67**
Maximum Motor Speed	**3600**	**3600**	**3600**	**3600**

D. Motors: Motors shall be explosion proof. Provide with motor winding temperature sensors and 120Vac space heaters. Motors shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the WK^2 of the load from standstill to rated speed under conditions of six starts per hour. Motors shall be suitable for an outdoor installation in Morristown, Vermont.

E. Manufacturer's Service Engineer: Provide the services of an experienced service engineer on the jobsite to verify proper installation, assist in start-up and testing, and instruct Owner's operating personnel.

2.03 SLIDING VANE TYPE POSITIVE DISPLACEMENT PUMPS:

A. General Requirements: As an alternate to the horizontal self-priming centrifugal pumps, sliding vane type positive displacement pumps with an internal pressure relief valve may be utilized for the Jet-A and Avgas supply pumps. Blackmer XL Series or approved equal. Provide pumps as a complete assembly with pump, motor, couplings, and all materials necessary for a complete installation. Maximum total dynamic head shall be the highest at no flow and decrease continually from no flow to design flow. Furnish with mechanical seals.

B. Performance: Pumps shall be designed for both continuous and intermittent service. Provide certified performance curves of head, horsepower and efficiency at all flow rates for each pump.
C. Operating Conditions: Refer to operation conditions for Self-Priming Centrifugal Pumps
D. Motors: Motors shall be explosion proof. Provide with motor winding temperature sensors and 120Vac space heaters. Motors shall have performance characteristics which will allow, without injurious overheating of the motor, accelerating the WK^2 of the load from standstill to rated speed under conditions of six starts per hour. Motors shall be suitable for an outdoor installation in Morristown, Vermont.
E. Manufacturer's Service Engineer: Provide the services of an experienced service engineer on the jobsite to verify proper installation, assist in start-up and testing, and instruct Owner's operating personnel.

PART 3 - EXECUTION

3.01 INSPECTIONS:

A. The Work will be inspected by Owner at intervals appropriate to the stage of construction during the course of construction.
B. Provide for inspection by all others having jurisdiction over the Work performed under this Section of the Specifications during the proper phase.
C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction.

3.02 INSTALLATION:

A. Install pumps in accordance with manufacturer's recommendations.
B. Replace any and all Equipment items that prove defective during testing.

3.03 START-UP, MOTORS AND DRIVES:

A. Check all motors and drives carefully for correct rotation and alignment before placing Equipment into operation.
B. Disconnect and realign couplings before placing into service or testing.

3.04 SETTING AND ALIGNING EQUIPMENT:

A. Set and align all Equipment supplied under this Section in accordance with manufacturer's recommendations.
B. Set true and level all Equipment at the locations shown. Demonstrate adequate leveling of installed Equipment.
C. Provide coupling alignment records indicating parallel and angular dial indicator readings as well as coupling manufacturer's tolerances. Alignment for pumps, couplings, and drivers requiring "cold" and "hot" settings shall be checked in both conditions and so indicated on the alignment record.
D. Retighten all bolted connections after installation.

3.05 CLEANING AND PROTECTION:

A. Clean all fabricated assemblies and all Equipment items thoroughly before operating or testing.
B. Protect Equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.06 EQUIPMENT TEST AND CHECKOUT:

A. Before Equipment installations will be accepted, the Contractor-furnished Equipment shall be tested and demonstrated to be correctly connected and installed.
B. All testing and checkout procedures of the manufacturer shall be carried out completely.
C. All tested Equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.
D. Any operating difficulty or defective item as a result of Manufacturer's or Contractor's work shall be repaired or replaced and put into proper operation by Contractor immediately.
E. Protect all Equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF ITEM 13069

ITEM 13071 - FUEL SYSTEM FILTRATION

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers special filters applicable to the fuel system.

B. Related Work Specified Elsewhere:
   1. Fuel System General Requirements: SECTION 13051.
   2. Fuel System Pipe, Connections and Installation: SECTION 13061.
   3. Fuel System Coatings for Corrosion Protection: SECTION 13063.
   4. Fuel System Valves: SECTION 13065.
   5. Fuel Storage Tank Packages: SECTION 13201.

C. Extent of Work shall be as follows:
   1. All special valves, pilots, fittings, equipment, and other items, shall meet the following requirements:
      a. Be furnished, installed, tested, and put into successful operation.
      b. Be complete with all necessary miscellaneous pipe, valves, unions, fittings, auxiliaries, and related items, whether shown on the Drawings or not, but required.
      c. Meet the requirements of applicable codes and standards as specified.
   2. Piping connected to Equipment shall be furnished and installed as required to make a complete and workable installation without additional cost to Owner. This requirement includes changes due to the selection of a different Equipment manufacturer than what is specified, or a design change made by the manufacturer between the time the piping system was designed and the time of installation.
   3. Spare, Replacement or Additional Parts:
      a. Where spare, replacement or additional parts are required for the Equipment specified herein, these items shall be delivered to Owner at time of system acceptance.
      b. Parts shall be packaged and sealed for long storage and be securely and visibly labeled as to part, function, and name of Equipment to which they apply.
      c. Contractor shall prepare an inventory list of the items delivered to Owner.

D. This Section covers filtration related to the aircraft fueling system for this Project. All items, materials, and components specified herein shall be suitable for use within an aviation fuel system with a maximum operating condition of 275 psig, -40°F to 100°F, and having a specific gravity of 0.81 (Jet A) or 0.67 (Aviation Gasoline).

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):
   1. Section VIII of the ASME Boiler and Pressure Vessel Code.

B. American Petroleum Institute (API):
   1. 1581, 6th Edition - Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators.

C. Military Specifications:
   1. MIL-PRF-4556 - Coating Kit, Epoxy for Interior of Steel Fuel Tanks.

D. Local governing code.

1.03 QUALITY ASSURANCE:

A. Manufacturer's Qualification: Firms regularly engaged in manufacture of valves and equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide products by one of the following:
   1. Filter Separators:
      a. Facet.
      b. Velcon.

2.02 FILTER SEPARATORS:

A. General Requirements: Vertical filter separator for removing free and entrained water and solid contaminants in conformance to API 1581, Category C, Type S, 5th Edition requirements. The vessel shall be designed for two-stage operation containing coalescer and separator cartridges.

B. Performance Characteristics: Flow rate shall be 200 gpm for Jet A receipt, and 50 gpm for Jet-A supply and 22 gpm for Avgas supply.

C. Tests:
   1. Shop tests shall be conducted on the filter separator in the manufacturer's shop in accordance with the standards of the ASME Code.
   2. Furnish certified shop test reports and submit to Engineer.
   3. Perform hydrostatic pressure tests of the vessel at 150% of the maximum design pressure.

D. Construction:
   1. Vessels shall be designed and fabricated of carbon steel in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. Vessels shall be designed and stamped for 150 psig maximum working pressure.
   2. Head closure shall be removable for access to cartridge elements. The assembly shall include swing-type, cadmium-plated eye bolts attached to the shell compatible with slotted bolt clips attached to the head. A hydraulic jacking device with pivot assembly capable of smoothly raising, lowering and rotating the head assembly shall be provided.
   3. All wettable components inside the vessel shall be epoxy coated conforming to MIL-PRF-4556 to a dry film thickness of 3 mils.
   4. Coalescer cartridges shall be inside/outside flow. Separator cartridges shall be outside/inside flow. Cartridge shall be screw mount.
   5. Cartridge chamber shall be complete with a sloped mounting plate to provide positive draining. Cartridge removal will be from the top of the vessel.
   6. Piping connections shall be 150-pound ANSI raised-face weld-neck flanges. for 3-inch and larger connections, and threaded FNPT for 2-1/2 inch connections. Connections shall have Gammon Kit No. 7 millipore test taps on the Inlet and outlet.

E. Accessories:
   1. Automatic Air Vents:
      a. Automatic air vent shall be all stainless steel construction including float and body. Seat shall be Buna-N for Jet A and Viton for aviation gasoline.
      b. Connections shall be 3/4-inch FNPT inlet and outlet.
      c. Provide a tee with a manual air vent between vessel and automatic air vent.

2. Ball Valves:
    a. Provide valves as specified in SECTION 13065 - FUEL SYSTEM VALVES.
3. Check Valves:
    a. A Gammon Technical Products GTP 2916 check valve shall be installed in the automatic air vent outlet.
    b. Check valve shall be stainless steel with 3/4-inch MNPT connections.
4. Differential Pressure Gauges:
    a. Provide a direct-reading differential pressure indicator with a stainless steel housing, push-button test and a 0-30 psi scale. Indicator shall be a Gammon Technical Products GTP-534PB-30S or approved equal.
    b. Gauge shall be mounted directly on the vessel and shall be complete with dampeners, stainless steel tubing, valves, and fittings.
5. Differential Pressure Switches:
    a. Provide switch mounted directly on vessel.
    b. Switch shall be 24Vdc, SPDT.
    c. Switch shall be a Custom Control Sensor Model 646DZE1.
    d. Switch shall have a field adjustable set point range on increasing pressure of 1.2 to 18 psi.
6. Thermal Relief Valves:
    a. Provide valves as specified in SECTION 13065 - FUEL SYSTEM VALVES.
    b. Relief valves on vessels shall be set at 125 psi.
7. Water Detection:
    a. Water detection shall be via an internal float assembly, with a pilot valve that will hydraulically close the water slug control valve on detection of water in the sump.
    b. System shall include an integral manual test lever to verify operation of the control pilot.
    c. Cla-Val Model CFF 21-H2, or equal.
8. Provide clean-out connections with victaulic coupling and plug.
9. Provide one set of filter elements for each vessel for flushing operations. Provide an additional set of filter elements for each vessel to be installed after system start-up. Provide an additional set of filter elements for each vessel for spares.

F. Manufacturer's Service Engineer: Furnish the services of an experienced service engineer for (1) day on the Site to verify proper installation, assist in start-up, flushing, and testing, and instruct Owner's operating personnel.

PART 3 - EXECUTION

3.01 SETTING AND ALIGNING EQUIPMENT:

A. Set and align all equipment supplied under this Section in accordance with manufacturer's recommendations.
B. Set true and level all Equipment at the locations shown. Demonstrate adequate leveling of installed Equipment.
C. Retighten all bolted connections after installation.

3.02 INSPECTIONS:

A. The Work will be inspected by Owner at intervals appropriate to the stage of construction during the course of construction.

B. Provide for inspection by all others having jurisdiction over the work performed under the various Sections of the Specifications during the proper phase.

C. At time of final inspection, furnish certificate or certificates of final approval by all others having jurisdiction.

3.03 TUBING INSTALLATIONS:

A. Assemble using Hy-Fer-Set presetting device as recommended by the manufacturer.

B. Route as required to interconnect the instrumentation provided.

C. Provide an instrument valve and threadolet for all "root" valve locations where instrumentation tubing connections are made to the piping system or equipment.

3.04 GAUGES:

A. Install where readily accessible to operations personnel.

3.05 VALVE AND EQUIPMENT INSTALLATION:

A. Install in accordance with manufacturer's recommendations.

B. Replace any and all valves and Equipment that prove defective during testing.

C. Arrange all valves during installation such that operating handles and controls are accessible, have sufficient clearance, and in the correct orientation for Owner's operation.

D. For adapters with integral screens; remove, clean, and reinstall screen after completion of flushing, before putting system into service.

3.06 CLEANING AND PROTECTION:

A. Clean all fabricated assemblies and all Equipment items thoroughly before operating or testing.

B. Protect Equipment from damage, deterioration, paint or coating spills or spots, corrosion, or harm from any source.

3.07 EQUIPMENT TEST AND CHECKOUT:

A. Before Equipment installations will be accepted, Contractor-furnished Equipment shall be tested and demonstrated to be correctly connected and installed.

B. All testing and checkout procedures of the manufacturer shall be carried out completely.

C. All tested Equipment found to be defective or inoperable to any extent is to be reported to Owner immediately.

D. Any operating difficulty or defective item as a result of Contractor's Work shall be repaired or replaced and put into proper operation by Contractor immediately.

E. Protect all Equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF ITEM 13071

ITEM 13075 - INSPECTION, TESTING, AND FLUSHING

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the inspection, testing, and/or flushing of all fuel system piping, and Equipment performance.

B. Provide for the "Gas Free" conditions required by SECTION 13061, as applicable to the Work of this Section.

1.02 REFERENCES:

A. Air Transport Association of America (ATA):
   1. 103 - Standards for Jet Fuel Quality Control at Airports.

B. American Society for Testing and Materials (ASTM):
   1. D910 - Standard Specification for Aviation Gasolines.
   2. D1655 - Specification for Aviation Turbine Fuels.
   3. D2276 - Test Methods for Particulate Contaminants in Aviation Turbine Fuels.
   4. D4176 - Standard Test Method for Free Water and Particulate Contamination in Distillate Fuels.

C. American National Standards Institute (ANSI):
   1. B31.3 - Chemical Plant and Petroleum Refinery Piping.

1.03 SUBMITTALS:

A. Submit detailed procedures for testing methods for approval before proceeding with pipe fabrication. This includes all radiographing, pressure testing, holiday testing, and flushing.

B. Submit examination personnel qualifications before proceeding with any testing method.

C. Submit completed examination procedures with actual testing data (readings) and signatures of examination personnel.

1.04 QUALITY ASSURANCE:

A. All tests (radiographing, pressure testing, holiday testing, and flushing) shall be performed in accordance with ANSI B31.3.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION

3.01 GENERAL:

A. Compressors used for air testing shall have sufficient capacity to bring the system under test up to the test pressure in a maximum of 20 minutes.

B. Owner will furnish all aviation kerosene fuel and aviation gasoline for testing and flushing except as otherwise specified.

C. Contractor shall furnish and operate all equipment required, including tankers, fuel transport trucks, gauges, instruments, hoses, connections, temporary pumps, temporary filter separators, and other items specified or required.

D. Contractor shall furnish electronic holiday detectors and all other labor and Equipment required.

E. Procedures:
   1. Pneumatically test fuel piping.

2. Hydrostatically test fuel piping.
3. Flush fuel piping.
4. Water shall not be used for testing fuel piping.

F. Responsibility of Contractor:
1. Notify the proper authorities and Owner that items are ready for inspection and testing. Twenty-four hours' notice shall be given for all inspection and tests.
2. Furnish and install all necessary equipment, materials, and personnel including pumps, compressors, gauges, and valves. Valves shall be approved by Owner and shall be suitable to hold test pressure for the specified time without leakage.
3. Conduct the tests of all systems in a safe manner and correct all deficiencies.
4. Apply the specified test pressures by means of a pump or compressor connected to the piping of highest elevation, and plug tightly afterwards.
5. Be fully responsible for operating trucks and equipment throughout the testing and flushing operations.
6. Obtain and pay for all necessary approvals, acceptances, and permits.
7. Contractor shall make provisions to conduct all tests during inclement weather, if necessary.

3.02 FUEL PIPING HYDROSTATIC PRESSURE TEST:

A. Apply a liquid pressure test with a grade of aviation kerosene fuel or aviation gasoline (as applicable) approved by Owner to the entire system following the pneumatic pressure test.
B. The pressure shall be gradually increased until a gauge pressure which is one-half the test pressure, 75 psig, is attained, at which time a preliminary check shall be made, including examination of exposed joints in accordance with ANSI B31.3. Thereafter, the pressure shall be gradually increased in steps until the test pressure of 150 psig is reached, holding the pressure at each step long enough to equalize piping strains.
C. The test pressure of 150 psig shall be maintained for at least 4 hours.
D. Repair any leaks in a manner approved by Owner.
E. Provide calibrated temperature and pressure instruments and chart recorders to provide continuous temperature and pressure readings variations during the tests. Instruments shall be calibrated for temperature and pressure immediately prior to each test. Recorder charts shall be submitted to Owner for review prior to final acceptance of the piping.
F. Permanent valves and adapters which are rated for the test pressure shall be in place for the liquid pressure test. Equipment which is not rated by the manufacturer for the test pressure shall be removed prior to testing. Install temporary connections as necessary.

3.03 FLUSHING:

A. Before a new, modified, or repaired fuel system, or portion thereof, is placed into service, all piping affected by change shall be flushed to ensure system cleanliness before aircraft fueling is permitted.
B. All flushing procedures, fuel sampling and testing shall be in accordance with ATA 103, latest revision.
C. The installing contractor shall be responsible for all flushing requirements.
D. All fuel required for flushing and testing will be supplied by Owner. Contractor shall arrange for delivery of fuel. Fuel which is flushed into transport trucks and is determined acceptable by Owner, shall be unloaded back into storage. However, fuel which is unacceptable shall be removed from the Site and disposed of at Contractor's expense.

E. Product used for flushing shall meet ASTM D1655, latest revision, specifications for kerosene Jet A/A-1 type aviation grade turbine fuels or ASTM D910, latest revision, specifications for aviation gasolines (100 low lead).

F. Desired flow rate of flush is 10 feet per second minimum unless a lesser rate is agreed upon by fuel quality assurance representative. Additional temporary pumps and filters, if required to provide minimum flow velocity, shall be provided by Contractor.

G. Test samples shall be drawn immediately ahead of filtration on closed loop recirculation systems; immediately ahead of storage tanks in receiving manifold on recirculation systems returning flushed fuel to tankage; or immediately ahead of transport trucks on single line systems.

H. Where possible, temporary piping connections to form a closed loop piping system shall be installed and the system flushed by means of recirculation. All temporary cross connections or special fabrication of adapters required shall be provided by Contractor.

I. For flushing into tank trucks, Contractor shall supply any temporary manifolds plus sufficient number of single compartment tank trucks and hoses to allow the desired flow rates to be achieved in a safe manner. Hoses and couplings shall be aircraft type with a minimum 350 pound rating and shall be hydrostatically tested

J. All general service valves and adapters shall be in place throughout the flushing procedure. Contractor shall remove control valves and metering assemblies prior to initiating flush.

K. Contractor shall provide all filtration media required for return of fuel to the airport fuel storage facility following the system flush. This includes intermediate filtration media changeouts if excessive media loading or disablement occurs during return of flushed fuel to the fuel storage facility. Upon completion of flush and return of flushed fuel to the airport fuel storage facility, Contractor shall again provide new filtration media if replacement is determined necessary by the Owner due to filter element loading from the return of flushed fuel. Contractor shall reimburse the Owner for fuel facility operator labor costs incurred during these filter media changeouts.

L. Flushing into Tank Trucks:

1. The system pumps of the fueling system shall be used for the flushing procedure and shall be operated at Contractor's expense.
2. The filtration system of the fueling system shall be used for the flushing procedure.
3. Flushing shall be accomplished by flushing fuel from the storage tank, through the pumping/filter system, down the main dead-end pipe run into Contractor-furnished fuel transport trucks.
4. Procedure:

   Caution: All electrical and motorized equipment in area should be shut down in case of a mishap or fuel spill. For safety, all persons not involved in the flushing operation shall be kept a minimum of 100 feet away from tank trucks and hydrant pits used in the flushing operation.

   a. Tank truck internal valves should be safety wired in an open position.
   b. Dry break couplers shall be provided at the end of all truck feeder hoses.
   c. Hoses shall be secured in a manner to prevent whipping during flush.
   d. Bond truck to system piping.
   e Start product flow slowly before reaching flushing velocity to check for leaks and system tightness.
   f. Fire extinguishers shall be in place in case of emergency.
   g. Location of test personnel:
      (1) One person per each tank truck to monitor fuel level in tank.

(2) One person at each shut-off valve to control fuel flow into tank truck.
(3) One person at main pump control station to shut down pump in emergency.
(4) One person at nearest g EFS station to shut down pump in emergency.
(5) One person manning fire extinguisher(s).
(6) One person removed from manual tasks in command of flushing operation.

M. Acceptance Specifications:
1. Visual - All fuel samples shall be clear and bright. Other visual clues must be observed and acted upon accordingly, i.e.; feel, color, odor, and similar characteristics. This test shall be performed in accordance with ASTM D4176.
2. Perform a membrane test per ASTM D2276. A minimum of 1 gallon of jet fuel shall be used for this test. Visually assess the membrane and compare it with a color rating booklet. The color shall be a maximum of #3 Rated Wet with a particulate contamination not exceeding the B scale. Flushing shall continue and the membrane test repeated, until a sample is obtained which meets these requirements.
   Note: If color rating exceeds the above limits or is in dispute, a matched weight gravimetric rating not to exceed 0.5 mg/gal shall govern.
3. Water - 5 ppm maximum.
4. Water Separation (Microsep) Rating - 85 minimum.

N. Final Acceptance:
1. It shall be the responsibility of the fuel quality assurance representative, or his designee, to have final decision on system cleanliness and acceptance before aircraft fuel servicing is permitted.

O. After flushing has been completed and approved, Contractor shall remove all temporary cross connections and related items, and install control valves, metering elements, strainer baskets, and other system components. Contractor shall also be responsible for replacing all filter media and cleaning the interior of aboveground fuel storage tanks after flushing and return of fuel to storage has been completed, so that the entire facility may be received in a new and clean condition as described previously.

3.05 PERFORMANCE TESTING:

A. Contractor shall subject the entire fueling system to such operating tests as required by Owner, to demonstrate satisfactory functioning and operating efficiency.
B. Tests shall include checks to determine that all control valves and switches are properly adjusted.
C. Testing shall include the functions of the complete electrical system.
D. All instruments required to conduct the tests shall be furnished by Contractor.
E. All tests may be witnessed by a representative of Owner.
F. Submit typed samples of test reports to Owner for approval.
G. Submit completed test reports.

END OF ITEM 13075

ITEM 13201 - FUEL STORAGE TANK PACKAGES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers the requirements for shop fabricated aboveground packaged storage tank systems, including tank, appurtenances, packaged pump and filtration equipment, metering, and operational controls.

B. Storage tanks shall be epoxy coated, cylindrical, horizontal, double-wall, shop fabricated butt-welded steel tanks for the aboveground storage of Jet A fuel or low lead aviation gasoline. The Jet-A and AVGAS tanks shall have a nominal capacity of 12,000 gallons and the waste fuel tank shall have a nominal capacity of 400 gallons.

C. The AVGAS tank shall be a double-wall, fire-resistant, protected, tank, constructed, listed, and labeled in accordance with UL-2085. The Jet-A tank shall be a double wall tank constructed, listed, and labeled in accordance with UL-142. The waste fuel tank shall be single-wall listed and labeled in accordance with UL-142 with secondary containment.

D. The Jet-A and AVGAS tanks shall be provided with tank skids, fabricated to provide a tank slope of 1/8" per foot towards the water draw off end. The waste fuel tank shall be provided with skids, fabricated to provide a slope of 1/8" per foot towards the suction inlet.

E. The tanks shall be equipped with openings and appurtenances specified herein. All tank openings shall be through the top of the tank.

F. The Jet A fuel and low-lead aviation gasoline tank systems shall be provided as a packaged unit with pump and filtration equipment, meters, valves, piping and instrumentation. The equipment shall be placed on secondarily contained porches, attached to tank support structure. The waste tank does not require packaged equipment.

G. The tank systems shall meet the requirements of NFPA 30 for aboveground storage of flammable and combustible liquids.

H. The tank systems shall include an emergency fuel shut-off system (EFS) in conformance with NFPA-407.

I. Related Work Specified Elsewhere:
   1. Fuel System General Requirements: SECTION 13051.
   2. Identification of Fuel Piping and Equipment: SECTION 13053.
   3. Fuel System Pipe, Connections, and Installation: SECTION 13061.
   4. Fuel System Coatings for Corrosion Protection: SECTION 13063.
   5. Fuel System Valves: SECTION 13065.
   6. Fuel System Accessories: SECTION 13067.
   7. Fuel System Pumps: SECTION 13069.
   8. Fuel System Filtration: SECTION 13071.
   9. Inspection, Testing and Flushing: SECTION 13075.

1.02 REFERENCES:

A. Applicable Codes and Standards:
   1. American Petroleum Institute (API) Publications:
      a. 2000 - Venting Atmospheric and Low Pressure Storage Tanks.
      b. 2350 - Overfill Protection for Storage Tanks in Petroleum Facilities
      c. 607 - Fire Test for Soft Seated Quarter Turn Valves
      d. 608 - Metal Ball Valves

e. 1581 - Specifications and Qualification Procedures for Aviation Jet Fuel Filter/Separators.
f. 1542 - Airport Equipment Marking for Fuel Identification
g. 1529 - Aviation Fueling Hose and Hose Assemblies

2. Underwriters Laboratories Inc. (UL) Publications:
   a. 142 - Steel Aboveground Tanks for Flammable and Combustible Liquids.
   b. 2080 - Fire Resistant Tanks for Flammable and Combustible Liquids.
   c. 2085 - Protected Aboveground Tanks for Flammable and Combustible Liquids.
3. National Fire Protection Association (NFPA) Publications:
   a. 30 - Flammable and Combustible Liquids Code.
   b. 70 - National Electrical Code
   c. 407 - Standard for Aircraft Fuel Servicing.
4. Applicable State of Wyoming and local regulations and ordinances.

1.03 SUBMITTALS:

A. Equipment Supplier will provide the manufacturer's literature and shop drawings for the storage tank systems, equipment skids, and accessories including, but not limited to, the following:
   1. Fuel storage tanks, showing construction and location of all fittings.
   2. Equipment skid plans showing layout of equipment and piping, frame, and construction.
   3. Anchor bolt and foundation plans.
   4. Platform shop drawings.
   5. Interior and exterior coatings.
B. Provide results of all tightness testing.
C. Provide UL-142 and UL-2085 certification.

1.04 QUALITY ASSURANCE:

A. All equipment and material shall be the latest design, new, first quality standard product of manufacturers regularly engaged in the production of such equipment and material.
B. When two or more units of the same class of equipment are required, they shall be products of a single manufacturer.
C. Manufacturer shall have had a minimum of five years experience in the design and fabrication of packaged aviation fueling systems, including tanks, of similar size and configuration.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance requirements, provide products by one of the following:
   1. Fuel Storage Tank Packages:
      a. First Fueling Systems, Inc.
      b. Garsite LLC.
      c. MSI Automated Fuel Management Systems.
      d. Approved Equal

2.02 SHOP FABRICATED ABOVEGROUND STORAGE TANKS:

A. Provide double-wall horizontal storage tanks constructed in accordance with and listed under UL-142 and UL-2085 as applicable, and in accordance with Paragraph 2-4.2 of ATA-103.

B. Materials of construction shall be carbon steel conforming to ASTM materials, grades and thickness unless specified otherwise herein.

C. Provide with skids and supports that conform to requirements of UL-142 and NFPA 30. Adjust fabricated skid heights to slope tank bottom to water draw-off end at a 1% slope.

D. Provide strike plates under all tank openings. Plates shall be made of at least 10-gauge steel plate and shall be 24 inches square, minimum.

E. Lifting lugs shall be provided at the balance points.

F. Provide blind flanges, threaded plugs and threaded caps during shipment and installation, to protect tank openings.

G. Coat all fuel system surfaces in accordance with the requirements of SECTION 13063.

H. Provide the following nozzles and accessories for each of the storage tanks. Locations shall be indicated on the shop drawings and submitted for approval. All nozzles shall be located on the top centerline of the tank, and shall be level and true to line.

1. Jet-A Tank:
   a. 3-Inch ASME 150# Flanged Fill Nozzle with overfill prevention valve, drop tube, elbow, and inlet diffuser. Overfill prevention valve shall function as anti-siphon valve in addition to providing overfill shut-off at 95% of tank capacity. Centerline of inlet diffuser shall be within 6-inches of tank bottom.
   b. 4-Inch ASME 150# Flanged Suction Nozzle, with anti-siphon valve, drop tube, and 4-inch floating suction. Floating suction shall include a stainless steel cable to limit maximum height, suction baffle and support leg to maintain minimum intake level of 6-inches above the tank bottom, and external indication of floating suction height.
   c. 4-Inch ASME 150# Flanged Automatic Tank Gauge Nozzle.
   d. 4-Inch ASME 150# Flanged High/Low Level Switch Nozzle.
   e. 1-Inch FNPT Water Draw-Off port within ½-inch of tank bottom.
   f. 3-inch ASME 150# Flanged Pressure/Vacuum Vent Nozzle.
   g. 8-inch ASME 150# Flanged Primary and Secondary Emergency Vent Nozzles.
   h. 2-Inch ASME 150# Flanged Floating Suction Test Cable Nozzle.
   i. Two each 24-inch bolted manways with welded internal ladders.
   j. 4-Inch FNPT Gauge Hatch Nozzle, with perforated drop tube stilling well.
   k. 2-Inch ASME 150# Flanged Leak Detection Nozzle.
2. Avgas Tank:
   a. 3-Inch ASME 150# Flanged Fill Nozzle with overfill prevention valve and drop tube. Overfill prevention valve shall function as anti-siphon valve in addition to providing overfill shut-off at 95% of tank capacity.
   b. 3-Inch ASME 150# Flanged Stage I Vapor Recovery Nozzle.
   c. 2-Inch ASME 150# Flanged Suction Nozzle with anti-siphon valve, drop tube, and 2-inch floating suction. Floating suction shall include a stainless steel cable to limit maximum height, suction baffle and support leg to maintain minimum intake level of 6-inches above the tank bottom, and external indication of floating suction height.
   d. 4-Inch ASME 150# Flanged Automatic Tank Gauge Nozzle.
   e. 4-Inch ASME 150# Flanged High/Low Level Switch Nozzle.

f. 1-Inch FNPT Water Draw-Off Nozzle with drop tube to within ½-inch of tank bottom.
g. 3-inch ASME 150# Flanged Pressure/Vacuum Vent Nozzle.
h. ASME 150# Flanged Primary and Secondary Emergency Vent Nozzles sized in accordance with NFPA-30 requirements.
i. 2-Inch ASME 150# Flanged Floating Suction Test Cable Nozzle
j. 24-inch bolted manway with welded internal ladder.
k. 4-Inch FNPT Gauge Hatch Nozzle, with perforated drop tube stilling well.
l. 2-inch ASME 150# flanged leak detection nozzle.

3. Waste Tank:
   a. 2-Inch FNPT drain funnel inlet.
   b. 1-inch FNPT pressure inlet with overfill prevention valve and drop tube to within 6-inches of tank bottom.
   c. 2-Inch ASME 150# Flanged Suction Nozzle with anti-siphon valve and drop tube with anti-vortex baffle to within 1-inch of tank bottom.
   d. 2-Inch FNPT Mechanical Level Indicator Nozzle.
   e. 4-Inch ASME 150# Flanged High Level Switch Nozzle.
   f. 4-Inch FNPT Gauge Hatch Nozzle.
   g. 2-Inch ASME 150# Flanged Pressure/Vacuum Vent Nozzle.
   h. ASME 150# Flanged Primary and Secondary Emergency Vent Nozzles sized in accordance with NFPA-30 requirements.
   i. 18-Inch Bolted Access Cover.
   j. 2-Inch ASME 150# Flanged Leak Detection Nozzle

I. Tank Accessories:
1. Provide fill nozzles with internal drop tube of carbon steel piping. Jet-A and Avgas drop tubes shall be coated on both internal and external surfaces. Avgas drop tube shall extend to within 6 inches of bottom of tank. Provide with a 45 degree beveled end. Jet-A drop tube shall include 90-degree elbow and inlet diffuser in accordance with paragraph 2-4.2(b) of ATA-103. Centerline of diffuser shall be within 6-inches of tank bottom.
2. Provide suction nozzles with a floating suction assembly. Floating suction shall be all welded aluminum construction with aluminum and stainless steel trim. Inlet shall have an anti-vortex baffle and bell opening. Outlet shall connect to a 150# ASME flange. Provide with a stainless steel test cable.
3. Provide a pressure vacuum vent with an aluminum body and stainless steel pallets for normal venting of each tank. Tank manufacturer shall verify the size of the vent based on a fill and discharge rate of 200-gpm for Jet A and Avgas tanks, and a fill rate of 20-gpm and discharge rate of 50-gpm for the waste tank. Sizing shall meet the requirements of API STD 2000 and NFPA 30. Submit sizing calculations.
4. Provide an emergency vent with aluminum base and epoxy powder coated cast iron top for each tank. Seals shall be Buna-N. Emergency vents shall mount on an ASME 150# flange. Tank manufacturer shall verify the size of the vent based the requirements of API STD 2000 and NFPA 30. Submit sizing calculations.
5. Provide an internal ladder for access to the interior of the Jet-A and Avgas tanks through the manway. Ladder shall be carbon steel coated in accordance with the requirements of SECTION 13063. Ladder shall not interfere with floating suction assembly movement.
6. Provide Jet-A and Avgas tanks with electronic level gauge system with, and separate level alarm system with visual alarm point indication for high-high, high, low, and low-low fuel levels. The high level alarm shall initiate at the 90% tank fill level, and the high-high alarm level shall initiate at the 95% tank fill

level. The Jet-A high-high level alarm shall be interlocked with the receipt pump to stop fuel receipt. The low-low level alarms in both the Jet-A and Avgas tanks shall be interlocked with the respective supply pump to stop fuel delivery.

For the Waste Tank, provide an analog gauge system with local read-out, in addition to separate high and low level visual alarms. Provide digital leak detection senor in the interstitial space between the primary and secondary containment tank walls. Connect all electronic level and leak detection sensors to a Veeder-Root TLS-350 tank monitoring system, or equal. Tank monitoring system shall also monitor fuel inventory and be capable of local printing of fuel inventory reports. System shall also control the visual alarm indication for tank level warning.

7. Provide a maintenance platform along the full length of the top of the tank for access to all tank nozzles and tank accessories. Platform width shall be a minimum of 36 inches. Provide platform with OSHA approved handrails. Extend catwalk as required. Platform and handrails shall be constructed of structural shapes and grates of ASTM carbon steel materials. Platform shall be coordinated with catwalk for a step down to the platform from the catwalk. Platform shall maintain access to and clearances from manways and all other tank appurtenances. Platforms, steps, external ladders and handrails shall be galvanized.

2.03 PUMPS, VALVES, FILTRATION AND METERING EQUIPMENT:

A. Provide as complete units, the pumping, filtration and metering equipment. The equipment units shall be shop fabricated and shall be attached, either in the field or in the shop, to the tank storage system. Units shall include frame, secondary containment pan, pump, filters, filter/separators, meters, valves, instruments, and piping specified and as necessary to provide a complete operational system. As a minimum, each system shall include the following:

1. Jet-A System Fuel Receipt:
   4-inch Kamlok adaptor with lockable dust cap, 4x3 eccentric reducer, 3-inch steel fire rated API-607 full port ball valve, 3-inch basket strainer, 15 Gallon (min.) spill container, self- priming centrifugal pump sized for 200-gpm receipt flow rate at the maximum system head, dead-man control of pump, 3-inch check valve, 200-gpm tank-type bulk air eliminator with control valve, API-1581, 5th Edition compliant 200-gpm rated filter/separator with water float valve, sump heater, and flow limiting slug valve (in accordance with 2-4.3 of ATA-103), air eliminator with check valve and pressure relief valve, and 3-inch isolation butterfly valves, spring rewind static grounding reel.
2. Jet-A System Over the Wing Fuel Supply:
   22-gpm rated direct into plane delivery system including: 2-inch Fire Rated shut-off valve with fusible link, 2-inch steel fire rated API-607 full port ball valve, self-priming centrifugal or sliding vane type positive displacement pump, API-1581, 5th Edition compliant filter/separator with water float valve, sump heater, and flow limiting slug valve (in accordance with 2-4.3 of ATA-103), air eliminator with check valve and pressure relief valve, and 2-inch isolation ball valves, positive displacement meter with electronic pulsar, electric rewind hose reel, 75-ft API-1529 aviation fueling hose, and mechanical dead-man type 22-gpm duck-bill nozzle, spring rewind static grounding reel. In addition, the Jet-A delivery system shall be configured to re-circulate fuel back to the tank to facilitate Millipore testing. The hose and static ground cable shall be mounted with in a enclose cabinet to protect against accumulation of snow or ice on the reels. The access door of the cabinet shall be at least 2-ft above the apron surface to prevent blockage from accumulated snow and ice.

3. Jet-A System Single Point Connection Fuel Supply:
   50-gpm rated single point delivery system including: 2-inch Fire Rated shut-off valve with fusible link, 2-inch steel fire rated API-607 full port ball valve, self-priming centrifugal or sliding vane type positive displacement pump, API-1581, 5th Edition compliant filter/separator with water float valve, sump heater, and flow limiting slug valve (in accordance with 2-4.3 of ATA-103), air eliminator with check valve and pressure relief valve, and 2-inch isolation ball valves, positive displacement meter with electronic pulsar, electric rewind hose reel, 75-ft API-1529 aviation fueling hose, single point refueling nozzle, spring rewind static grounding reel, and spring rewind intrinsically safe electric deadman switch on 75-ft cable. The hose, static ground cable and deadman control shall be mounted with in a enclose cabinet to protect against accumulation of snow or ice on the reels. The access door of the cabinet shall be at least 2-ft above the apron surface to prevent blockage from accumulated snow and ice.
4. Avgas System Receipt:
   3-inch Kamlok adaptor with lockable dust cap, 15 gallon (min.) spill container, , self- priming centrifugal pump sized for 200-gpm receipt flow rate at the maximum system head, dead-man control of pump, 3-inch API-607 fire rated butterfly valve, 200-gpm rated Avgas filter, 3-inch check valve, and spring rewind static grounding reel. Provide 3-inch vapor recovery pipe with 3-inch fire rated shut-off valve with fusible link, 3-inch API 607 fire rated butterfly valve, and 3-inch Kamlok adaptor with locking dust cap.
5. Avgas System Fuel Supply:
   22-gpm rated direct into plane delivery system including: 2-inch Fire Rated shut-off valve with fusible link, 2-inch steel fire rated API-607 full port ball valve, self-priming centrifugal or sliding vane type positive displacement pump, dispenser with electronic pulsar, avgas filter, electric rewind hose reel, 75-ft API-1529 aviation fueling hose, aviation avgas over-wing nozzle, and spring rewind static grounding reel. The hose and static ground cable shall be mounted with in a enclose cabinet to protect against accumulation of snow or ice on the reels. The access door of the cabinet shall be at least 2-ft above the apron surface to prevent blockage from accumulated snow and ice.
6. Fuel Recovery:
   Provide sump separators with return pumps for both the Jet-A and Avgas system. The sump drains from the Jet-A system filter/separators shall be piped to the Jet-A sump separator, and the drain line from the Avgas receipt filter shall be piped to the Avgas sump separator. Provide valves and piping to enable selected return of fuel through filtration to the applicable storage tank, or to the waste tank.
7. Waste Fuel Tank:
   Inlet line to the waste tank shall include a 1-inch check valve, and a 1-inch steel fire rated API-607 full port ball valve. The suction line from the tank shall include a 2-inch Fire Rated shut-off valve with fusible link, 2-inch steel fire rated API-607 full port ball valve, and a 2-inch Cam-lok adaptor with an aluminum dust cover.
8. Water Draw Off Pump:
   A 1-inch line shall be routed from the water draw off port to a hand operated diaphragm pump. The pump shall discharge to the waste tank inlet line. 1-inch isolation valves shall be installed on either side of the hand pump to allow for maintenance as well as a 1-inch check valve downstream of the hand pump. Water draw off nozzle with drip tube shall be installed upstream of the pump to test for the presence of water. Elevation of the water draw off nozzle shall be at or below the elevation of the water drain off port on the tank. All lines installed

prior to the water draw off nozzle shall be installed at or below the level of the water draw off port on the tank to prevent creating a water trap. A 1-inch isolation valve shall be installed immediately downstream of the water draw off connection point on the fuel tank for isolation of the entire water draw off line. The Avgas and Jet A shall each have their own water draw off system connected to the respective waste fuel tank.

9. Self-Service System:
   Fuel supply shall be controlled through a card access system equivalent to a QT Technologies M4000 system, and shall include: Credit Card fuel management unit with pedestal, hose control for up to four hoses, Smartcard activation, alphanumeric keypad, USB connection and Wireless for connection between system and office computer, Smartcard access keys, weather covering to protect the panel and controls from snow and ice buildup, and pedestal mounted credit card receipt printer. Note: The Jet-A system shall be configured as a slave to the Avgas master system.

B. Piping, valves, equipment, and instruments shall be provided as specified in the following sections:
   1. Piping shall meet the requirements of SECTION 13061 - FUEL SYSTEM PIPE, CONNECTIONS, AND INSTALLATION.
   2. Valves shall meet the requirements of SECTION 13065 - FUEL SYSTEM VALVES.
   3. Meters, equipment and instruments shall meet the requirements of SECTION 13067 - FUEL SYSTEM ACCESSORIES.
   4. Pumps shall meet the requirements of SECTION 13069 - FUEL SYSTEM PUMPS.
   5. Filter separators shall meet the requirements of SECTION 13071 - FUEL SYSTEM FILTRATION.

C. All exterior carbon steel surfaces shall be coated in accordance with the requirements of Section 13063. This includes frame and secondary containment pan, piping, valves, equipment, and applicable instruments.

D. All wetted carbon steel surfaces shall be coated in accordance with the requirements of Section 13063.

E. Do not coat stainless steel, galvanized or aluminum surfaces.

2.04 ADDITIONAL ACCESSORY EQUIPMENT:

A. Contractor to include providing a spill kit. Coordinate with local authority having jurisdiction on the size of the spill kit.

B. Contractor to include an enclosure for a fire extinguisher located at the fueling station. This should protect the extinguisher from ice and snow. Enclosure should conform to all NFPA, state and local code requirements.

C. A second Emergency Fuel Shutoff (EFSO) shall be installed at the Terminal Building. Primary EFSO shall be installed per NFPA 407 location requirements.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. System shall be installed per manufacturer's recommendations; recognized industry standards; and federal, state and local codes.

3.02 TESTS:

A. Primary tank shall withstand an independent air pressure test applied in the manufacturer's shop at 5 psig. The air pressure shall hold for a period of 4 hours without a drop after the test apparatus has been removed.
B. After tank is set on its foundation, Contractor shall perform 5 psig air test of the primary tank. Tests on each vessel shall not be performed simultaneously. Hold each air test for 4 hours.
C. Any leakage or other defects shall be considered a failure of these tests. Necessary repairs shall be made upon failure and the test shall be rerun until all defects are eliminated.
D. Perform operational tests for all electrical equipment provided as part of the packaged systems.
E. Perform operation test to verify operation of the EFS system.
F. Upon completion of system flushing and testing requirements in accordance with Section 13075, perform complete operational test of entire fueling system.
G. Owner's representative will witness system tests.
H. Contractor shall submit field test reports to Engineer.

3.03 PAINTING:

A. As specified in SECTION 13063.

3.04 CERTIFICATION: The Contractor shall provide to the Owner a certification letter with attached "as-constructed" data sheet for the tank, certifying that the tank is constructed in accordance with applicable standards, including UL 142, UL 2080, and UL-2085.

3.05 TRAINING:

A. Contractor shall provide one (1) training session on the operation and maintenance of the system to airport personnel and other personnel as designated by the airport.

END OF ITEM 13201

GEOTECHNICAL DATA SUMMARY

Task 1

PROPOSED RUNWAY IMPROVEMENTS
Morrisville-Stowe State Airport
Morristown, Vermont

Prepared for:

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Table of Contents

1.0 INTRODUCTION

John Turner Consulting, Inc. (JTC) is pleased to present this *Geotechnical Data Summary* for the proposed Runway Improvements Project for the Morrisville-Stowe State Airport in Morristown, Vermont. JTC conducted geotechnical explorations, laboratory testing, and engineering evaluations in general accordance with our proposed scope of services (Task 1) submitted to Jacobs Engineering Group on May 30, 2018. The work was authorized on August 10, 2018.

The purpose of the geotechnical investigation was to obtain information on the subsurface conditions at the site to support the planning, design, and construction of the proposed Runway Improvements. Geotechnical explorations and laboratory testing services were performed in August, September, and October of 2019.

The contents of this report are subject to the attached *Limitations*.

2.0 PROJECT INFORMATION

The following subsections provide general descriptions of the site, the regional geologic setting, and the proposed development.

2.1 Site and Project Description

The site is located at 2305 Laporte Road in Morristown, Vermont, about 750 feet west of the Ryder Brook and 650 feet from Route 100 (Laporte Road). The airport property is largely surrounded by undeveloped forestland and plains.

Presently, the site is occupied by Runway '1-19', Taxiways A and B, various airport buildings, hangars, and airplane parking areas. Existing site conditions are depicted on the attached *Boring Plan*. Runway '1-19' is approximately 75 feet wide and 3,700 feet long. Taxiway A and B connect to Runway '1-19' from the nearby airport buildings. The airport buildings, hangars, and parking areas are located approximately 270 feet to the west of the runway.

The proposed Runway Improvement area is located to the northwest of the runway in an unpaved area. The geotechnical work is depicted on the attached *Proposed Boring Location Plan*.

2.2 Regional Geologic Setting

JTC's review of the "Ground water favorability map of the Lamoille River basin, Vermont" (Hodges, A.L., Jr., and Butterfield, David;1967) indicates that the site soils are characterized by Glacial Drift. Glacial Drift is typically described as coarse-grained stream gravel with some sand, silt and/or clay.

3.0 GEOTECHNICAL EXPLORATIONS

3.1 Soil Borings

JTC subcontracted Cascade to perform seven (7) test borings (designated as B-1 through B-7, inclusive) via a Mobile B57 truck-mounted drill rig. JTC directed the drilling, testing, and sampling activities and logged the subsurface conditions encountered at each boring location.

The test boring locations were selected in relation to the existing site features and proposed development, and under the constraints of drill rig access and utility conflicts. Subsequently, the relative location of each boring was established via measurements from existing site features and scaling the dimensions onto the provided plan(s). The attached *Test Boring Location Plan* depicts the approximate exploration locations.

The test borings were advanced to a depth of 10 feet below the ground surface (bgs) utilizing 3¼-inch inner-diameter hollow stem augers (HSAs). As the borings were advanced, standard penetration tests (SPTs) were conducted at regular intervals and soil samples were obtained via 2-inch outside-diameter split-spoon samplers driven by a 140-pound automatic hammer. SPTs were performed in general accordance with ASTM D1586, *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*. Soil samples were sealed in moisture-tight containers and returned to JTC's office for further review, classification, and geotechnical laboratory testing.

The test borings were backfilled with soil cuttings upon completion of drilling. Detailed records of the drilling, testing, and sampling performed, and the soil, bedrock, and groundwater conditions observed at each test boring location are provided on the attached *Test Boring Logs*.

4.0 GEOTECHNICAL LABORATORY TESTING

JTC selected representative soil samples for geotechnical laboratory testing at our in-house laboratory. The following tests were performed:

- 9 Moisture contents;
- 3 Particle-size analyses;
- 3 Proctors; and
- (3) 3-Point CBRs.

Geotechnical laboratory testing was performed in general accordance with ASTM procedures. The results of the laboratory testing have been tabularized below. For further information refer to the attached *Geotechnical Laboratory Testing Reports*.

4.1 California Bearing Ratio (CBR)

CBR testing of the subgrade soils indicates a CBR value of 32 for specimens compacted to 100% of modified proctor maximum dry density (MPMDD) at optimum moisture content. CBRs typically ranged from 5 to 55 for specimens compacted to 97 to 100% of MPMDD at up to 9.3% moisture content.

Table 1 – CBR Testing Results

Exploration # (Combined Sample)	CBR Values & Test Conditions				
	CBR at 6% moisture (Corrected)	CBR at 9% moisture (Corrected)	Target moisture Content (%)	Actual moisture Content (%)	In-Situ Moisture Content (%)
B-1, B-2, B-3 [Point 1]	42	21	6	6.5	3.4
B-1, B-2, B-3 [Point 2]	51	32	9	8.8	3.4
B-4 [Point 1]	32	5	6	6.5	3.8
B-4 [Point 2]	41	9	9	9.2	3.8
B-5, B-6, B-7 [Point 1]	38	4	6	6.6	7.0
B-5, B-6, B-7 [Point 2]	55	6	9	9.3	7.0

Table 2 - Modified Proctor, Particle Size Analysis and Moisture Content				
Exploration and Sample #	**Maximum Dry Density (pcf)**	**Optimum Moisture (%)**	**Percent Finer (by weight)**	
			#4	#200
B-1, B-2, B-3	126.3	9.2	84.2	9.8
B-4	127.7	8.8	84.8	8.8
B-5, B-6, B-7	137.1	6.0	68.1	12.8

5.0 SUBSURFACE CONDITIONS

The following subsections describe the site soil, bedrock, and groundwater conditions encountered, based on results of the geotechnical explorations and laboratory testing. Detailed descriptions of the conditions observed at each test boring are provided on the attached *Test Boring Logs*.

5.1 Soils

The overburden soils encountered at the test boring locations appear to be consistent with those described by the published geologic data. The primary soil strata are briefly described in the paragraphs below.

5.1.1 Topsoil

Topsoil materials were encountered at the ground surface at all boring locations. These soils were described primarily as dark brown silty sand (SM) with trace gravel and organic. The thickness of the Topsoil was usually about 6 inches and was described as very loose to medium dense based on SPT N-Values.

5.1.2 Subsoil

Soils described as light brown silty sand (SM) or sand with silt (SW-SM) were encountered beneath the topsoil layer at most of the boring location. The subsoil was encountered at depths of 0.25 feet to 4 feet bgs. These soils were considered to be very loose to medium dense based on SPT N-Values.

5.1.3 Fill

Fill materials were encountered underneath the ground surface and Subsoil layers at some of the boring locations, B-4, B-4A, B-6 and B-7. These soils were described primarily as brown silty sand (SM) with trace gravel. The Fill was encountered at depths of 0.33 to 4 feet bgs and was described as loose to medium dense based on SPT N-Values.

5.1.4 Glacial Deposits

Native soils described primarily as brown silty sand (SM) or brown sand with silt (SW-SM) were encountered beneath the Fill or Subsoil layers at each boring location. Glacial Deposits were encountered at depths of 2 feet to at least 10 feet bgs. These soils were considered to be very loose to medium dense based on SPT N-Values.

5.2 Bedrock

Bedrock was not encountered at any of the exploration locations and is not expected to impact the project, based on the results of this investigation.

5.3 Groundwater

Groundwater was not encountered during this subsurface exploration. However, short-term (i.e., during drilling, upon completion of drilling, and/or a few hours after drilling) water levels observed in test borings performed in silty soils should be considered approximate.

JTC estimates that this investigation occurred during a period of seasonally normal ground water. Site groundwater levels should be expected to fluctuate seasonally and in response to precipitation events, construction activity, site use, and adjacent site use.

6.0 CLOSING

We trust the contents of this memorandum are responsive to your needs at this time. Should you have any questions or require additional assistance, please do not hesitate to contact our office.

APPENDIX A: LIMITATIONS

Explorations

1. The analyses and recommendations presented in this report are based in part upon the data obtained from widely-spaced subsurface explorations. Subsurface conditions between exploration locations may vary from those encountered at the exploration locations. The nature and extent of variations between explorations may not become evident until construction. If variations appear, it will be necessary to re-evaluate the recommendations of this report.
2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretation of widely-spaced explorations and samples; actual strata transitions are probably more gradual. For specific information, refer to the individual test pit and/or boring logs.
3. Water level readings have been made in the test pits and/or test borings under conditions stated on the logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors differing from the time the measurements were made.

Review

4. It is recommended that John Turner Consulting, Inc. be given the opportunity to review final design drawings and specifications to evaluate the appropriate implementation of the geotechnical engineering recommendations provided herein.
5. In the event that any changes in the nature, design, or location of the proposed areas are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed, and conclusions of the report modified or verified in writing by John Turner Consulting, Inc.

Construction

6. It is recommended that John Turner Consulting, Inc. be retained to provide geotechnical engineering services during the installation phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

Use of Report

7. This report has been prepared for the exclusive use of Jacobs Engineering Group and the Stowe-Morrisville State Airport for the Proposed Runway Improvements in Morristown, Vermont. All considerations are based on the available information and is in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.
8. This report has been prepared for this project by John Turner Consulting, Inc. This report was completed for preliminary design purposes and may be limited in its scope to complete an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to preliminary geotechnical design considerations.

APPENDIX B: RECOMMENDED SOIL GRADATION & COMPACTION SPECIFICATIONS

TABLE 1: Structural Fill

SIEVE SIZE	PERCENT PASSING BY WEIGHT
5-inch	100
¾-inch	60 - 100
No. 4	20 - 80
No. 200	0 - 10

NOTES:

1. For use as structural load support below foundations and within the building pad. Structural Fill placed beneath building foundations should include the Footing Zone of Influence which is defined as that area extending laterally one foot from the edge of the footing then outward and downward at a 1:1.5 (H:V) splay.
2. ¾-inch crushed stone may be used in wet conditions.
3. Structural Fill should be free of construction and demolition debris, frozen soil, organic soil, peat, stumps, brush, trash, and refuse;
4. Structural Fill should not be placed on soft, saturated, or frozen subgrade soils;
5. Structural Fill should be placed in lifts not exceeding 12 inches for heavy vibratory rollers and 8 inches for vibratory plate compactors.
6. Place and compact within ± 3% of optimum moisture content.
7. Compact to at least 95% relative compaction per ASTM D1557.
8. The adequacy of the compaction efforts should be verified by field density testing.

TABLE 2: Clean Granular Fill

Clean SIEVE SIZE	PERCENT PASSING BY WEIGHT
3-inch	100
¾-inch	60 – 90
No. 4	20 – 70
No. 200	2 – 8

NOTES:

1. Should consist of *crushed stone* beneath the concrete pad, as approved by on-site geotechnical engineer.
2. For minimum 9-inch base below the cast-in-place concrete equipment pads.
3. For minimum 12-inch base for exterior concrete slabs exposed to frost.
4. For minimum 18-inch base at exterior ramps, aprons, and loading bays adjacent to entrances/exit ways.
5. For use as footing and foundation wall backfill.
6. For use as backfill behind unbalanced foundation/retaining walls.
7. Place in lifts not exceeding 12 inches for heavy vibratory rollers and 8 inches for vibratory plate compactors.
8. Place and compact within ± 3% of optimum moisture content.
9. Compact to at least 95% relative compaction per ASTM D1557.
10. Compact to at least 95% relative compaction per ASTM D1557 when placed as foundation wall backfill in conjunction with a bond break.
11. The adequacy of the compaction efforts should be verified by field density testing.

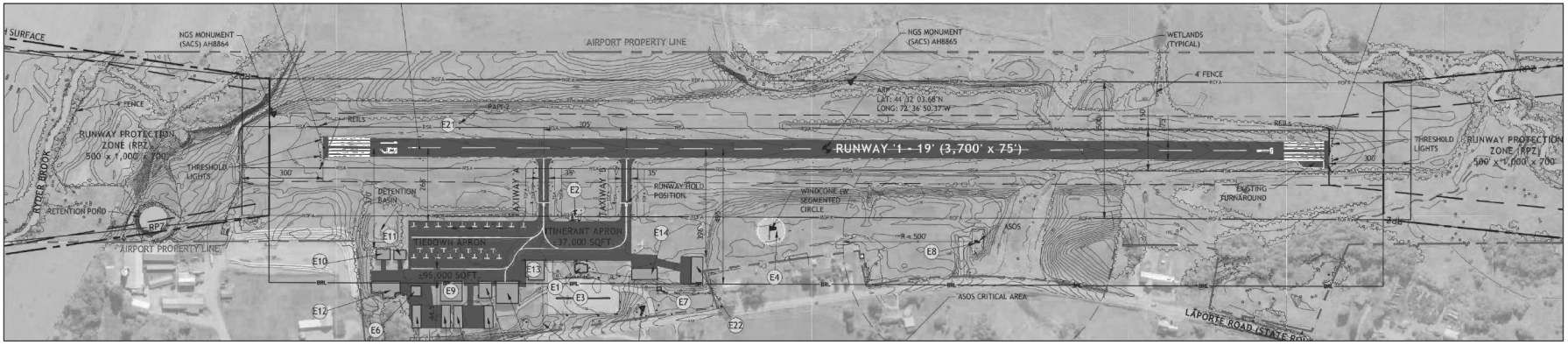
TABLE 3: Common Fill

SIEVE SIZE	PERCENT PASSING BY WEIGHT
6-inch	100
¾-inch	60 – 100
No. 4	20 – 85
No. 200	0 – 25

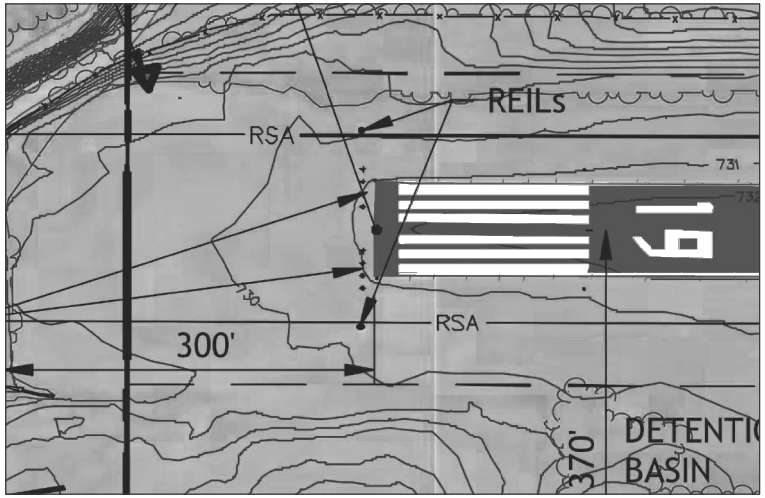
NOTES:

1. For use as common/subgrade fill in parking areas and roadway embankments.
2. For use as foundation wall backfill if used in conjunction with a bond break and sized/screened to 3-inch minus.
3. Place in lifts not exceeding 12 inches.
4. Maximum stone size should not exceed ½ the actual lift thickness.
5. Compact to at least 92% relative compaction per ASTM D1557 when placed as subgrade fill in parking areas or roadway embankments.
6. Compact to at least 95% relative compaction per ASTM D1557 when placed as foundation wall backfill in conjunction with a bond break.
7. The adequacy of the compaction efforts should be verified by field density testing.

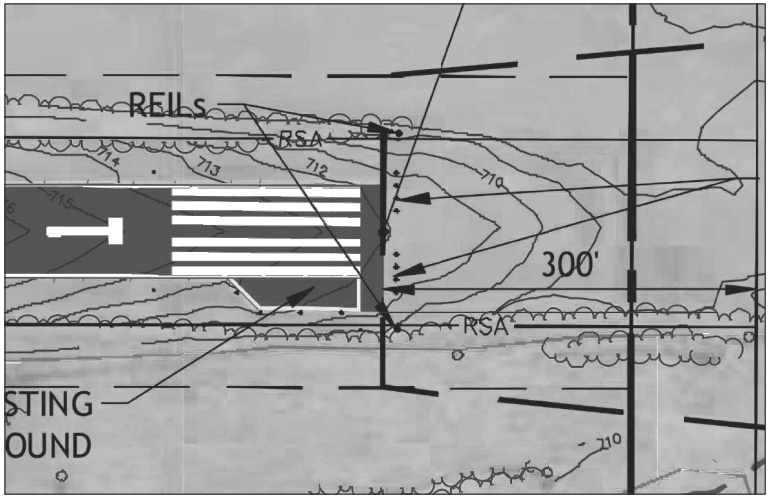
APPENDIX C: EXISTING CONDITIONS PLAN, SITE PLAN, & BORING LOCATION PLAN



AIRPORT LAYOUT PLAN
SCALE: 1" = 400'



RUNWAY '19' BORING PLAN
SCALE: 1" = 100'



RUNWAY '1' BORING PLAN
SCALE: 1" = 100'

HORIZONTAL SCALE
1"=100'

JACOBS
2 Executive Park Drive
Suite 200
Bedford, NH 03110
Phone: (603) 666-7181
Fax: (603) 666-7185

BORING REQUEST

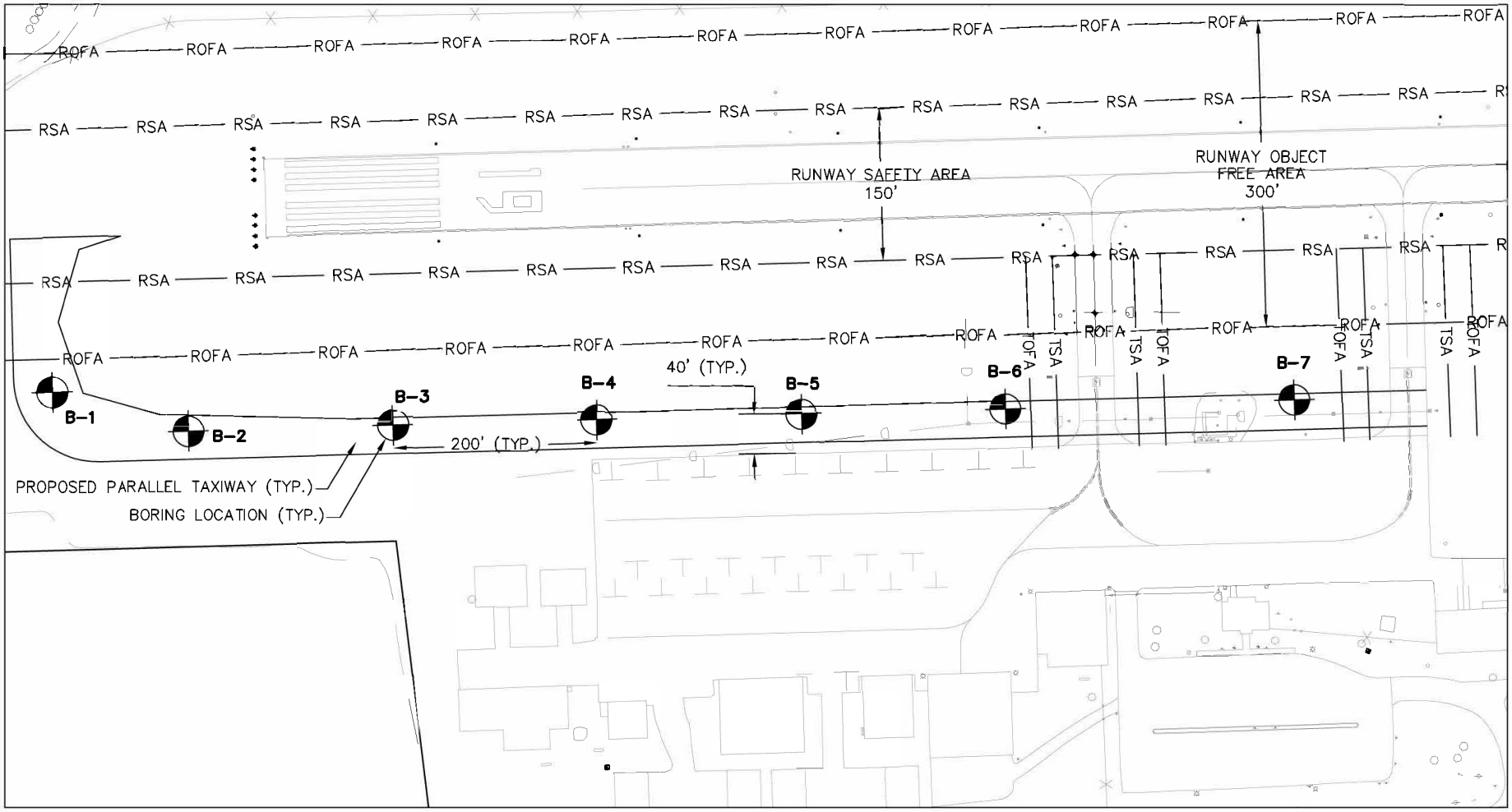
SCALE: AS SHOWN
DATE: 5/29/18
DRAWN BY: SST
CHKD. BY:
APPROVED:

MORRISVILLE-STOWE STATE AIRPORT

RSA IMPROVEMENTS

REV. NO.	DATE	DESCRIPTION	MADE BY	CHK. BY	APPR. BY

DWG. NO:
SK-B1
SHEET 1 OF 1



PARALLEL TAXIWAY
BORING LOCATION PLAN
SCALE: 1" = 100'

HORIZONTAL SCALE
1"=100'

100 0 50 100 200

PRIOR TO START OF DRILLING, VERIFY LOCATION OF BORING WITH ON-SITE JACOBS ENGINEER

JACOBS
2 Executive Park Drive
Suite 205
Bedford, NH 03110
Phone: (603) 668-7181
Fax: (603) 668-7183

BORING LOCATION PLAN

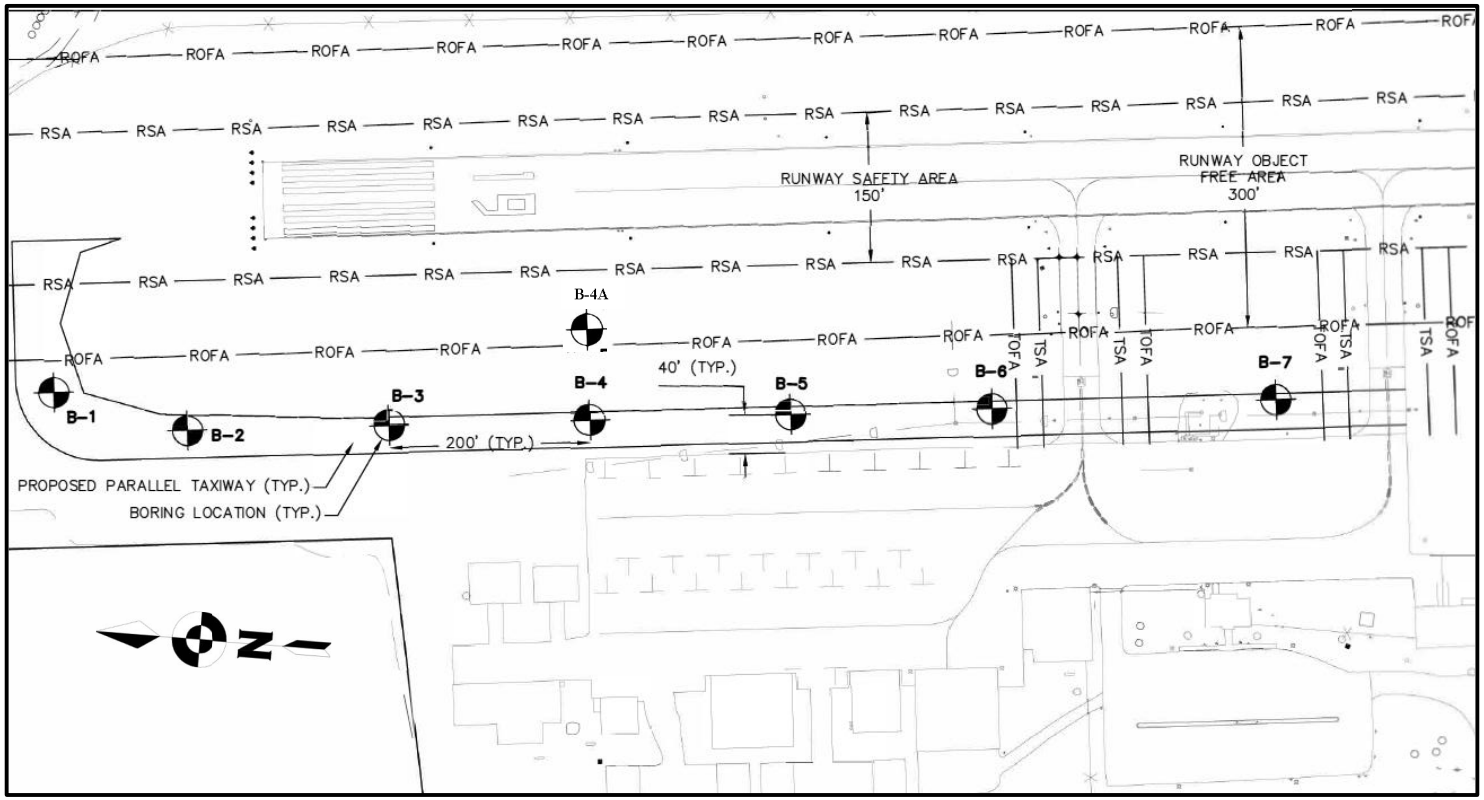
SCALE: AS SHOWN
DATE: 8/13/19
DRAWN BY: JMH
CHKD. BY:
APPROVED:

MORRISVILLE-STOWE STATE AIRPORT

PARALLEL TAXIWAY

REV. NO.	DATE	DESCRIPTION	MADE BY	CHK. BY	APPR. BY

DWG. NO:
SK-B1
SHEET 1 OF 1



Notes:

1. Test borings were performed on August 26, 2019 under the direction of JTC. Test boring locations should be considered approximate.
2. Refer to the Test Boring Logs for the subsurface conditions encountered at each boring location.
3. Basemap source(s): May 29, 2018 "Boring Location Plan" prepared by Jacobs Engineering Group
4. Not to Scale.

Jacobs Engineering Group 2 Executive Park Drive, Suite 205 Bedford, New Hampshire	Proposed Runway Improvements 2305 Laporte Road Morristown, Vermont
JOHN TURNER CONSULTING	TEST BORING LOCATION PLAN

APPENDIX D: TEST BORING LOGS & KEY TO SYMBOLS AND DESCRIPTIONS

JOHN TURNER CONSULTING

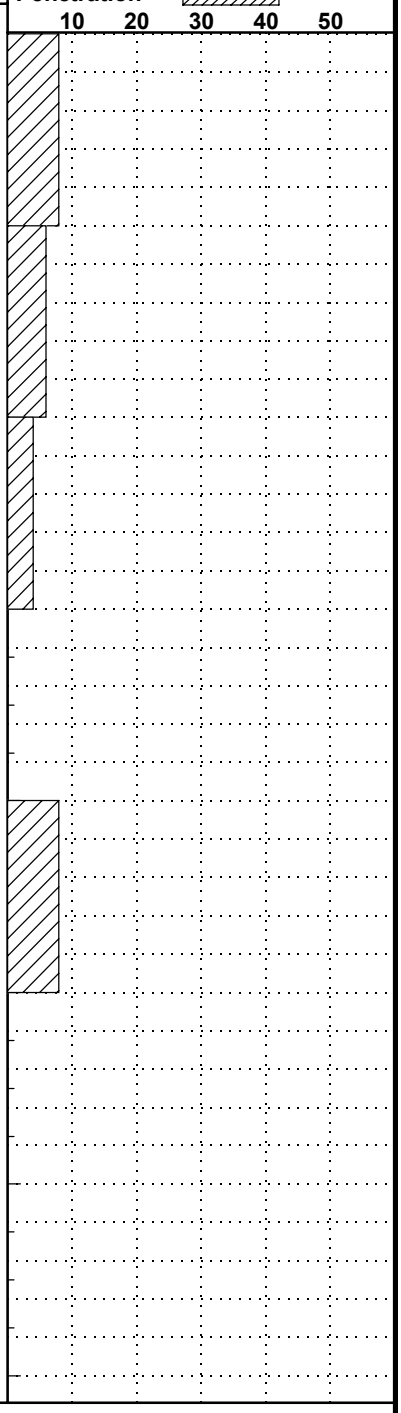
LOG OF BORING No. B-1

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200
0	Dark Brown silty sand (SM) with organics; moist; loose: TOPSOIL					
	0.25					
	Gray, sand with silt (SW-SM); moist; loose; SUBSOIL			SS01	1 5 3 5	
2	2.25					
				SS02	1 2 4 2	
4				SS03	2 2 2 3	
6	Brown sand with silt and gravel (SW-SM); moist; loose: GLACIAL DEPOSIT					
8				SS04	3 3 5 3	
10	Boring terminated at 10 ft.					
12						
14						

TEST RESULTS
Plastic Limit ⊢⊣ Liquid Limit
Water Content - ●
Penetration - ▨



Soil borings were backfilled with cuttings upon completion.

JOHN TURNER CONSULTING

LOG OF BORING No. B-2

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200
0	Dark Brown silty sand (SM) with trace gravel and organics; moist; loose: TOPSOIL					
	0.5 Light brown, sand with silt (SW-SM); moist; loose; SUBSOIL			SS01	1 2 4 5	
2	2.0			SS02	4 3 4 3	
4				SS03	3 3 4 3	
6	Brown/grey sand with silt and gravel (SW-SM); moist; loose: GLACIAL DEPOSIT			SS04	3 3 3 3	
8				SS05	3 4 3 5	
10	Boring terminated at 10 ft.					
12						
14						

TEST RESULTS
Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

Soil borings were backfilled with cuttings upon completion.

JOHN TURNER CONSULTING

LOG OF BORING No. B-3

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200
0	Dark Brown silty sand (SM) with trace gravel and organics; moist; loose: TOPSOIL			SS01	1 3 3 2	
	0.75					
2	Brown/grey fine sand with trace coarse sand and gravel (SW-SM); moist; loose; SUBSOIL			SS02	3 3 2 3	
4	4.0			SS03	1 3 2 1	
6	Brown sand with silt and gravel (SW-SM); moist; loose: GLACIAL DEPOSIT			SS04	2 3 2 2	
8				SS05	2 3 2 3	
10	Boring terminated at 10 ft.					
12						
14						

TEST RESULTS
Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

Soil borings were backfilled with cuttings upon completion.

JOHN TURNER CONSULTING

LOG OF BORING No. B-4

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200	TEST RESULTS (Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50)
0	Dark Brown silty sand (SM) with trace gravel and organics; moist; very loose: TOPSOIL				1 2 2 2		
	0.75 Light brown, sand with silt (SW-SM); moist; loose; SUBSOIL			SS01			
2	2.0 Brown silty sand (SM) with coarse sand and trace gravel; moist; medium dense; FILL			SS02	3 7 6 3		
4	4.0 Brown silty sand (SM); moist; very loose: GLACIAL DEPOSIT			SS03	1/12" - 1/12" -		
6				SS04	1/18" - - 1		
8				SS05	1/18" - - 1		
	Obstruction at 9.7'						
10	Boring terminated at 9.7 ft.						
12							
14							

Soil borings were backfilled with cuttings upon completion. Obstruction occured at 9.7', boring B-4A offset 12 feet northwest.

JOHN TURNER CONSULTING

LOG OF BORING No. B-4A

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200
0	Dark Brown silty sand (SM) with trace gravel and organics; moist; loose: TOPSOIL (0.33)			SS01	4 4 3 3	
2	Brown silty sand (SM) with frequent organics; moist; loose: FILL (2.5)			SS02	3 3 3 3	
4	No Recovery			SS03	1/18" - - 1	
6	Brown/grey sand with silt and gravel (SW-SM); moist; very loose: GLACIAL DEPOSIT			SS04	1/18" - - 1	
8				SS05	1/12" - 1 1	
10	Boring terminated at 10 ft.					
12						
14						

TEST RESULTS
Plastic Limit ⊢⊣ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

Soil borings were backfilled with cuttings upon completion.

JOHN TURNER CONSULTING

LOG OF BORING No. B-5

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200
0	Dark Brown silty sand (SM) with trace gravel and organics; moist; medium dense: TOPSOIL (0.33)			SS01	1 4 6 6	
	Brown silty sand (SM) with trace gravel; moist; medium dense; SUBSOIL					
2	-becomes loose			SS02	4 5 3 4	
4	(4.0)			SS03	1 2 3 3	
6	Brown silty sand (SM) with gravel; moist; very loose: GLACIAL DEPOSIT			SS04	3 2 1 1	
8				SS05	1 2 2 2	
10	Boring terminated at 10 ft.					
12						
14						

TEST RESULTS
Plastic Limit ⊢—⊣ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

Soil borings were backfilled with cuttings upon completion.

JOHN TURNER CONSULTING

LOG OF BORING No. B-6

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200
0	Dark Brown silty sand (SM) with trace gravel and organics; moist; medium dense: TOPSOIL				1 4 11 13	
	0.33					
	Light brown, sand with silt (SW-SM); moist; loose; SUBSOIL			SS01		
2	2.0				8 10 9 9	
	Brown silty fine sand (sm) with trace gravel; moist; medium dense; FILL			SS02		
4	4.0				5 5 4 5	
	Brown silty sand (SM) with gravel; moist; loose: GLACIAL DEPOSIT			SS03		
6	- becomes loose				4 3 3 4	
				SS04		
8					2 3 3 3	
				SS05		
10	Boring terminated at 10 ft.					
12						
14						

TEST RESULTS
Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

Soil borings were backfilled with cuttings upon completion.

JOHN TURNER CONSULTING

LOG OF BORING No. B-7

PROJECT: Runway Improvements **PROJECT NO.:** 19-15-073
CLIENT: Jacobs Engineering Group
PROJECT LOCATION: 2305 Laporte Rd, Morristown, VT
LOCATION: See Boring Location Plan **ELEVATION:**
DRILLER: Cascade **LOGGED BY:** EL
DRILLING METHOD: 3.25" ID HSA **DATE:** 08/26/19
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:**

This information pertains only to this boring and should not be interpreted as being indicative of the site.

Depth (feet)	Description	Graphic	Elevation (feet)	Sample No.	Blow Counts	% < #200
0	Dark Brown silty sand (SM) with trace gravel and organics; moist; medium dense: TOPSOIL (0.5)			SS01	1 7 6 3	
	Brown, silty fine sand with trace gravel; moist; medium dense: FILL					
2	-becomes loose			SS02	3 4 5 5	
4	(4.0)			SS03	4 8 7 7	
6	Brown/grey silty sand (SM) with gravel; moist; medium dense: GLACIAL DEPOSIT			SS04	8 4 4 5	
8				SS05	4 5 5 5	
10	Boring terminated at 10 ft.					
12						
14						

TEST RESULTS
Plastic Limit ├─┤ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

Soil borings were backfilled with cuttings upon completion.

JOHN TURNER CONSULTING

KEY TO SYMBOLS AND DESCRIPTIONS

MAJOR DIVISIONS			SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS OVER 50% > No.200 SIEVE SIZE	GRAVELS MORE THAN 1/2 OF COARSE FRACTION > No.4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW	Well-graded gravels or gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GRAVELS WITH OVER 15% FINES	GM	Silty gravels, gravel-sand mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS MORE THAN 1/2 OF COARSE FRACTION < No.4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES	SW	Well-graded sand or gravelly sands, little or no fines
			SP	Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH OVER 15% FINES	SM	Silty sand, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS OVER 50% < No.200 SIEVE SIZE	SILTS & CLAYS LIQUID LIMIT 50% OR LESS		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS LIQUID LIMIT GREATER THAN 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

TYPICAL SYMBOLS

- Shelby Tube
- Standard Split Spoon Sample
- Rock Core
- Vane Shear
- Geoprobe Sample
- Water Table (at time of drilling)
- Auger Cuttings
- 3" Split Spoon Sample
- Dynamic Cone Penetrometer
- Bulk/Grab Sample
- Sonic or Vibro-Core Sample
- Water Table (after 24 hours)

SOIL MOISTURE MODIFIERS

Term	Description
Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

The descriptor "damp" should not be used (use "moist").
The descriptor "saturated" should not be used (use "wet").

WELL SYMBOLS

- Recessed Cover Set in Concrete
- Top of Well, Recessed Pipe
- Covered Riser
- Capped Riser w/ Locking Cover
- Pipe Riser
- Concrete Seal
- Gravel Backfill
- Assorted Cuttings
- Bentonite Slurry
- Bentonite Pellets
- Silica Sand, blank PVC
- Slotted Pipe w/ Sand
- Endcap on Pipe Packed in Sand
- Silica Sand, No Pipe (End Plug)

CLASSIFICATION	RANGE OF GRAIN SIZES: U.S. Standard Sieve Size	RANGE OF GRAIN SIZES: Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	305 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.75
coarse	3" to 3/4"	76.2 to 19.1
fine	3/4" to No. 4	19.1 to 4.75
SAND	No. 4 to No. 200	4.75 to 0.075
coarse	No. 4 to No. 10	4.75 to 2.00
medium	No. 10 to No. 40	2.00 to 0.425
fine	No. 40 to No. 200	0.425 to 0.075
SILT & CLAY	Below No. 200	Below 0.075

RELATIVE DENSITY/CONSISTENCY

Gravel, Sand, and Silt (nonplastic)		Silt (plastic) and Clay		
N-Value	Relative Density	N-Value	Su	Consistency
0 - 4	Very Loose	0 - 2	0 - 250	Very Soft
5 - 10	Loose	3 - 4	251 - 500	Soft
11-30	Medium Dense	5 - 8	501 - 1000	Medium Stiff
31 - 50	Dense	9 - 15	1001 - 2000	Stiff
51 +	Very Dense	16 - 30	2001 - 4000	Very Stiff
		31 +	4001+	Hard

Standard Penetration Testing (SPT) N_{60} based on blows per 12 inches.
WR = Weight of Rods; WH = Weight of Hammer

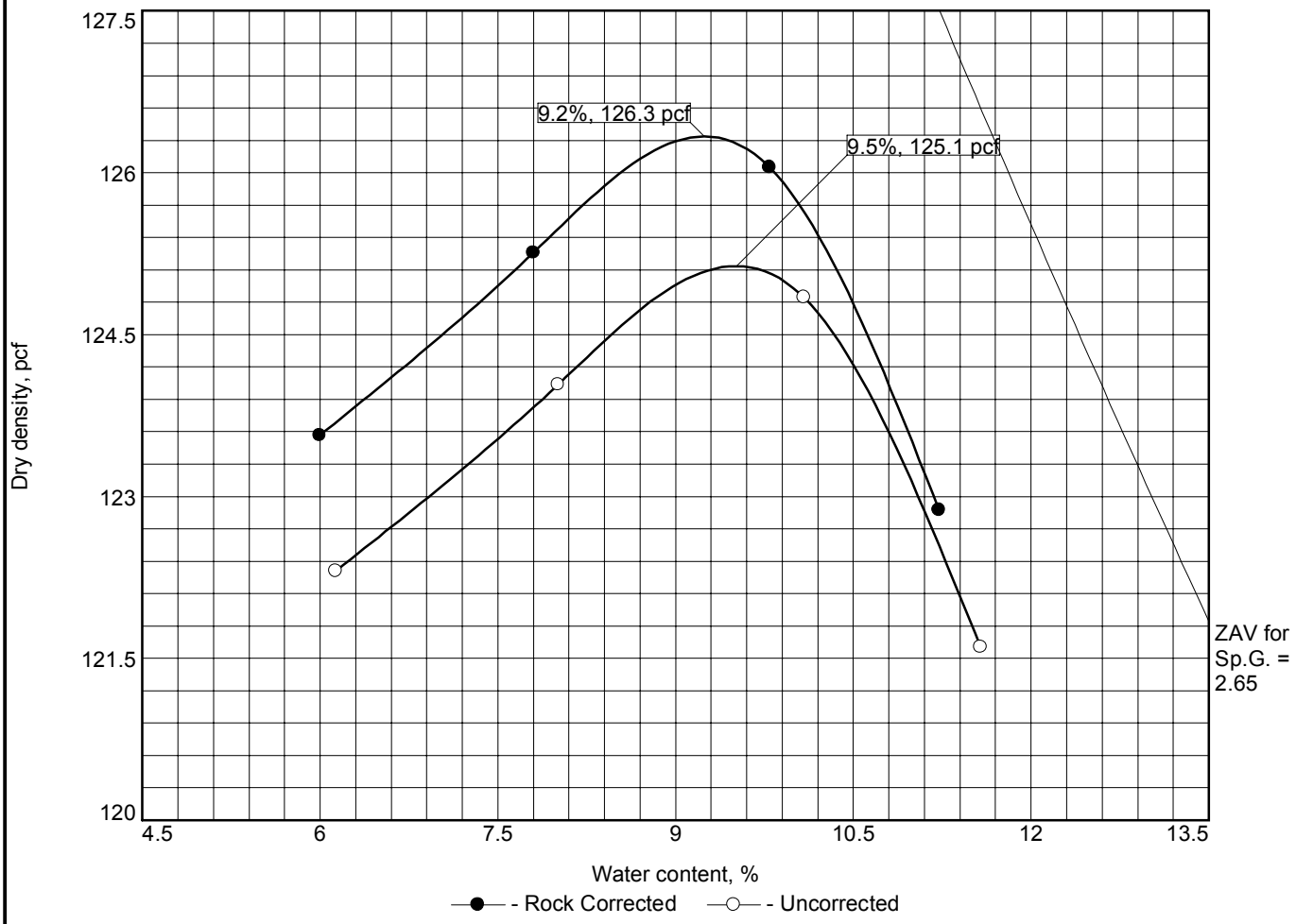
PERCENT OR PORTIONS OF SOIL

Term	Description
Parting:	> 1/16 in.
Seam:	0.5 in. to 1/16 in.
Layer:	12 in. to 0.5 in.
Stratum:	> 12 in.
Pocket:	Small erratic deposit
Lens:	Lenticular deposit
Occasional:	One or less per foot of thickness
Frequent	More than one per foot of thickness
Varved	Alternating seams or layers of silt and/or clay and sometimes f. sand

REFERENCE: UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D2488-93

APPENDIX E: GEOTECHNICAL LABORATORY TESTING REPORT

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
1'-10'	SW-SM	-	-	2.65	-	-	3.9	9.8

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 126.3 pcf	125.1 pcf	Dark brown sand with silt and gravel
Optimum moisture = 9.2 %	9.5 %	

Project No. 19-15-073 **Client:** Jacobs Engineering Group
Project: Runway Improvements - Morissville-Stowe State Airport

○**Location:** B-1/B-2/B-3 **Sample Number:** 3519-587

Remarks:

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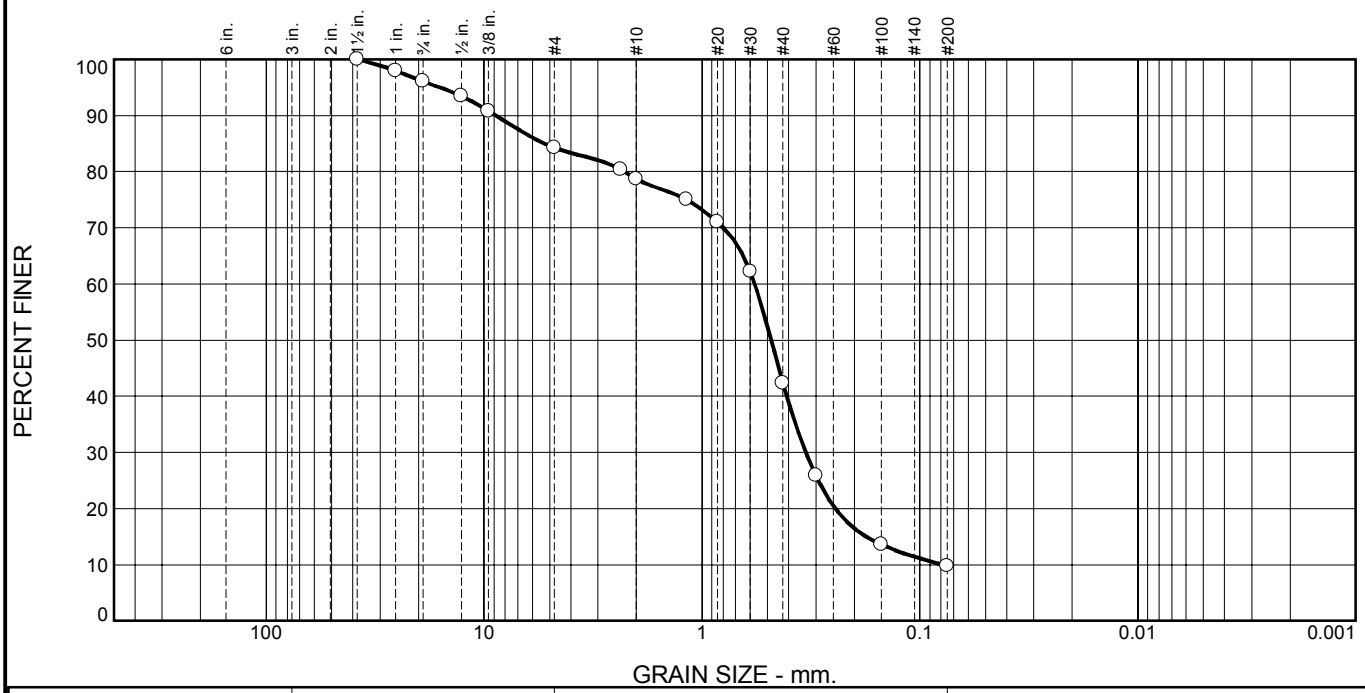
Figure 587B

Tested By: Eric Tavares **Checked By:** Shalini Kanuganti

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	3.9	11.9	5.5	36.3	32.6	9.8	

Test Results (AASHTO T 27 & AASHTO T11)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	97.9		
3/4	96.1		
1/2	93.4		
3/8	90.8		
#4	84.2		
#8	80.4		
#10	78.7		
#16	75.0		
#20	71.0		
#30	62.2		
#40	42.4		
#50	25.9		
#100	13.6		
#200	9.8		

* (no specification provided)

Material Description

Dark brown sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= - **LL=** - **PI=** -

Classification

USCS (D 2487)= SW-SM **AASHTO (M 145)=** -

Coefficients

D_{90}= 8.8398 D_{85}= 5.2956 D_{60}= 0.5726
D_{50}= 0.4815 D_{30}= 0.3334 D_{15}= 0.1767
D_{10}= 0.0783 C_u= 7.31 C_c= 2.48

Remarks

Moisture content =3.4%

Date Received: 8/28/19 **Date Tested:** 9/2/19

Tested By: Eric Tavares

Checked By: Shalini Kanuganti

Title: Lab Manager

Location: B-1/B-2/B-3 **Date Sampled:** 8/26/19

Sample Number: 3519-587 **Depth:** 1'-10'

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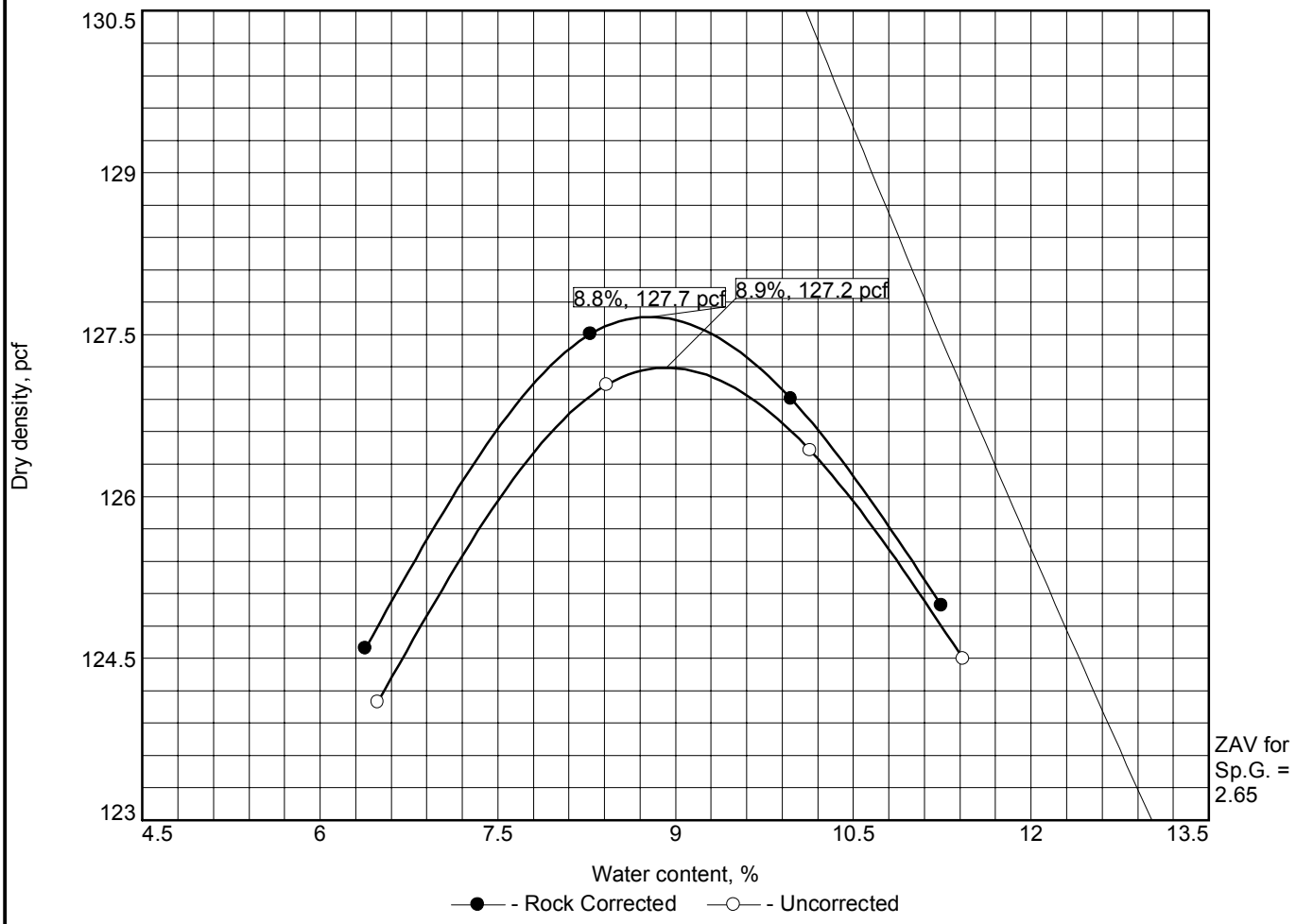
Client: Jacobs Engineering Group

Project: Runway Improvements - Morissville-Stowe State Airport

Project No: 19-15-073 **Figure** 587A

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
6'-10'	SW-SM	-	-	2.65	-	-	1.6	8.8

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 127.7 pcf	127.2 pcf	Dark brown sand with silt and gravel
Optimum moisture = 8.8 %	8.9 %	

Project No. 19-15-073 **Client:** Jacobs Engineering Group
Project: Runway Improvements - Morissville-Stowe State Airport

○**Location:** B-4 **Sample Number:** 3519-588

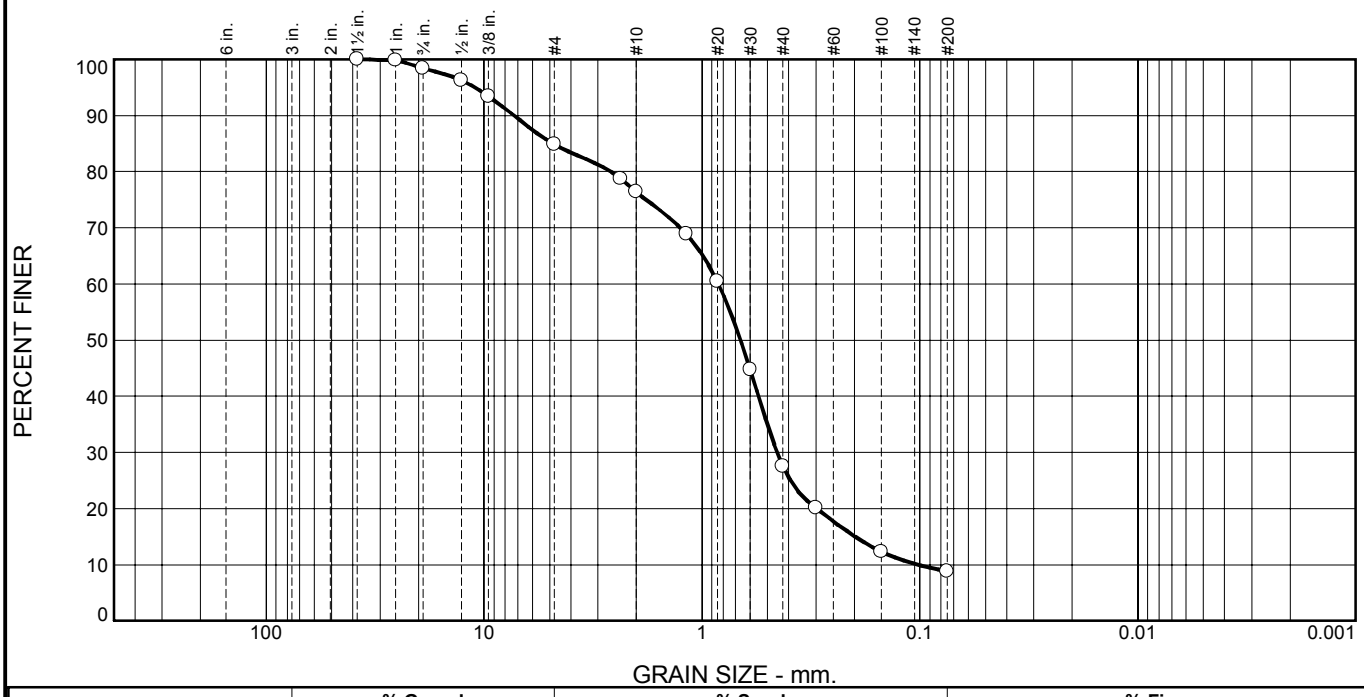
JOHN TURNER CONSULTING

Remarks:

Figure 588B

Tested By: Eric Tavares **Checked By:** Shalini Kanuganti

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.6	13.6	8.4	48.9	18.7	8.8	

Test Results (AASHTO T 27 & AASHTO T11)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	99.8		
3/4	98.4		
1/2	96.3		
3/8	93.4		
#4	84.8		
#8	78.7		
#10	76.4		
#16	68.9		
#20	60.4		
#30	44.7		
#40	27.5		
#50	20.1		
#100	12.3		
#200	8.8		

* (no specification provided)

Material Description

Dark brown sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= - **LL=** - **PI=** -

Classification

USCS (D 2487)= SW-SM **AASHTO (M 145)=** -

Coefficients

D_{90}= 7.2959 D_{85}= 4.8264 D_{60}= 0.8397
D_{50}= 0.6648 D_{30}= 0.4516 D_{15}= 0.1982
D_{10}= 0.1017 C_u= 8.26 C_c= 2.39

Remarks

Moisture content =3.8%

Date Received: 8/28/19 **Date Tested:** 9/2/19

Tested By: Eric Tavares

Checked By: Shalini Kanuganti

Title: Lab Manager

Location: B-4
Sample Number: 3519-588 **Depth:** 6'-10'

Date Sampled: 8/26/19

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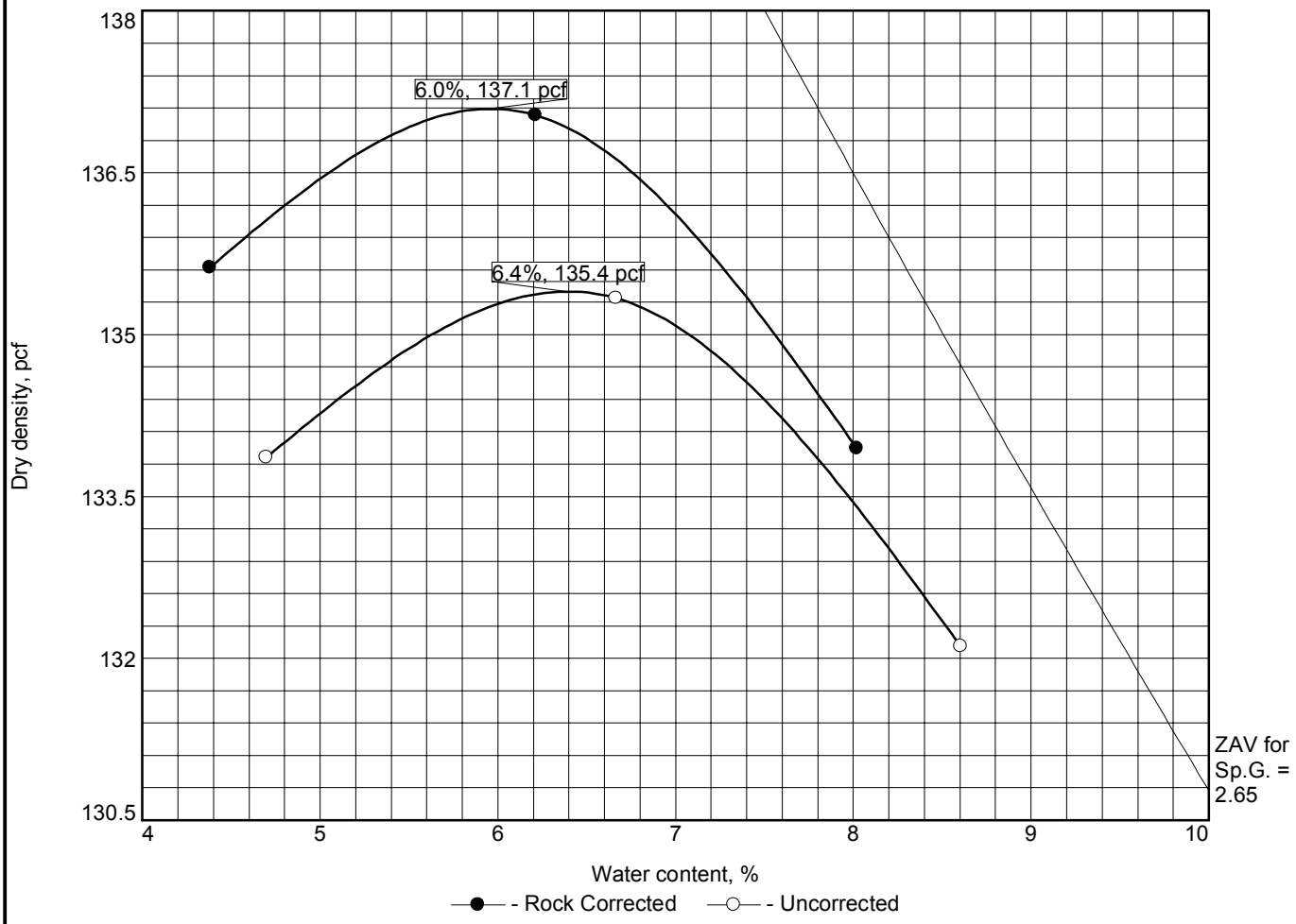
Client: Jacobs Engineering Group
Project: Runway Improvements - Morissville-Stowe State Airport

Project No: 19-15-073 **Figure** 588A

COMPACTION TEST REPORT



Test specification: ASTM D 1557-12 Method C Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
4'-10'	SM	-	-	2.65	-	-	6.8	12.8

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 137.1 pcf	135.4 pcf	Dark brown silty sand with gravel
Optimum moisture = 6.0 %	6.4 %	

Project No. 19-15-073 **Client:** Jacobs Engineering Group
Project: Runway Improvements - Morissville-Stowe State Airport

○**Location:** B-5/B-6/B-7 **Sample Number:** 3519-589

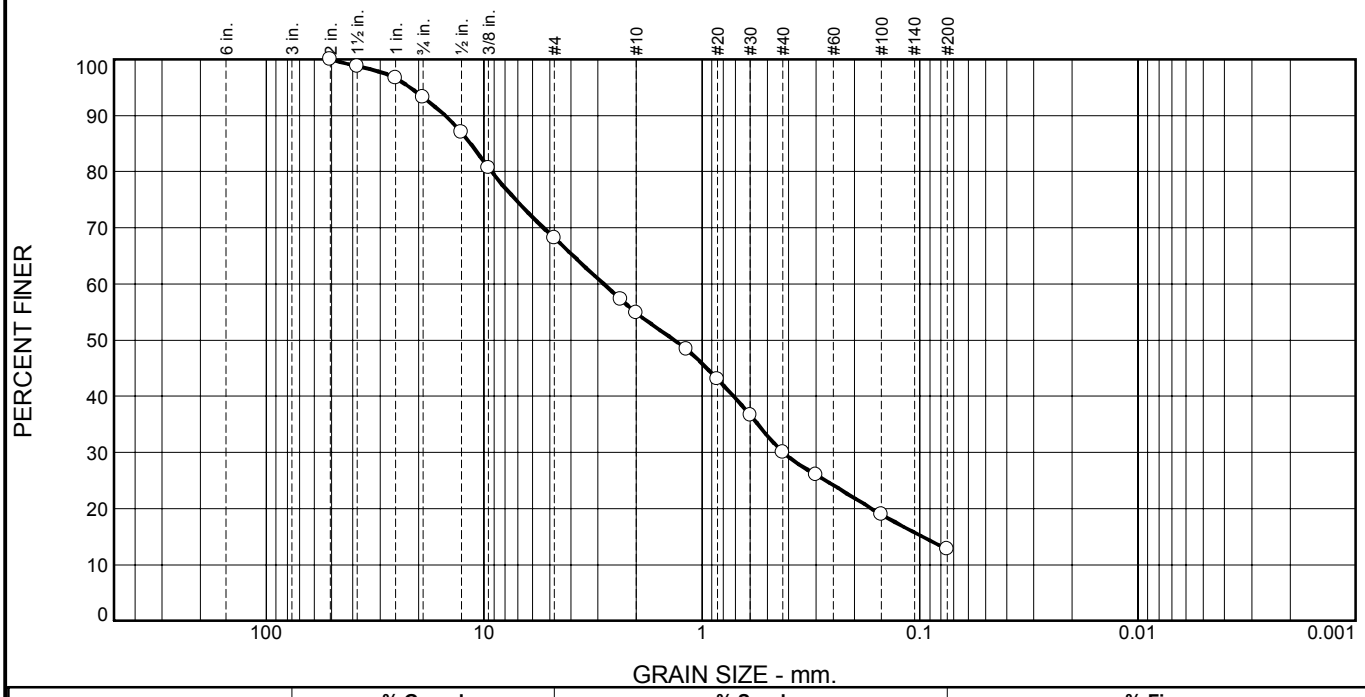
JOHN TURNER CONSULTING

Remarks:

Figure 589B

Tested By: Eric Tavares **Checked By:** Shalini Kanuganti

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	6.8	25.1	13.3	24.8	17.2	12.8	

Test Results (AASHTO T 27 & AASHTO T11)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2	100.0		
1.5	98.8		
1	96.6		
3/4	93.2		
1/2	87.0		
3/8	80.7		
#4	68.1		
#8	57.3		
#10	54.8		
#16	48.4		
#20	43.1		
#30	36.6		
#40	30.0		
#50	26.0		
#100	19.0		
#200	12.8		

* (no specification provided)

Material Description

Dark brown silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= - **LL=** - **PI=** -

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** -

Coefficients

D_{90}= 15.0959 D_{85}= 11.5373 D_{60}= 2.8254
D_{50}= 1.3359 D_{30}= 0.4241 D_{15}= 0.0973
D_{10}= C_u= C_c=

Remarks

Moisture content =7.0%

Date Received: 8/28/19 **Date Tested:** 9/02/19

Tested By: Eric Tavares

Checked By: Shalini Kanuganti

Title: Lab Manager

Location: B-5/B-6/B-7
Sample Number: 3519-589 **Depth:** 4'-10'

Date Sampled: 8/26/19

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Client: Jacobs Engineering Group
Project: Runway Improvements - Morissville-Stowe State Airport

Project No: 19-15-073 **Figure** 589A

Report of California Bearing Ratio (ASTM D1883)

Client: Jacobs Engineering Group
Bedford, NH

Project: Runway Improvements
Morissville-Stowe State Airport

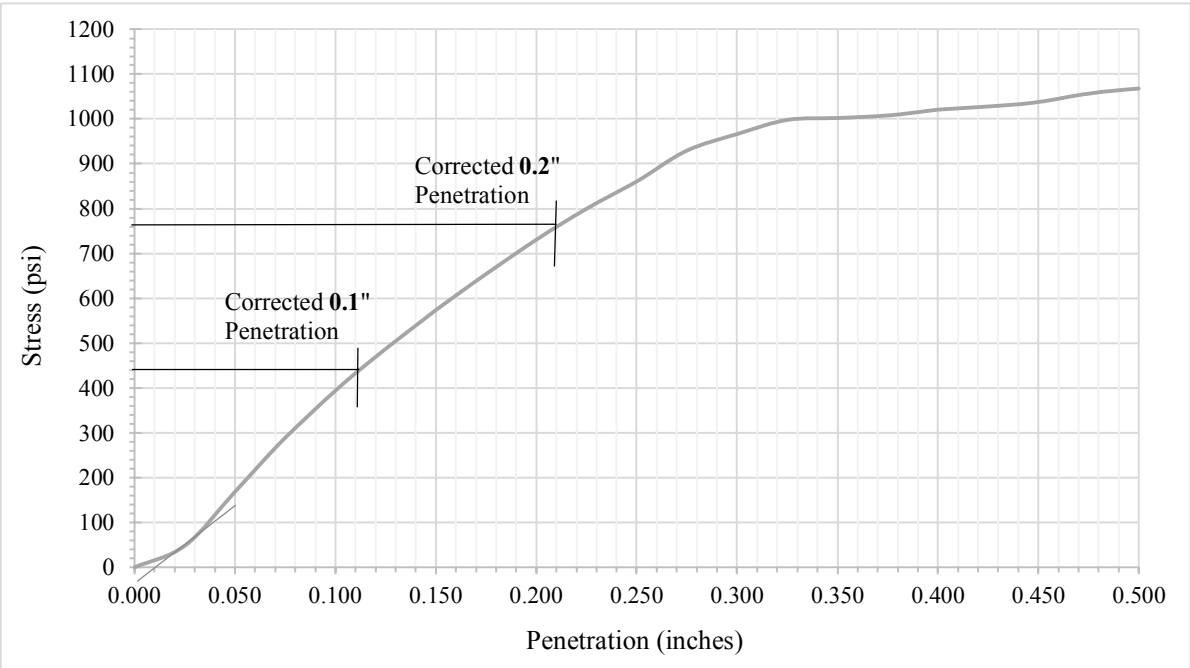
Date: September 25, 2019

Report #: 19-15-073-001

Sample Source: B-1/B-2/B-3
Material ID#: 3519-587
Date Received: 8/28/2019
Method of Test: ASTM D1883
Soaked 96 Hours
Compacted 100%+ Modified Proctor
Moisture Content 6%

Material Type: Dark brown sand with silt and gravel
Intended Use: Subgrade
Sampled by: Judson Zachar
Tested by: Eric Tavares
Moisture After Soak: 6.5%
Swell: 0.00%

Uncorrected CBR @ 0.100":	39	Corrected CBR @ 0.100":	42
Uncorrected CBR @ 0.200":	49	Corrected CBR @ 0.200":	51



Report of California Bearing Ratio (ASTM D1883)

Client: Jacobs Engineering Group
Bedford, NH

Project: Runway Improvements
Morissville-Stowe State Airport

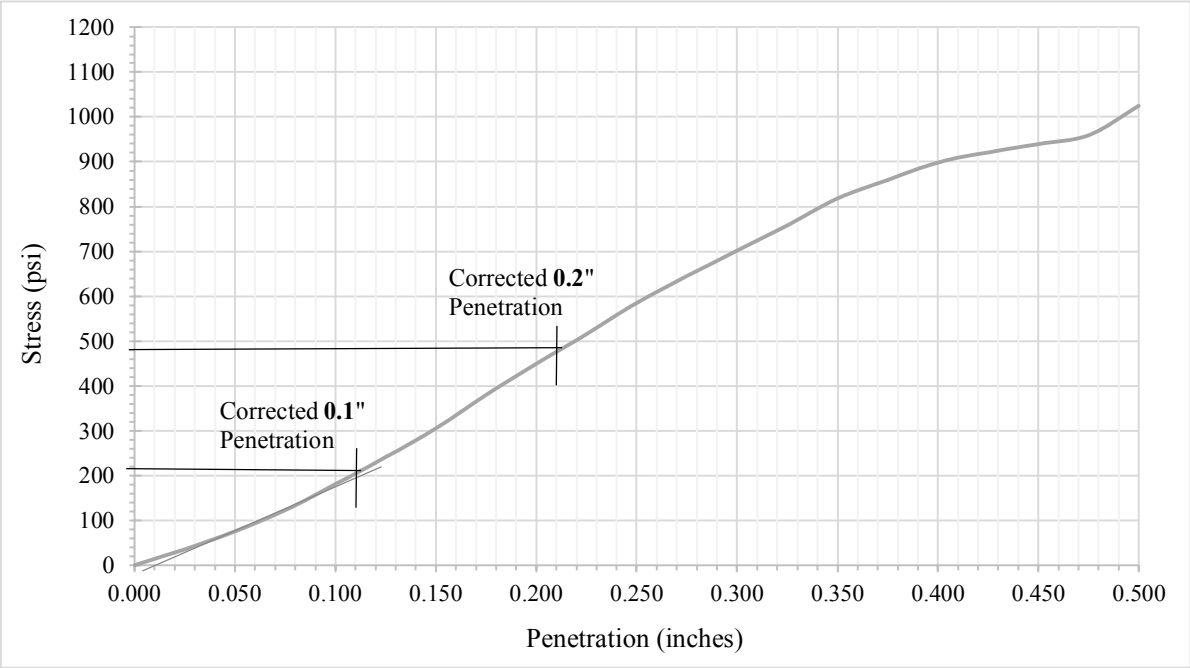
Date: September 25, 2019

Report #: 19-15-073-001

Sample Source: B-1/B-2/B-3
Material ID#: 3519-587
Date Received: 8/28/2019
Method of Test: ASTM D1883
Soaked 96 Hours
Compacted 100%+ Modified Proctor
Moisture Content 9%

Material Type: Dark brown sand with silt and gravel
Intended Use: Subgrade
Sampled by: Judson Zachar
Tested by: Eric Tavares
Moisture After Soak: 8.8%
Swell: 0.00%

Uncorrected CBR @ 0.100":	18	Corrected CBR @ 0.100":	21
Uncorrected CBR @ 0.200":	30	Corrected CBR @ 0.200":	32



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Report of California Bearing Ratio (ASTM D1883)

Client: Jacobs Engineering Group
Bedford, NH

Project: Runway Improvements
Morissville-Stowe State Airport

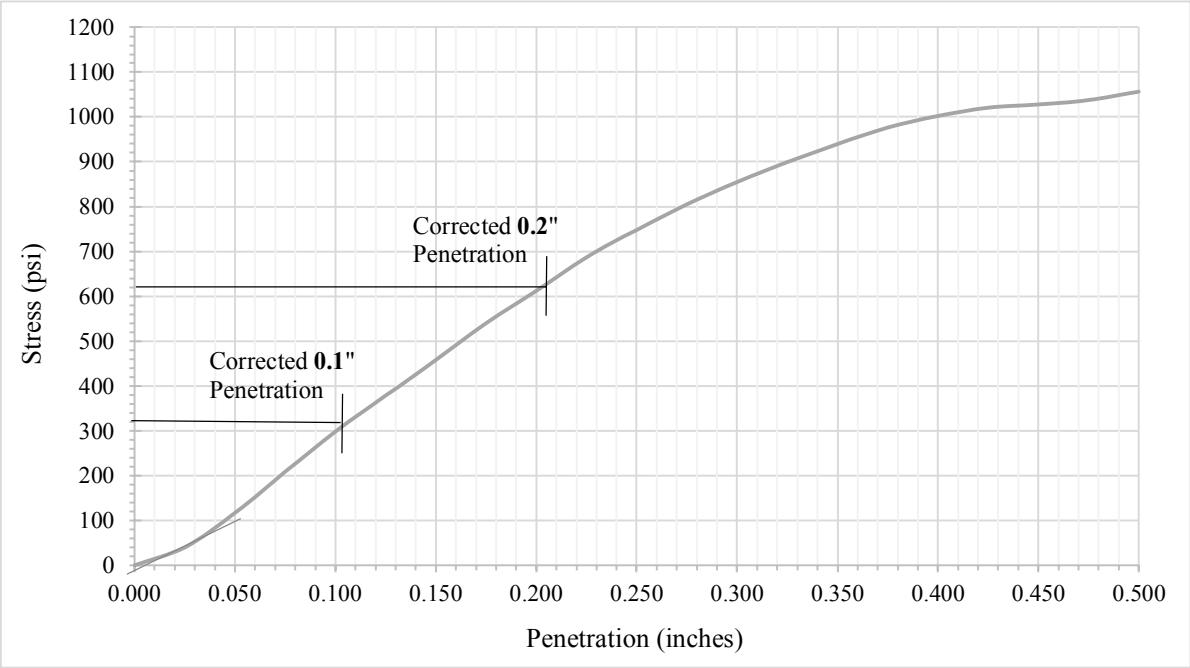
Date: September 25, 2019

Report #: 19-15-073-002

Sample Source: B-4
Material ID#: 3519-588
Date Received: 8/28/2019
Method of Test: ASTM D1883
Soaked 96 Hours
Compacted 100%+ Modified Proctor
Moisture Content 6%

Material Type: Dark brown sand with silt and gravel
Intended Use: Subgrade
Sampled by: Judson Zachar
Tested by: Shalini Kanuganti
Moisture After Soak: 6.5%
Swell: 0.0%

Uncorrected CBR @ 0.100": 30
Uncorrected CBR @ 0.200": 41
Corrected CBR @ 0.100": 32
Corrected CBR @ 0.200": 41



Report of California Bearing Ratio (ASTM D1883)

Client: Jacobs Engineering Group
Bedford, NH

Project: Runway Improvements
Morissville-Stowe State Airport

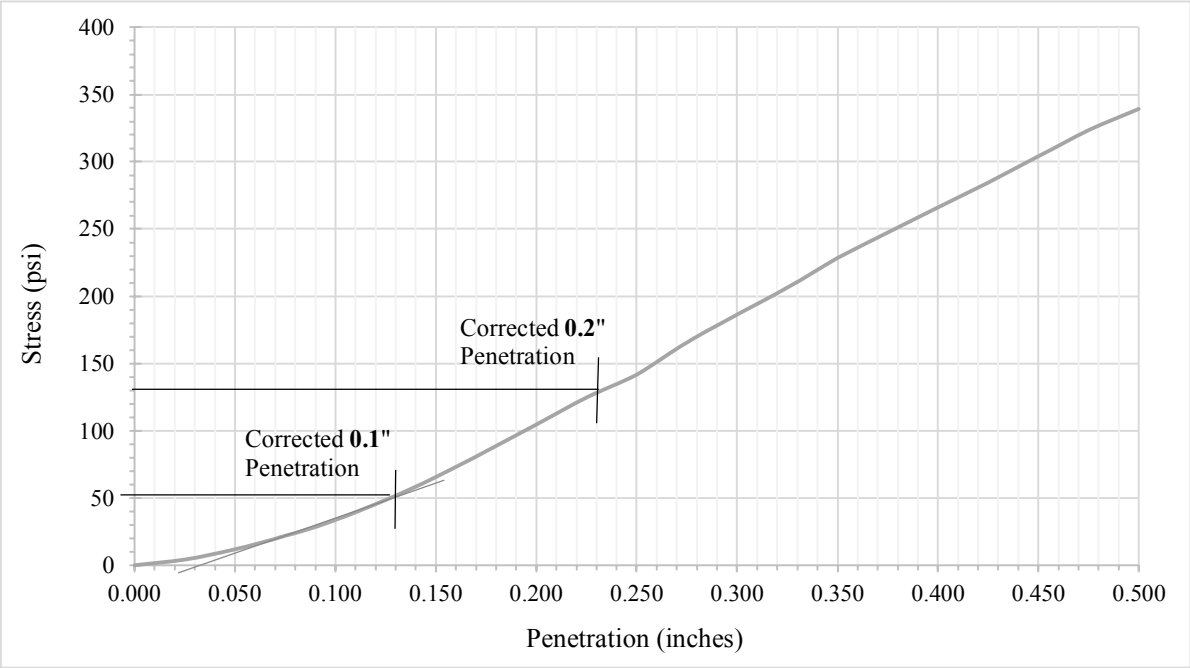
Date: September 25, 2019

Report #: 19-15-073-002

Sample Source: B-4
Material ID#: 3519-588
Date Received: 8/28/2019
Method of Test: ASTM D1883
Soaked 96 Hours
Compacted 100%+ Modified Proctor
Moisture Content 9%

Material Type: Dark brown sand with silt and gravel
Intended Use: Subgrade
Sampled by: Judson Zachar
Tested by: Shalini Kanuganti
Moisture After Soak: 9.2%
Swell: 0.0%

Uncorrected CBR @ 0.100":	3	Corrected CBR @ 0.100":	5
Uncorrected CBR @ 0.200":	7	Corrected CBR @ 0.200":	9



Report of California Bearing Ratio (ASTM D1883)

Client: Jacobs Engineering Group
Bedford, NH

Project: Runway Improvements
Morissville-Stowe State Airport

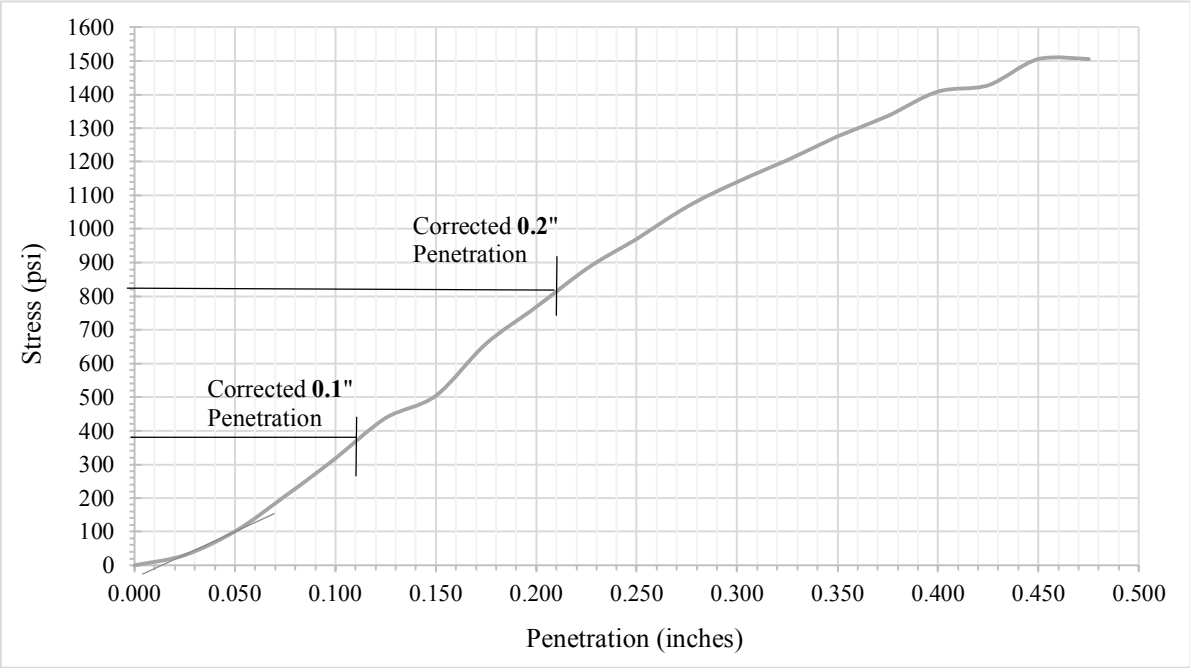
Date: September 25, 2019

Report #: 19-15-073-003

Sample Source: B-5/B-6/B-7
Material ID#: 3519-589
Date Received: 8/28/2019
Method of Test: ASTM D1883
Soaked 96 Hours
Compacted 100%+ Modified Proctor
Moisture Content 6%

Material Type: Dark brown silty sand with gravel
Intended Use: Subgrade
Sampled by: Judson Zachar
Tested by: Shalini Kanuganti
Moisture After Soak: 6.6%
Swell: 0.0%

Uncorrected CBR @ 0.100":	32	Corrected CBR @ 0.100":	38
Uncorrected CBR @ 0.200":	51	Corrected CBR @ 0.200":	55



Report of California Bearing Ratio (ASTM D1883)

Client: Jacobs Engineering Group
Bedford, NH

Project: Runway Improvements
Morissville-Stowe State Airport

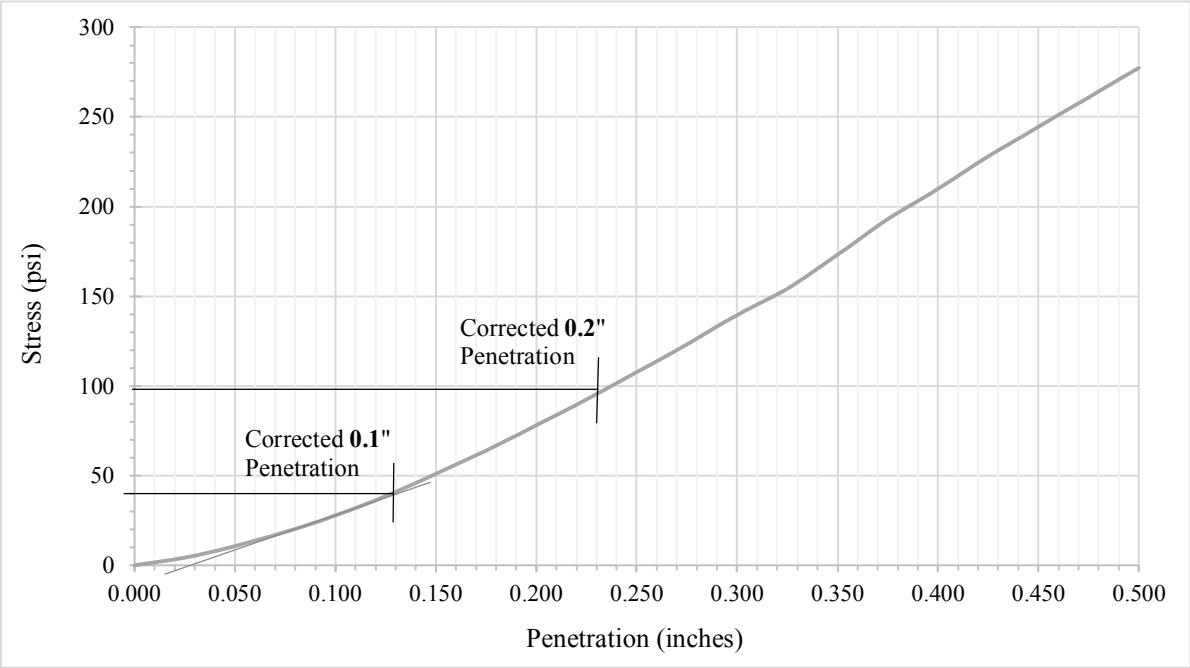
Date: September 25, 2019

Report #: 19-15-073-003

Sample Source: B-5/B-6/B-7
Material ID#: 3519-589
Date Received: 8/28/2019
Method of Test: ASTM D1883
Soaked 96 Hours
Compacted 100%+ Modified Proctor
Moisture Content 9%

Material Type: Dark brown silty sand with gravel
Intended Use: Subgrade
Sampled by: Judson Zachar
Tested by: Shalini Kanuganti
Moisture After Soak: 9.3%
Swell: 0.0%

Uncorrected CBR @ 0.100":	3	Corrected CBR @ 0.100":	4
Uncorrected CBR @ 0.200":	5	Corrected CBR @ 0.200":	6



APPENDIX F: SITE PHOTOGRAPHS

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MORRISVILLE-STOWE AIRPORT
2305 Laporte Road
Morristown, Vermont

SITE PHOTOGRAPHS


Site, facing east


Site, facing north (Near B-1)


Drilling set up, facing north


Drilling set up on B-1


Sample of Sand with gravel


Soil sample from B-4