

WEST DESERT AIRPARK

Fairfield, Utah

TECHNICAL SPECIFICATIONS

SCHEDULE I

Construct Taxiway A

SCHEDULE II

Construct Apron

SCHEDULE III

Runway and Taxiway Pavement Maintenance

UDOT No. XXX

ACI No. 206685

February 2022



ARMSTRONG

751 Horizon Court, Suite 255

Grand Junction, CO 81506

O: 970.242.0101

www.armstrongconsultants.com

WEST DESERT AIRPARK

FAIRFIELD, UTAH

Technical Specifications

UDOT No. XXX
ACI No. 206685

CERTIFICATION

I hereby certify that these plans and specifications for West Desert Airpark Improvements, UDOT No. XXX, were prepared under my direct supervision for the Owners thereof.

Designed by:

Thorsen Milton

Engineer

2/15/2022

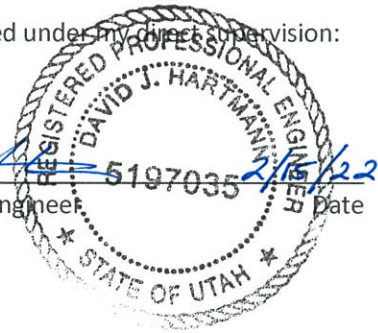
Date

Reviewed by and prepared under my direct supervision:

David J. Hartmann
Registered Professional Engineer

5197035

2/16/22
Date



ARMSTRONG CONSULTANTS, INC.

Airport Engineering, Planning & Environmental Studies
751 Horizon Court, Suite 255
Grand Junction, Colorado 81506
O: (970) 242-0101
www.armstrongconsultants.com

**CONTRACT DOCUMENTS
TABLE OF CONTENTS**

Proposal 4 Pages

Technical Specifications

- General Construction Items
 - ITEM C-105
 - Mobilization*
- Site Work
 - ITEM P-101
 - Preparation/Removal of Existing Pavements
 - ITEM P-151
 - Clearing and Grubbing*
 - ITEM P-152
 - Excavation, Subgrade, and Embankment*
- Base Courses
 - ITEM P-208
 - Aggregate Base Course*
- Flexible Pavements
 - ITEM P-401
 - Asphalt Mix Pavement*
- Surface Treatments
 - ITEM P-608 R
 - Rapid Cure Seal Coat*
- Miscellaneous
 - ITEM P-602
 - Emulsified Asphalt Prime Coat*
 - ITEM P-603
 - Emulsified Asphalt Tack Coat*
 - ITEM P-620
 - Runway and Taxiway Painting*
 - ITEM S-10
 - Aircraft Tiedowns*
- Lighting Installation
 - ITEM L-125
 - Installation of Airport Lighting Systems*

Soils Boring Logs 9 Pages

Appendix 1: Utah Department of Transportation Specifications 93 pages

**IMPROVEMENTS TO
WEST DESERT AIRPARK
CONSTRUCT TAXIWAY A AND APRON
FAIRFIELD, UTAH
UDOT NO. XXX**

TO: West Desert Airpark, LLC
86 West Aviators Way
Fairfield, Utah 84013

The undersigned Bidder, having examined the Plans, Specifications and other Contract Documents as designated and all Addenda thereto; having investigated the location of and conditions affecting the Proposed Work; and being acquainted with and fully understanding the extent and character of the Work covered by this Proposal and all factors and conditions affecting or which may be affected by the Work;

HEREBY PROPOSES, pursuant to the Invitation for Bids published _____, 2022, to furnish all required materials, tools, equipment and plant; to perform all necessary labor and superintendence; and to undertake and complete the Work required for West Desert Airpark, UDOT No. XXX, in Fairfield, Utah, in full accordance with Plans, Specifications and Contract Documents hereto attached or by reference made a part thereof, at and for the following prices:

BID SCHEDULE

SCHEDULE I - CONSTRUCT TAXIWAY A						
Item No.	Spec. No.	Description	Est. Qty.	Unit	Unit Price in Figures and in Writing	Total Price
I-1	C-105	Mobilization	1	LS	\$	\$
I-2	P-101a	Pavement Removal	1890	SF	\$	\$
I-3	P-151	Clearing and Grubbing	0.5	ACRE	\$	\$
I-4	P-152a	Embankment in Place	767	CY	\$	\$
I-5	P-152b	Shoulder Grading	625	SY	\$	\$
I-6	P-208	Aggregate Base Course	1997	SY	\$	\$
I-7	P-401a	Asphalt Surface Course	344	TON	\$	\$
I-8	P-401b	Asphalt Binder	24	TON	\$	\$
I-9	P-602	Emulsified Asphalt Prime Coat	599	GAL	\$	\$
I-10	P-603	Emulsified Asphalt Tack Coat	Incidental		Incidental	
I-11	P-620a	Pavement Markings	478	SF	\$	\$
I-12	P-620b	Reflective Media	29	LBS	\$	\$
I-13	L-125	Retroreflective Edge Markers	41	EA	\$	\$
TOTAL BID AMOUNT – SCHEDULE I					\$	

SCHEDULE II - CONSTRUCT APRON						
Item No.	Spec. No.	Description	Est. Qty.	Unit	Unit Price in Figures and in Writing	Total Price
II-1	C-105	Mobilization	1	LS	\$	\$
II-2	S-10	Aircraft Tiedowns (Set of 3)	3	EA	\$	\$
II-3	P-151	Clearing and Grubbing	0.35	ACRE	\$	\$
II-4	P-152a	Embankment in Place	209	CY	\$	\$
II-5	P-208	Aggregate Base Course	1650	SY	\$	\$
II-6	P-401a	Asphalt Surface Course	299	TON	\$	\$
II-7	P-401b	Asphalt Binder	21	TON	\$	\$
II-8	P-602	Emulsified Asphalt Prime Coat	520	GAL	\$	\$
II-9	P-603	Emulsified Asphalt Tack Coat	Incidental		Incidental	
II-10	P-620a	Pavement Markings	50	SF	\$	\$
II-11	P-620b	Reflective Media	3	LBS	\$	\$
TOTAL BID AMOUNT – SCHEDULE II					\$	

SCHEDULE III - RUNWAY AND TAXIWAY PAVEMENT MAINTENANCE						
Item No.	Spec. No.	Description	Est. Qty.	Unit	Unit Price in Figures and in Writing	Total Price
III-1	C-105	Mobilization	1	LS	\$	\$
III-2	P-101b	Joint and Crack Repair (1/8-Inch to 2-inch)	4	TON	\$	\$
III-3	P-101c	Joint and Crack Repair (greater than 2-inch)	2	TON	\$	\$
III-4	P-101d	Pavement Marking Removal	675	SF	\$	\$
III-5	P-608Ra	Emulsified Asphalt Rapid Seal Coat (w/ Sand - for Runway)	8142	SY	\$	\$
III-6	P-608Rb	Emulsified Asphalt Rapid Seal Coat (wo/ Sand - for Taxiways)	3539	SY	\$	\$
III-7	P-608Rc	Runway Friction Testing	1	LS	\$	\$
III-8	P-620a	Pavement Markings	1926	SF	\$	\$
III-9	P-620b	Reflective Media	117	LBS	\$	\$
III-10	P-620c	Temporary Pavement Markings	1926	SF	\$	\$
TOTAL BID AMOUNT – SCHEDULE III					\$	

SUMMARY	
Bid Amount - Schedule I	\$
Bid Amount - Schedule II	\$
Bid Amount - Schedule III	\$
TOTAL OF ALL SCHEDULES	\$

GENERAL CONSTRUCTION ITEMS

**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.

With Engineers approval, C-105 Mobilization, may be replaced with the requirements of Utah Department of Transportation (UDOT) Mobilization per UDOT-2022 Standard Specifications. See Appendix 1, Section 01501 for full UDOT Standard Specification regarding Mobilization.

105-2 MOBILIZATION LIMIT. Mobilization shall be limited to 10 percent of the total project cost, per schedule, as bid, with mobilization included into the total.

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. These notices must remain posted until final acceptance of the work by the Owner.

105-4 ENGINEER/RPR FIELD OFFICE. The Contractor shall furnish, for the duration of the Project, one building or work space for the use of the field engineers and inspectors, as a field office. The space shall be furnished and maintained by the Contractor as specified herein and shall become property of the Contractor when the contract work is completed. This facility shall be weatherproof. This building shall be located conveniently near to the construction and shall be separate from any building used by the Contractor and all keys to the building shall be turned over to the RPR. The RPR will approve the location of the building and it shall remain on the work site until released by the RPR. Each field office shall be equipped with fire extinguishers having a minimum Underwriter's Laboratory rating of 2A10BC. The field office shall have a ceiling height of not less than 7-feet and a floor space of not less than 100 square feet. The field office shall be provided with sufficient natural and artificial light. Doors and windows shall be equipped with locks approved by the RPR. The Contractor shall furnish wireless internet access to be paid by the Contractor. The Contractor shall furnish the following equipment and furniture meeting the approval of the RPR: 1 desk, 2 chairs, 1 2-drawer legal-size filing cabinet, 1 drafting table and stool, document scanner (capable of scanning 8.5" x 11" minimum), water and/or water cooler dispenser, sanitary facilities, heat, air conditioning and electricity (to be paid by Contractor). No direct payment will be made for this building or labor, materials, ground rental, or other expense in connection therewith. The cost hereof shall be included in the Price Bid for the various items of the Contract. The Contractor and his/her Superintendent shall provide all reasonable facilities to enable the RPR to inspect the workmanship and materials entering into the Project.

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:

Item C-105 Mobilization – 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

SITWORK

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.

With Engineer approval, P-101b and P-101c Joint and Crack Repair, may be substituted with material that meets the requirements of Utah Department of Transportation (UDOT) Crack Seal Asphalt Material per UDOT-2022 Standard Specifications. See Appendix 1, Section 02745 for full UDOT Specification regarding Crack Seal Asphalt Material.

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. If the material is to be wasted on the airport site, it shall be reduced to a maximum size of 2 inches. Concrete slabs that are damaged by under breaking shall be repaired or removed and replaced as advised 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 underlying 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 wasted on the airport site, it shall be broken to a maximum size of 1 inch.

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 advised 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. Remove all vegetation and debris from cracks to a minimum depth of 1 inch. If extensive vegetation exists, treat the specific area with a concentrated solution of a water-based herbicide approved by the RPR. Fill all cracks greater than 1/4 inch wide) with a crack sealant per ASTM D6690. The crack sealant, preparation, and application shall be compatible with the surface treatment/overlay to be used. To minimize contamination of the asphalt with the crack sealant, underfill the crack sealant a minimum of 1/8 inch, not to exceed ¼ inch. Any excess joint or crack sealer shall be removed from the pavement surface.

Wider cracks (over 1-1/2 inch wide), along with soft or sunken spots, indicate that the pavement or the pavement base should be repaired or replaced as stated below.

Cracks and joints may be filled with a mixture of emulsified asphalt and aggregate. The aggregate shall consist of limestone, volcanic ash, sand, or other material that will cure to form a hard substance. The combined gradation shall be as shown in the following table.

GRADATION

Sieve Size	Percent Passing
No. 4	100
No. 8	90-100
No. 16	65-90
No. 30	40-60
No. 50	25-42
No. 100	15-30
No. 200	10-20

The proportions of asphalt emulsion and aggregate shall be determined in the field and may be varied to facilitate construction requirements. Normally, these proportions will be approximately one part asphalt emulsion to five parts aggregate by volume. The material shall be poured or placed into the joints or cracks and compacted to form a voidless mass. The joint or crack shall be filled to within +0 to -1/8 inches of the surface. Any material spilled outside the width of the joint shall be removed from the pavement surface prior to constructing the overlay. Where concrete overlays are to be constructed, only the excess joint material on the pavement surface and vegetation in the joints need to be removed.

101-3.3 REMOVAL OF FOREIGN SUBSTANCES/CONTAMINATES PRIOR TO SEAL-COAT. Removal of foreign substances/contaminates from existing pavement that will affect the bond of the new treatment shall consist of removal of rubber, fuel spills, oil, crack sealer, at least 90% of paint, and other foreign substances from the surface of the pavement. Areas that require removal are designated on the plans and as identified by the RPR in the field during construction.

High-pressure water may be used. If chemicals are used, they shall comply with the state's environmental protection regulations. Removal methods used shall not cause major damage to the pavement, or to any structure or utility within or adjacent to the work area. Major damage is defined as changing the

properties of the pavement, removal of asphalt causing the aggregate to ravel, or removing pavement over 1/8 inch deep. If it is deemed by the RPR that damage to the existing pavement is caused by operational error, such as permitting the application method to dwell in one location for too long, the Contractor shall repair the damaged area without compensation and as identified by the RPR.

Removal of foreign substances shall not proceed until approved by the RPR. Water used for high-pressure water equipment shall be provided by the Contractor at the Contractor's expense. No material shall be deposited on the pavement shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans.

101-3.4 CONCRETE SPALL OR FAILED ASPHALTIC CONCRETE PAVEMENT REPAIR.

a. Repair of concrete spalls in areas to be overlaid with asphalt. The Contractor shall repair all spalled concrete as shown on the plans or as identified by the RPR. The perimeter of the repair shall be saw cut a minimum of 2 inches outside the affected area and 2 inches deep. The deteriorated material shall be removed to a depth where the existing material is firm or cannot be easily removed with a geologist pick. The removed area shall be filled with asphalt mixture with aggregate sized appropriately for the depth of the patch. The material shall be compacted with equipment approved by the RPR until the material is dense and no movement or marks are visible. The material shall not be placed in lifts over 4 inches in depth. This method of repair applies only to pavement to be overlaid.

b. Asphalt pavement repair. The Contractor shall repair all spalled concrete as shown on the plans or as identified by the RPR. The failed areas shall be removed as specified in paragraph 101-3.1b. All failed material including surface, base course, subbase course, and subgrade shall be removed. Materials and methods of construction shall comply with the applicable sections of these specifications.

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 underlying 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 in areas designated on the plans. 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 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 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 in areas designated on the plans.

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 in areas designated on the plans.

101-3.6. PREPARATION OF ASPHALT PAVEMENT SURFACES PRIOR TO SURFACE TREATMENT. Existing asphalt pavements to be treated with a surface treatment shall be prepared as follows:

a. Patch asphalt pavement surfaces that have been softened by petroleum derivatives or have failed due to any other cause. Remove damaged pavement to the full depth of the damage and replace with new asphalt pavement similar to that of the existing pavement in accordance with paragraph 101-3.4b.

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

c. Remove oil or grease that has not penetrated the asphalt pavement by scrubbing with a detergent and washing thoroughly with clean water. After cleaning, treat these areas with an oil spot primer.

d. Clean pavement surface immediately prior to placing the surface treatment so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film.

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. Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the joint and does not damage the joint.

101-3.8.1 REMOVAL OF EXISTING JOINT SEALANT. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry.

101-3.8.2 CLEANING PRIOR TO SEALING. Immediately before sealing, joints shall be cleaned by removing any remaining laitance and other foreign material. Allow sufficient time to dry out joints prior to sealing. Joint surfaces will be surface-dry prior to installation of sealant.

101-3.8.3 JOINT SEALANT. Joint material and installation will be in accordance with Item P-605.

101-3.9 PREPARATION OF CRACKS IN FLEXIBLE PAVEMENT PRIOR TO SEALING. Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the cracks and does not damage the pavement.

101-3.9.1 PREPARATION OF CRACK. Widen crack with router by removing a minimum of 1/16 inch from each side of crack. Immediately before sealing, cracks will be blown out with a hot air lance combined with oil and water-free compressed air.

101-3.9.2 REMOVAL OF EXISTING CRACK SEALANT. Existing sealants will be removed by routing. Following routing any remaining debris will be removed by use of a hot lance combined with oil and water-free compressed air.

101-3.9.3 CRACK SEALANT. Crack sealant material and installation will be in accordance with Item P-605.

101-3.9.4 REMOVAL OF PIPE AND OTHER BURIED STRUCTURES.

- a. **Removal of Existing Pipe Material.** Not used.
- b. **Removal of Inlets/Manholes.** Not used.

METHOD OF MEASUREMENT

101-4.1 PAVEMENT REMOVAL. The unit of measurement for pavement removal shall be the number of square yards removed by the Contractor. Any pavement removed outside the limits of removal because the pavement was damaged by negligence on the part of the Contractor shall not be included in the measurement for payment. 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.

101-4.2 JOINT AND CRACK REPAIR. The unit of measurement for joint and crack repair shall be by the ton of crack seal material used.

101-4.4 REMOVAL OF PAVEMENT MARKINGS. The quantity of pavement marking removals to be paid for shall be the number of square feet of marking removals. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to complete this item in accordance with paragraph 101-3.10.

101-4.5 REMOVAL OF PIPE AND OTHER BURIED STRUCTURES. Not required.

BASIS OF PAYMENT

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

Item P 101a	Pavement Removal – per square foot
Item P 101b	Joint and Crack Repair ($\frac{1}{8}$ Inch to $1\frac{1}{2}$ Inch) – per ton
Item P 101c	Joint and Crack Repair ($>1\frac{1}{2}$ Inch) – per ton
Item P-101d	Pavement Marking Removal - 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.

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-151
CLEARING AND GRUBBING**

DESCRIPTION

151-1.1 This item shall consist of clearing or clearing and grubbing, including the disposal of materials, for all areas within the limits designated on the plans or as required by the Resident Project Representative (RPR).

With Engineer approval, P-151 Clearing and Grubbing, may be replaced with the requirements of Utah Department of Transportation (UDOT) Site Clearing and Grubbing per UDOT-2022 Standard Specifications. See Appendix 1 Section 02231 for full UDOT Standard Specification regarding Site Clearing and Grubbing.

a. Clearing. Clearing shall consist of the cutting and removal of all trees, stumps, brush, logs, hedges, the removal of fences and other loose or projecting material from the designated areas. The grubbing of stumps and roots will not be required.

b. Clearing and Grubbing. Clearing and grubbing shall consist of clearing the surface of the ground of the designated areas of all trees, stumps, down timber, logs, snags, brush, undergrowth, hedges, heavy growth of grass or weeds, fences, structures, debris, and rubbish of any nature, natural obstructions or such material which in the opinion of the RPR is unsuitable for the foundation of strips, pavements, or other required structures, including the grubbing of stumps, roots, matted roots, foundations, and the disposal from the project of all spoil materials resulting from clearing and grubbing.

c. Tree Removal. Tree removal shall consist of the cutting and removal of isolated single trees or isolated groups of trees, and the grubbing of stumps and roots. The removal of all the trees of this classification shall be in accordance with the requirements for the particular area being cleared.

CONSTRUCTION METHODS

151-2.1 GENERAL. The areas denoted on the plans to be cleared shall be staked on the ground by the Contractor as indicated on the plans.

The removal of existing structures and utilities required to permit orderly progress of work shall be accomplished by local agencies, unless otherwise shown on the plans. Whenever a telephone pole, pipeline, conduit, sewer, roadway, or other utility is encountered and must be removed or relocated, the Contractor shall advise the RPR who will notify the proper local authority or owner to secure prompt action.

151-2.1.1 DISPOSAL. All materials removed by clearing or by clearing and grubbing shall be disposed of outside the Airport's limits at the Contractor's responsibility, except when otherwise identified by the RPR. As far as practicable, waste concrete and masonry shall be placed on slopes of embankments or channels. When embankments are constructed of such material, this material shall be placed in accordance with requirements for formation of embankments. Any broken concrete or masonry that cannot be used in construction and all other materials not considered suitable for use elsewhere, shall be disposed of by the Contractor. In no case, shall any discarded materials be left in windrows or piles adjacent to or within the airport limits. The manner and location of disposal of materials shall be subject to the approval of the RPR and shall not create an unsightly or objectionable view. When the Contractor is required to locate a disposal area outside the airport property limits, the Contractor shall obtain and

file with the RPR permission in writing from the property owner for the use of private property for this purpose.

151-2.1.2 BLASTING. Blasting shall not be allowed.

151-2.2 CLEARING. The Contractor shall clear the staked or indicated area of all materials as indicated on the plans. Trees unavoidably falling outside the specified clearing limits must be cut up, removed, and disposed of in a satisfactory manner. To minimize damage to trees that are to be left standing, trees shall be felled toward the center of the area being cleared. The Contractor shall preserve and protect from injury all trees not to be removed. The trees, stumps, and brush shall be cut flush with the original ground surface. The grubbing of stumps and roots will not be required.

Fences shall be removed and disposed of as identified by the RPR. Fence wire shall be neatly rolled and the wire and posts stored on the airport if they are to be used again, or stored at a location designated by the RPR if the fence is to remain the property of a local owner or authority.

151-2.3 CLEARING AND GRUBBING. In areas designated to be cleared and grubbed, all stumps, roots, buried logs, brush, grass, and other unsatisfactory materials as indicated on the plans, shall be removed, except where embankments exceeding 3-1/2 feet in depth will be constructed outside of paved areas. For embankments constructed outside of paved areas, all unsatisfactory materials shall be removed, but sound trees, stumps, and brush can be cut off flush with the original ground and allowed to remain. Tap roots and other projections over 1-1/2 inches in diameter shall be grubbed out to a depth of at least 18 inches below the finished subgrade or slope elevation.

Any buildings and miscellaneous structures that are shown on the plans to be removed shall be demolished or removed, and all materials shall be disposed of by removal from the site. The cost of removal is incidental to this item. The remaining or existing foundations, wells, cesspools, and like structures shall be destroyed by breaking down the materials of which the foundations, wells, cesspools, etc., are built to a depth at least 2 feet below the existing surrounding ground. Any broken concrete, blocks, or other objectionable material that cannot be used in backfill shall be removed and disposed of at the Contractor's expense. The holes or openings shall be backfilled with acceptable material and properly compacted.

All holes in embankment areas remaining after the grubbing operation shall have the sides of the holes flattened to facilitate filling with acceptable material and compacting as required in Item P-152. The same procedure shall be applied to all holes remaining after grubbing in areas where the depth of holes exceeds the depth of the proposed excavation.

METHOD OF MEASUREMENT

151-3.1 The quantities of clearing and grubbing as shown by the limits on the plans shall be the number of acres or fractions thereof, of land specifically cleared.

BASIS OF PAYMENT

151-4.1 Payment shall be made at the contract unit price per acre or fractions thereof for clearing and grubbing. 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:

Item P-151

Clearing and Grubbing – per acre or fractions thereof

END OF ITEM P-151

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.

With Engineer approval, P-152 Excavation, Subgrade, and Embankment, may be substituted with material that meets the requirements of Utah Department of Transportation (UDOT) Embankment, Borrow, and Backfill per UDOT-2022 Standard Specifications. See Appendix 1, Section 02056 for full UDOT Specification regarding Embankment, Borrow, and Backfill.

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

- a. **Unclassified excavation.** Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature.

152-1.3 UNSUITABLE EXCAVATION. 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.

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 or as identified by RPR. 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, to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 6 inches 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 shall not be allowed.

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.

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 of the stated elevations for ground surfaces, or within 0.04 foot 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 advised 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 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 for Embankment. 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 identified 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 below the top of subgrade or as indicated on the plans, and the material disposed of as identified 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. 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 identified 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. No placement of embankment material 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 existing ground surface. The Contractor and RPR shall agree that the original ground lines shown on original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

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 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 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 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 nor more than 12 inches 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 [advised](#) 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 $\pm 2\%$ 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 to 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 1,000 square yards of compacted embankment for the top lift and one test (minimum) per 1,000 cubic yards of lower lifts, or other appropriate frequencies as determined by the RPR.

If the material has greater than 30% retained on the 3/4-inch 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 95% 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.

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

not be allowed in the top 12 inches of the subgrade. Rockfill shall be brought up in lifts as specified or as identified 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 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 below the finished subgrade.

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. 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 three (3) 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 or show permanent deformation greater than 1 inch shall be removed and replaced with suitable material or reworked to conform to the moisture content and 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 $\pm 2\%$ 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 $\frac{3}{4}$ inch sieve, follow the methods in ASTM D698. Tests for moisture content and compaction will be taken at a minimum of 1,000 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 identified 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, 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 when tested with a 12-foot 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 straightedge for the full length of each line on a 50-foot grid.

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

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

METHOD OF MEASUREMENT

152-3.1 Measurement for payment specified by the cubic yard shall be computed by the the comparison of digital terrain model (DTM) surfaces for computation of neat line design quantities. The end area is that bound by the original ground line established by field measurements 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 embankment in place shall be the number of cubic yards measured in its final position.

BASIS OF PAYMENT

152-4.1 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:

Item P-152a	Embankment in place - per cubic yard
Item P-152b	Shoulder Grading – 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.

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/ft³)

ASTM D1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³)

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

BASE COURSES

**ITEM P-208
AGGREGATE BASE COURSE**

DESCRIPTION

208-1.1 This item shall consist of a base course composed of course aggregate bonded with fine aggregate base. It shall be constructed on a prepared subgrade or subbase course per these specifications and shall conform to the dimensions and typical cross-section shown on the plans.

With Engineer approval, P-208 base material, as described in section 208-2.1 and 208-2.2, may be substituted with material that meets the material requirements of Utah Department of Transportation (UDOT) Untreated Base Course Material (UTBC) Aggregate Class A, per UDOT-2022 Standard Specializations. See Appendix 1, Section 02721 for full UDOT Specification regarding Untreated Base Course.

All other base course requirements shall be per specification P-208 including requirements for sampling, testing, placement, acceptance, measurement, payment, etc.

MATERIALS

208-2.1 AGGREGATE BASE. The aggregate base material shall consist of both fine and coarse aggregate. Material shall be clean, sound, durable particles and fragments of stone or gravel, crushed stone, or crushed gravel mixed or blended with sand, screenings, or other materials. Materials shall be handled and stored in accordance with all federal, state, and local requirements. The aggregate shall be free from clay lumps, organic matter, 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 nearly constant and uniform as practicable. The fine aggregate portion, defined as the portion passing the No. 4 sieve produced in crushing operations, shall be incorporated in the base material to the extent permitted by the gradation requirements. Aggregate base material requirements are listed in the following table.

AGGREGATE BASE MATERIAL REQUIREMENTS

Material Test	Requirement	Standard
Coarse Aggregate		
Resistance to Degradation	Loss: 50% 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 60% by weight of particles with at least two fractured faces and 75% 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
Fine Aggregate		
Liquid limit	Less than or equal to 25	ASTM D4318
Plasticity Index	Not more than five (5)	ASTM D4318

Material Test	Requirement	Standard
---------------	-------------	----------

¹The 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.

²A 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).

208-2.2 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 for Contractor's Final Gradation ¹ Percent
2 inch	-		±0
1-1/2 inch	-		±5
1 inch	100		±8
3/4 inch	70-100		±8
No. 4	35-65		±8
No. 40	10-25		±5
No. 200	5-10		±3

¹The "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.

208-2.3 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 paragraphs 208-2.1 and 208-2.2. This sampling and testing will be the basis for approval of the aggregate base quality requirements. RPR may require additional iterations of materials sampling and testing during extended breaks in aggregate production or if differing materials become apparent.

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 all the requirements in paragraph 208-2.2. The samples shall be taken from the in-place, un-compacted material at sampling points and intervals designated by the RPR.

208-2.4 SEPARATION GEOTEXTILE. Not used.

CONSTRUCTION METHODS

208-3.1 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 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 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.

208-3.2 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.

208-3.3 PRODUCTION. The aggregate shall be uniformly blended and, when at a satisfactory moisture content per paragraph 208-3.5, the approved material may be transported directly to the placement.

208-3.4 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 layer shall be constructed in lifts as established in the control strip, but not less than 4 inches nor more than 12 inches 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.

208-3.5 COMPACTION. Immediately upon completion of the spreading operations, compact each layer of the base course, as specified, with approved compaction equipment. The number, type, and weight of rollers 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 base 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.

208-3.6 WEATHER LIMITATIONS. Material shall not be placed unless the ambient air temperature is at least 40 °F 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.

208-3.7 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 their expense.

208-3.8 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, reshaped and recompact 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 12-foot straight edge shall be provided by the Contractor and made available to the RPR at all times for testing of surface smoothness tolerance.

a. Smoothness. The finished surface shall not vary more than 3/8-inch when tested with a 12-foot 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 straightedge for the full length of each line on a 50-foot grid.

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

208-3.9 ACCEPTANCE SAMPLING AND TESTING. Aggregate base course shall be accepted for density and thickness on an area basis. Two tests will be made for density and thickness for each 1200 square yards. Sampling locations will be determined on a random basis per ASTM D3665.

a. Density. The Contractor's laboratory shall perform all density tests in the RPR's presence and provide the test results upon completion to the RPR 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 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 recompact 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 in diameter that extend through the base. The thickness of the base course shall be within +0 and -1/2 inch of the specified thickness as

determined by depth tests taken by the Contractor in the presence of the RPR for each area. Where the thickness is deficient by more than 1/2 inch, the Contractor shall correct such areas at no additional cost by scarifying to a depth of at least 3 inches, 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.

If approved by the RPR, lift thickness testing may also be performed via survey at no cost to the Sponsor. If survey is to be used, Contractor shall provide the RPR with electronic survey of both the final accepted underlying surface prior to placing of base course material and after the placement of base course. Thickness checks will use this survey as the basis for determining base course thickness. Format of electronic survey shall be approved by RPR.

c. The Contractor shall remove all survey and grade hubs from base courses prior to placing any surface course.

METHOD OF MEASUREMENT

208-4.1 The quantity of aggregate base course shall be measured by the number of square yards of material actually constructed and accepted by the RPR as complying with the plans and specifications. Base materials shall not be included in any other excavation quantities.

BASIS OF PAYMENT

208-5.1 Payment shall be made at the contract unit price per square yards for aggregate base course. This price shall be full compensation for furnishing all materials and for all operations, hauling, placing, and compacting of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-208 Aggregate Base Course - per square yards

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- μ m (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)
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)
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4643	Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating
ASTM 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-208

FLEXIBLE PAVEMENTS

**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.

With Engineer approval, P-401 Asphalt Mix Pavement, may be substituted with material that meets the material requirements of Utah Department of Transportation (UDOT) Hot Mix Asphalt Material (HMA) per UDOT-2022 Standard Specializations. See Appendix 1, Section 02741 for full UDOT Specification regarding Hot Mix Asphalt (HMA).

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 sieve. Fine aggregate is the material passing the No. 4 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
Bulk density of slag ³	Weigh not less than 70 pounds per cubic foot	ASTM C29.

¹The 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.

²A 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).

³Only required if slag is specified.

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) 70-34.

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 or gyrations
- Laboratory mixing and compaction temperatures.
- Supplier-recommended field mixing and compaction temperatures.
- Plot of the combined gradation on a 0.45 power gradation curve.
- Graphical plots of air voids, voids in the mineral aggregate (VMA), and unit weight versus asphalt content. 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	
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

¹Test 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.

²AASHTO 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.

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	--
3/4 inch	100
1/2 inch	90-100
3/8 inch	72-88
No. 4	53-73
No. 8	38-60
No. 16	26-48
No. 30	18-38
No. 50	11-27
No. 100	6-18
No. 200	3-6
Minimum Voids in Mineral Aggregate (VMA)¹	15.0
Asphalt Percent:	

Sieve Size	Percentage by Weight Passing Sieve
Stone or gravel	5.0-7.5
Slag	6.5-9.5
Recommended Minimum Construction Lift Thickness	2 inch

¹To 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. A control strip is not required.

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 or greater	40	4
Greater than 2 inches but less than 3 inches	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 are not required.

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 when added to the aggregate. The temperature of modified asphalt binder shall be no more than 350°F 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 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 PRIME AND TACK COAT. Immediately before placing the asphalt mixture, the underlying course shall be cleaned of all dust and debris.

A prime coat in accordance with Item P-602 shall be applied to aggregate base prior to placing the asphalt mixture.

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 10 feet 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; 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 from transverse joints in the previous course. Transverse joints in adjacent lanes shall be offset a minimum of 10 feet. 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 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; or are irregular, damaged, uncompacted or otherwise defective shall be cut back with a cutting wheel or pavement saw a maximum of 3 inches, horizontally, 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.

The Contractor may provide additional joint density QC by use of joint heaters at the Contractor's expense. Electrically powered infrared heating equipment should consist of one or more low-level radiant energy heaters to uniformly heat and soften the pavement joints. The heaters should be configured to uniformly heat an area up to 18 inches in width and 3 inches in depth. Infrared equipment shall be thermostatically controlled to provide a uniform, consistent temperature increase throughout the layer being heated up to a maximum temperature range of 200 to 300°F.

Propane powered infrared heating equipment shall be attached to the paving machine and the output of infrared energy shall be in the one to six-micron range. Converters shall be arranged end to end directly over the joint to be heated in sufficient numbers to continuously produce, when in operation, a minimum of 240,000 BTU per hour. The joint heater shall be positioned not more than one inch above the pavement to be heated and in front of the paver screed and shall be fully adjustable. Heaters will be required to be in operation at all times.

The heaters shall be operated so they do not produce excessive heat when the units pass over new or previously paved material.

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 wide. The saw blades shall be 1/8-inch wide with a sufficient number of blades to create grooves between 0.090 and 0.130 inches wide; and peaks and ridges approximately 1/32 inch 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 CONTRACTOR QC TESTING. The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to these specifications.

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.

In the presence of the RPR, 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 $\frac{1}{4}$ 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 straightedge, a rolling inclinometer meeting the requirements of ASTM E2133, or rolling external reference of ASTM E2133 or rolling external reference device that can simulate a 12-foot straightedge approved by the RPR. Straightedge 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 the FAA profile program, ProFAA, 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 or more often as determined by the RPR. The joint between lanes shall be tested separately to facilitate smoothness between lanes. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues.

(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; and at the third points of paving lanes when widths of paving lanes are 20 ft or greater.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch 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 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 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 1/2 inch and replacing with new material. Skin patching is not allowed.

401-5.4 SAMPLING. When indicated 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	±6%	±9%
1/2 inch	±6%	±9%
3/8 inch	±6%	±9%
No. 4	±6%	±9%
No. 16	±5%	±7.5%
No. 50	±3%	±4.5%
No. 200	±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	11%
3/8 inch	11%
No. 4	11%
No. 16	9%

Sieve	Suspension Limit
No. 50	6%
No. 200	3.5%
Asphalt Content	0.8%

c. Corrective Action. 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.

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 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 subplot basis.

(1) Sampling. Material from each subplot 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 subplot in accordance with ASTM D3203 for a set of compacted specimens prepared in accordance with ASTM D6926 or ASTM D6925.

d. In-place asphalt mat and joint density. Each subplot 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 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 indicated by the RPR to determine the extent of unbonded areas. Unbonded areas shall be removed by milling and replaced at no additional cost as indicated 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 subplot for density measurement. The maximum allowable deficiency at any point will not be more than 1/4 inch 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 subplot shall be corrected by the Contractor at his expense by removing the deficient area and replacing with new pavement. The Contractor, at his expense, may take additional cores as approved by the RPR to circumscribe the deficient area. Lots that are consistently thicker than indicated thickness may be limited to plan quantity for payment.

(4) Mat density. One core shall be taken from each subplot. 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 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 subplot sample by the TMD for that subplot.

(5) Joint density. One core centered over the longitudinal joint shall be taken for each subplot 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 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 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%. Lots that are consistently thicker than indicated thickness may be limited to plan quantity for payment.

e. Profilograph roughness for QA Acceptance. Not used.

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% 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 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 subplot shall be reduced by 5%.

**TABLE 6.
PRICE ADJUSTMENT SCHEDULE¹**

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

Percentage of material within specification limits (PWL)	Lot pay factor (percent of contract unit price)
Below 55	Reject ²

¹Although 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.

²The 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. Not used.

401-8.1 PAYMENT.

Payment will be made under:

- Item P-401a Asphalt Surface Course - per ton
- Item P-401b Asphalt Binder – 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- μ m (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 Gyrotory 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

SURFACE TREATMENT

**ITEM P-608-R
RAPID CURE SEAL COAT**

DESCRIPTION

608-R-1.1 This item shall consist of the application of an asphalt surface treatment composed of natural and refined asphalt materials, additives, and light oils, for taxiways and runways with the application of a suitable aggregate to maintain adequate surface friction; and airfield secondary and tertiary pavements including aprons, shoulders, overruns, roads, parking areas, and other general applications with or without aggregate applied as designated on the plans.

The terms seal coat, asphalt sealer, and asphalt material are interchangeable throughout this specification. The term asphalt means natural and refined asphalt materials in this specification.

With Engineers approval, P-608R, may be replaced with the material requirements of Utah Department of Transportation (UDOT) Asphalt Slurry Seal Coat per UDOT-2022 Standard Specifications. See Appendix 1, Section 02789 for full UDOT Standard Specification for Asphalt Slurry Seal Coat.

MATERIALS

608-R-2.1 AGGREGATE. The fine-aggregate material shall be a dry, clean, sound, durable, angular shaped, with highly textured surfaces, manufactured specialty abrasive aggregate. It shall have 100% fractured faces, SiO₂ content of 55% minimum, CaO of 3% max, with a sand equivalent greater than 85 and a Mohs hardness of 7 or greater. Additional characteristics as outlined in the following table(s). The Contractor shall submit specialty aggregate manufacturer's technical data and the specialty aggregate manufacturer's certification indicating that the specialty aggregate meets the requirements of the specification to the RPR prior to start of construction. The aggregate must be approved for use by the RPR and shall meet the following gradation limits:

AGGREGATE MATERIAL GRADATION REQUIREMENTS

Sieve Designation	Percentage by Weight Passing Sieves
3/8 inch	100
No. 4	70-90
No. 8	45-70
No. 14	28-50
No. 16	19-34
No. 30	12-28
No. 50	7-18
No. 70	5-15

AGGREGATE CHARACTERISTICS

Test	Standard	Range
Micro-Deval	ASTM D7428	15% max
Magnesium Sulfate Soundness	ASTM C88	2% max
Aggregate Angularity	ASTM C1252 – Test Method A	45% min

Moisture Content (%)	ASTM C566	2% max
Bulk Dry Specific Gravity	ASTM C128	2.6 – 3.0
Absorption (%)	ASTM D2216	3% max
Mohs Hardness	Mohs Scale	7 min

The Contractor shall provide a certification of analysis (COA) showing analysis and properties of the material delivered for use on the project. The Contractor's certification may be subject to verification by testing the material delivered for use on the project.

608-R-2.2 ASPHALT MATERIAL. The asphalt material base residue shall contain not less than 40% gilsonite, or uintaite, and shall not contain any tall oil pitch or coal tar material. The material shall be compatible with asphalt pavement, and have a 5-year minimum proven aviation performance record at airports with similar climatic conditions. The solvent-based rapid cure material shall meet the following properties:

PROPERTIES FOR ASPHALT SEALING MATERIAL

Properties	Specification	Limits
Kinematic Viscosity at 140 °F	ASTM D4402	10-30 cSt
Percent Residue by Distillation	ASTM D402	30-45%

TESTS ON RESIDUE FROM DISTILLATION

Properties	Specification	Limits
Penetration at 77 °F	ASTM D5	2-12 dmm
Softening Point	ASTM D36	180-200
Solubility in 1,1,1 Trichloroethylene	ASTM D2042	99% min.
HCl Precipitation Value		18-25

The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt sealer delivered to the project. If the asphalt sealer is diluted at other than the manufacturer's facility, the Contractor shall provide a supplemental COA from an independent laboratory verifying the asphalt sealer properties. The COA shall be provided to and approved by the RPR before the asphalt material is applied. The furnishing of the vendor's certified test report 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.

The asphalt sealing material must be applied in an undiluted form. The material may be stored at ambient temperature for long periods of time if necessary. Storage will follow industry standard recommendations due to the flammability of the material; avoid sparks and open flames to come into contact with the material or any gasses that might be escaping the storage vessel.

Contractor shall provide a list of airport pavement projects, exposed to similar climate conditions, where this product has been successfully applied within at least 5 years of the project.

608-R-2.3 SEAL COAT WITH AGGREGATE. The Contractor shall submit friction test data from at least two (2) prior airport projects identified under 608-R-2.2. The test data must be from the same project and include technical details on application rates, aggregate rates, and point of contact at the airport to confirm use and success of sealer with aggregate.

Friction test data in accordance with AC 150/5320-12, at 40 or 60 mph wet, must include as a minimum; the friction value prior to sealant application; two values, between 24 and 96 hours after application, with a minimum of 24 hours between tests; and one value between 180 days and 360 days after the application. The results of the tests between 24 and 96 hours shall indicate friction is increasing at a rate to obtain similar friction value of the pavement surface prior to application, and the long-term test shall indicate no apparent adverse effect with time relative to friction values and existing pavement surface.

Seal coat material submittal without required friction performance will not be approved. Friction tests performed on this project cannot be used as a substitute of this requirement.

COMPOSITION AND APPLICATION RATE

608-R-3.1 APPLICATION RATE. The approximate amounts of materials per square yard for the asphalt surface treatment shall be as provided in the table for the treatment area(s) at the specified rate(s) as noted on the plans. The actual application rates will vary within the range specified to suit field conditions and will be recommended by the manufacturer's representative for control strip evaluations, and approved by the RPR from the test area/sections evaluation.

APPLICATION RATE

Dilution Rate	Quantity of Sealer gal/yd ²	Quantity of Aggregate lb/yd ²
N/A	0.08-0.15	0.40-0.50

608-R-3.2 CONTROL AREAS AND CONTROL STRIPS. A qualified manufacturer's representative shall be present in the field to assist the Contractor in applying control areas and/or control strips to determine the appropriate application rate of both sealer and aggregate to be evaluated and approved by the RPR.

A test area and/or section shall be applied for each differing asphalt pavement surface identified in the project. The control area(s) and/or control strip(s) shall be used to determine the material application rate(s) of both sealer and aggregate prior to full production. The same equipment and method of operation shall be utilized on the control area(s) and/or control strip(s) as will be utilized on the remainder of the work.

a. For taxiway, taxilane and apron surfaces. Prior to full application, the Contractor shall place test areas at varying application rates as recommended by the Contractor's manufacturer's representative to determine appropriate application rate(s). The test areas will be located on representative section(s) of the pavement to receive the asphalt surface treatment designated by the RPR.

b. For runway and high-speed exit taxiway surfaces. Prior to full application, the Contractor shall place a series of control strips a minimum of 300 feet long by 12 feet wide, or width of anticipated application, whichever is greater, at varying application rates as recommended by the manufacturer's representative and acceptable to the RPR to determine appropriate application rate(s). The control strips should be separated by a minimum of 200 feet between control strips. The area to be tested will be located on a representative section of the pavement to receive the asphalt surface treatment designated by the RPR. The control strips should be placed under similar field conditions as anticipated for the actual application. Before beginning the control strip(s), the skid resistance of the existing pavement shall be determined for each control strip with a continuous friction measuring equipment (CFME). The skid

resistance of existing pavement can be immediately adjacent to the control strip or at the same location as the control strip if testing prior to application.

The Contractor may begin testing the skid resistance of runway and high-speed exit taxiway control strips after application of the asphalt surface treatment has fully cured, generally 2 to 4 hours after application of the control strips depending on site conditions. Aircraft shall not be permitted on the runway or high-speed exit taxiway control strips until such time as the Contractor validates that its surface friction meets the maintenance planning friction levels in AC 150/5320-12, Table 3-2 when tested at speeds of 40 and 60 mph wet with approved CFME.

c. Control strip. If the control strip should prove to be unsatisfactory, necessary adjustments to the application rate, placement operations, and equipment shall be made. Additional control strips shall be placed and additional skid resistance tests performed and evaluated. Full production shall not begin without the RPR's approval of an appropriate application rate(s). Acceptable control strips shall be paid for in accordance with paragraph 608-R-8.1.

CONSTRUCTION METHODS

608-R-4.1 WORKER SAFETY. The Contractor shall obtain a Safety Data Sheet (SDS) for both the asphalt sealer product and aggregate and require workmen to follow the manufacturer's recommended safety precautions. All additional industry standard safety precautions regarding the storage and applications of solvent based asphalts should be understood and followed by the Contractor.

608-R-4.2 WEATHER LIMITATIONS. The asphalt sealer shall be applied only when the existing pavement surface is dry and when the weather is not foggy, rainy, or when the wind velocity will prevent the uniform application of the material. No material shall be applied when dust or aggregate is blowing or when rain is anticipated within four (4) hours of application completion. The atmospheric temperature and the pavement surface temperature shall both be at, or above 55 °F and rising. The sealer will shall not be applied when pavement temperatures are expected to exceed 160 °F within the subsequent 72 hours if traffic will be opened on pavement within those 72 hours. During application, account for wind drift. Cover existing buildings, structures, runway edge lights, taxiway edge lights, informational signs, retro-reflective marking and in-pavement duct markers as necessary to protect against overspray before applying the sealer. Should sealer get on any light or marker fixture, promptly clean the fixture. If cleaning is not satisfactory to the RPR, the Contractor shall replace any light, sign or marker with equivalent equipment at no cost to the Owner.

608-R-4.3 EQUIPMENT AND TOOLS. The Contractor shall furnish all equipment, tools, and machinery necessary for the performance of the work.

a. Pressure distributor. The sealer 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 sealer. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour or seven hundred (700) feet per minute. The Contractor will provide verification of truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application per nozzle manufacturer, spray-bar height and pressure and pump speed appropriate for the viscosity and temperature of sealer material, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use. The distributor truck shall be

equipped with a 12 foot, minimum, spray bar with individual nozzle control. The distributor truck shall be capable of specific application rates in the range of 0.05 to 0.25 gallons per square yard. These rates shall be computer-controlled rather than mechanical. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the sealer, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy.

The distributor truck shall effectively mix the material prior to application.

The distributor shall be equipped with a hand sprayer to spray the sealer in areas not accessible to the distributor truck.

b. Aggregate spreader. The asphalt distributor truck will be equipped with an aggregate spreader mounted to the distributor truck that can apply aggregate to the sealer in a single pass operation without driving through wet sealer. The aggregate spreader shall be equipped with a variable control system capable of uniformly distributing the aggregate at the specified rate at varying application widths and speeds. The aggregate spreader must be adjusted to produce an even and accurate application of specified aggregate. Prior to any seal coat application, the aggregate spreader will be calibrated onsite to ensure acceptable uniformity of spread. The RPR will observe the calibration and verify the results. The aggregate spreader will be re-calibrated each time the aggregate rate is changed either during the application of test strips or production. The Contractor may consult the seal coat manufacturer representative for procedure and guidance. The aggregate spreader shall have a minimum hopper capacity of 3,000 pounds of aggregate. Push-type hand spreaders will be allowed for use around lights, signs and other obstructions, if necessary.

c. Power broom/blower. A power broom and/or blower shall be provided for removing loose material from the surface to be treated.

d. Equipment calibration. Asphalt distributors must be calibrated within the same construction season 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.

608-R-4.4 PREPARATION OF ASPHALT PAVEMENT SURFACES. Clean pavement surface immediately prior to placing the seal coat so that it is free of dust, dirt, grease, vegetation, oil or any type of objectionable surface film. Remove oil or grease from the asphalt pavement by scrubbing with a detergent, washing thoroughly with clean water, and treating these areas with the oil spot primer. Any additional surface preparation, such as crack repair, shall be in accordance with Item P-101, paragraph 101-3.6.

608-R-4.5 APPLICATION OF ASPHALT SEALER. The asphalt sealer shall be applied using a pressure distributor upon the properly prepared, clean and dry surface at the application rate recommended by the manufacturer's representative and approved by the RPR from the test area/sections evaluation for each designated treatment area. Recommended material temperature for application is 70 °F to 90 °F, but depending on the application equipment used, good material dispersion and pavement coverage may be achieved at lower material temperatures. The material should not be heated above 100 °F.

Pavement surfaces which have excessive runoff of seal coat due to excessive amount of material being applied or excessive surface grade shall be treated in two or more applications, if feasible, to the specified application rate at no additional cost to the Owner. Each additional application shall be performed after the prior application of material has penetrated into the pavement.

If low spots and depressions greater than 1/2 inch in depth in the pavement surface cause ponding or puddling of the applied materials, the pavement surface shall be lightly broomed with a broom or brush type squeegee. Brooming shall continue until the pavement surface is free of any pools of excess material. Ponding and/or puddling shall not cause excessive pavement tackiness and/or additional distress.

During all applications, the surfaces of adjacent structures shall be protected to prevent their being spattered or marred. Asphalt materials shall not be discharged into borrow pits or gutters or on the airport area.

Caution. *Heating asphalt binders of any kind always constitutes some degree of hazard. The most hazardous of these are cutback asphalts because of the highly volatile solvents used. Care must be taken not to allow any spark or open flame to come in contact with the cutback asphalt or the gases from cutback asphalt due to the low flash point. It is the Contractor's responsibility to understand and adhere to these standards in regards to staying within the recommended application temperatures of this material and at all times during production.*

608-R-4.6 APPLICATION OF AGGREGATE MATERIAL. Immediately following the application of the asphalt sealer, aggregate at the rate recommended by the manufacturer's representative and approved by the RPR from the test area/sections evaluation for each designated application area, shall be spread uniformly over the asphalt sealer in a single-pass operation simultaneous with the sealer application. The sealer material and aggregate shall be applied simultaneously in a single pass operation, so as to not drive through the applied fresh sealer. The aggregate shall be spread to the same width of application as the asphalt material and shall not be applied in such thickness as to cause blanketing.

Sprinkling of additional aggregate material, and spraying additional asphalt material over areas that show up having insufficient cover or bitumen, shall be done by hand whenever necessary. In areas where hand work is necessitated, the aggregate shall be applied before the sealant begins to break.

Minimize aggregate from being broadcast and accumulating on the untreated pavement adjacent to an application pass. Prior to the next application pass, the Contractor shall clean areas of excess or loose aggregate and remove from project site.

QUALITY CONTROL (QC)

608-R-5.1 MANUFACTURER'S REPRESENTATION. The manufacturer's knowledgeable representative of the material, procedures, and equipment described in the specification is responsible to assist the Contractor and RPR in determining the appropriate application rates of the emulsion and aggregate, as well as recommendations for proper preparation and start-up of seal coat application. Documentation of the manufacturer representative's experience and knowledge for applying the seal coat product shall be furnished to the RPR a minimum of 10 work days prior to placement of the control strips. The cost of the manufacturer's representative shall be included in the Contractor's bid price.

608-R-5.2 CONTRACTOR QUALIFICATIONS. The Contractor shall provide the RPR with the seal coat Contractor's qualifications for applicators, personnel and equipment. The Contractor shall also provide documentation that the seal coat Contractor is qualified to apply the seal coat and has made at least three (3) applications similar to this project in the past two (2) years.

MATERIAL ACCEPTANCE

608-R-6.1 APPLICATION RATE. The rate of application of the asphalt emulsion shall be verified at least twice per day.

608-R-6.2 FRICTION TESTS. Friction tests in accordance with AC 150/5320-12, *Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces*, shall be accomplished on all runway and high-speed taxiways that have received a seal coat. Each test includes performing friction tests at 40 mph and 60 mph both wet, 15 feet to each side of runway centerline. The Contractor shall coordinate testing with the RPR and provide the RPR a written report of friction test results. The RPR shall be present for testing.

METHOD OF MEASUREMENT

608-R-7.1 ASPHALT SURFACE TREATMENT. The quantity of asphalt surface treatment shall be measured by the square yards of material applied in accordance with the plans and specifications and accepted by the RPR.

The Contractor must furnish the RPR with the certified weigh bills when materials are received for the asphalt material used under this contract. The Contractor must not remove material from the tank car or storage tank until initial amounts and temperature measurements have been verified.

BASIS OF PAYMENT

608-R-8.1 Payment shall be made at the contract unit price per square yard for the asphalt surface treatment applied and accepted by the RPR, and the contract unit price per lump sum for runway friction testing. This price shall be full compensation for all surface preparation, furnishing all materials, delivery and application of these materials, for all labor, equipment, tools, and incidentals necessary to complete the item, including the friction testing and all work required to meet AC 150/5320-12, and any costs associated with furnishing a qualified manufacturer's representative to assist with control strips.

608-R-8.2 Payment shall be made at the contract unit price per lump sum for friction testing and all work required to meet AC 150/5320-12.

Payment will be made under:

Item P-608-Ra	Asphalt Surface Treatment (with sand) – per square yard
Item P-608-Rb	Asphalt Surface Treatment (without sand) – per square yard
Item P-608-Rc	Runway Friction Testing – 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.

ASTM International (ASTM)

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- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C128	Standard Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C1252	Standard Test Methods for Uncompacted Void Content of Fine Aggregate
ASTM D5	Standard Test Method for Penetration of Asphalt Materials
ASTM D36	Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
ASTM D402	Standard Test Method for Distillation of Cutback Asphalt
ASTM D2042	Standard Test Method for Solubility of Asphalt Materials in Trichloroethylene
ASTM D2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D2995	Standard Practice for Estimating Application Rate of Bituminous Distributors
ASTM D4402	Standard Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D5340	Standard Test Method for Airport Pavement Condition Index Surveys
ASTM D6433	Standard Practice for Roads and Parking Lots Pavement Condition Index Surveys
ASTM D6997	<u>Standard Test Method for Distillation of Emulsified Asphalt</u>
ASTM D7428	Standard Test Method for Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus

Advisory Circulars (AC)

AC 150/5320-12	Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces
AC 150/5320-17	Airfield Pavement Surface Evaluation and Rating (PASER) Manuals
AC 150/5380-6	Guidelines and Procedures for Maintenance of Airport Pavements
AC 150/5380-7	Airport Pavement Management Program (PMP)

END OF ITEM P-608-R

MISCELLANEOUS

ITEM P-602
EMULSIFIED ASPHALT PRIME COAT

DESCRIPTION

602-1.1 This item shall consist of an application of emulsified asphalt material on the prepared base course in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

With Engineer approval, P-602 Emulsified Asphalt Prime Coat, may be substituted with material that meets the requirements of Utah Department of Transportation (UDOT) Prime Coat/Tack Coat per UDOT-2022 Standard Specifications. See Appendix 1, Section 02748 for full UDOT Specification regarding Prime Coat/Tack Coat.

MATERIALS

602-2.1 EMULSIFIED ASPHALT MATERIAL. The emulsified asphalt material shall be as specified in ASTM D3628 for use as a prime coat appropriate to local conditions. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the emulsified asphalt material. The COA shall be provided to and approved by the Resident Project Representative (RPR) before the emulsified asphalt material is applied. The furnishing of the COA for the emulsified 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

602-3.1 WEATHER LIMITATIONS. The emulsified asphalt prime coat shall be applied only when the existing surface is dry; the atmospheric temperature is 50°F or above, and the temperature has not been below 35°F for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when identified by the RPR.

602-3.2 EQUIPMENT. The equipment shall include a self-powered pressure asphalt material distributor and equipment for heating asphalt material.

Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 65.0 psi of tire width to prevent rutting, shoving or otherwise damaging the base, surface or other layers in the pavement structure. Design and equip the distributor to spray the asphalt material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 1.0 gallons per square yard, with a pressure range of 25 to 75 psi and with an allowable variation from the specified rate of not more than ±5%, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying asphalt material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the asphalt material during the heating process. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

A power broom and power blower suitable for cleaning the surfaces to which the asphalt coat is to be applied shall be provided.

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.

602-3.3 APPLICATION OF EMULSIFIED ASPHALT MATERIAL. Immediately before applying the prime coat, the full width of the surface to be primed shall be swept with a power broom to remove all loose dirt and other objectionable material.

The asphalt emulsion material shall be uniformly applied with an asphalt distributor at the rate of 0.5 gallons per square yard depending on the base course surface texture. The type of asphalt material and application rate shall be approved by the RPR prior to application.

Following application of the emulsified asphalt material and prior to application of the succeeding layer of pavement, allow the asphalt coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas. Allow the prime coat to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course. Furnish and spread sand to effectively blot up and cure excess asphalt material. The Contractor shall remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Owner. Keep traffic off surfaces freshly treated with asphalt material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

602-3.4 TRIAL APPLICATION RATES. The Contractor shall apply a minimum of three lengths of at least 100 feet for the full width of the distributor bar to evaluate the amount of emulsified asphalt material that can be satisfactorily applied with the equipment. Apply three different application rates of emulsified asphalt materials within the application range specified in paragraph 602-3.3. Other trial applications can be made using various amounts of material as identified by the RPR. The trial application is to demonstrate the equipment can uniformly apply the emulsified asphalt material within the rates specified and determine the application rate for the project.

602-3.5 FREIGHT AND WAYBILLS. The Contractor shall submit waybills and delivery tickets during the progress of the work. Before the final estimate 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

602-4.1 The emulsified asphalt material for prime coat shall be measured by the gallon. Volume shall be corrected to the volume at 60°F in accordance with ASTM D4311. 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

602-5.1 Payment shall be made at the contract unit price per gallon for emulsified asphalt prime coat. This price shall be full compensation for furnishing all materials and for all preparation, delivering, and applying the materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item P-602 Emulsified Asphalt Prime 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 D2995 Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors

ASTM D3628 Standard Practice for Selection and Use of Emulsified Asphalts

END OF ITEM P-602

ITEM P-603
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.

With Engineer approval, P-603 Emulsified Asphalt Tack Coat, may be substituted with material that meets the requirements of Utah Department of Transportation (UDOT) Prime Coat/Tack Coat per UDOT-2022 Standard Specifications. See Appendix 1, Section 02748 for full UDOT Specification regarding Prime Coat/Tack Coat.

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.

603-2.1 BITUMINOUS MATERIALS. The bituminous material shall be an emulsified asphalt indicated in ASTM D3628 as a bituminous application for tack coat appropriate to local conditions or as designated by the Engineer. The type grade controlling specification application temperature and application rate (not more than 0.15 gal/square yard) of bituminous material to be used shall be specified by the Engineer.

CONSTRUCTION METHODS

603-3.1 WEATHER LIMITATIONS. The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F or above; the temperature has not been below 35°F 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 or seven hundred (700) feet 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 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	Emulsion Application Bar Rate, gal/SY
New asphalt	0.02-0.05	0.03-0.07
Existing asphalt	0.04-0.07	0.06-0.11
Milled Surface	0.04-0.08	.06-0.12
Concrete	0.03-0.05	0.05-0.08

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

The Contractor shall furnish the vendor's certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The engineer may use the local state DOT agency supplier certification program for approval instead of the test reports. The tests reports shall be provided to and approved by the Engineer before the bituminous material is applied. If the bituminous material does not meet the specifications, it shall be replaced at the Contractor's expense. Furnishing the vendor's certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. Samples may be taken and tested for verification by the engineer when material is delivered to the site.

603-3.5 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 bituminous material for tack coat shall not be measured.

BASIS OF PAYMENT

603.5-1 No payment shall be made for bituminous tack coat material. The price 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 shall be incidental to P-403 / P-401.

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

**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 identified 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.

With Engineer approval, P-620 Runway and Taxiway Marking, may be substituted with material that meets the material requirements of Utah Department of Transportation (UDOT) Pavement Marking Materials per UDOT-2022 Standard Specifications. See Appendix 1, Section 02768 for full UDOT Specification regarding Pavement Marking Materials.

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 ¹				Glass Beads ²	
Type	Color	Fed Std. 595 Number	Application Rate Maximum	Type	Application Rate Minimum
Waterborne, Type II	Black	37038	155 ft ² /gal	Type I, Gradation A	7 lb/gal
Waterborne, Type II	Yellow	33538 or 33655	155 ft ² /gal	Type I, Gradation A	7 lg/gal

¹ See paragraph 620-2.2a

² See paragraph 620-2.2b

- a. Paint.** Paint shall be waterborne in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595. See Appendix 1, Section 02765 for full UDOT Standard Specification regarding Pavement Marking Paint.

- b. Reflective media.** Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type I, Gradation A.

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 contaminants 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. See P-620-3.9 Removals of Markings for construction method of marking removals. Method of Measurement for marking removals and Basis of Payment for marking removals are addressed under P-620-3.9.

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 final 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 in 50 feet, and marking dimensions and spacing shall be within the following tolerances:

MARKING DIMENSIONS AND SPACING TOLERANCE

Dimension and Spacing	Tolerance
36 inch or less	±1/2 inch
greater than 36 inch to 6 feet	±1 inch
greater than 6 feet to 60 feet	±2 inch
greater than 60 feet	±3 inch

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted. A period of one (1) day shall elapse between placement of a bituminous surface course or seal coat and application of temporary paint. Temporary paint may be applied sooner if the seal coat has broken and is no longer tacky. However, if discoloration is evident, painting shall be discontinued and additional cure time of the seal coat will be required. All discolored paint shall be replaced at the Contractor's expense.

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 readings shall be taken over a 6 square foot area with three (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.

620-3.10 REMOVAL OF MARKINGS. Designated existing pavement markings shall be physically removed by sandblasting, chemical removal or other means approved by the Engineer. Removal by painting over existing markings will not be allowed. Any methods used shall not cause major damage to the pavement. Major damage is defined as changing the properties of the pavement or removing pavement over 1/8 inch deep. If chemicals are used, they shall comply with the state's environmental protection regulations. No material shall be deposited on the runway shoulders. All wastes shall be disposed of as indicated by the RPR.

METHOD OF MEASUREMENT

620-4.1a The quantity of surface preparation shall be measured by lump sum.

620-4.1b The quantity of markings to be paid for shall be measured by the number of square feet of painting.

620-4.1c The quantity of reflective media shall be paid for by the number of pounds of reflective media.

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. See Appendix 1, Section 01558 for full UDOT Standard Specification regarding Temporary Pavement Markings.

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 lump sum.

620-5.1b Payment for markings shall be made at the contract price for the number of square feet of painting and the number of pounds of reflective media.

620-5.1c Payment for reflective media shall be made at the contract unit price for the number of pounds of reflective media.

620-5.1d 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:

Item P-620a	Marking - per square foot
Item P-620b	Reflective Media - per pound
Item P-620c	Temporary Runway and Taxiway Marking - 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 S-10
AIRCRAFT TIEDOWNS**

DESCRIPTION

S-10-1.1 This Work shall consist of the installation of new aircraft tiedowns in accordance with this Specification at the locations and in accordance with the dimensions, designs and details shown on the Plans. This item shall include all excavation, backfilling and restoration of paved areas to the satisfaction of the Engineer.

MATERIALS

S-10-2.1 GENERAL. All materials shall be subject to acceptance by the Engineer.

S-10-2.2 CONCRETE. Concrete shall conform to Specification P - 610.

S-10-2.3 REINFORCING BARS. Reinforcing Bars shall be 5/8" diameter, Grade 60, billet steel, conforming to the requirements of ASTM A 615.

METHOD OF MEASUREMENT

S-10-3.1 An aircraft tiedown shall consist of 3 separate anchors - 2 wing anchors and 1 tail anchor. The quantity of aircraft tiedowns to be paid for shall be the number of 3 anchor units installed, and accepted.

BASIS OF PAYMENT

S-10-4.1 Payment will be made at the Contract Unit Price for each 3 anchor tiedown unit completed and accepted. This price shall be full compensation for furnishing all materials and for all preparation, assembly and installation of these materials, and for all labor, equipment, tools and incidentals necessary to complete this item. Aircraft tiedowns which are removed or paved over shall be incidental to and included in Contract Unit Prices for the various pavement items.

Payment will be made under:

Item S-10 Aircraft Tiedowns (Set of 3) - per each

MATERIAL REQUIREMENTS

ASTM A 615 Concrete Rebar

END OF ITEM S-10

LIGHTING INSTALLATION

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.

With Engineer approval, L-125 Installation of Airport Lighting Systems, may be substituted with material that meets the material requirements of Utah Department of Transportation (UDOT) Retroreflective Sheeting per UDOT-2022 Standard Specifications. See Appendix 1, Section 02890 for full UDOT Specification regarding Retroreflective Sheeting.

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 perform 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 indicated 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, tabbed by specification section. The RPR reserves the right to reject any or all equipment, materials or procedures, which, in the RPR's opinion, does not meet the system design and the standards and codes, specified herein.

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.

EQUIPMENT AND MATERIALS

125-2.2 CONDUIT/DUCT. Not required.

125-2.3 CABLE AND COUNTERPOISE. Not required.

125-2.4 TAPE. Not required.

125-2.5 CABLE CONNECTIONS. Not required.

125-2.6 RETROREFLECTIVE MARKERS. Retroreflective markers shall be type L-853 and shall conform to the requirements of AC 150/5345-39. See Appendix 1, Section 02890, for full UDOT Standard Specification on Retroreflective Sheeting.

125-2.7 RUNWAY AND TAXIWAY LIGHTS. Not required.

125-2.8 RUNWAY AND TAXIWAY SIGNS. Not required.

125-2.9 RUNWAY END IDENTIFIER LIGHT (REIL). Not required.

125-2.10 PRECISION APPROACH PATH INDICATOR (PAPI). Not required.

125-2.11 CIRCUIT SELECTOR CABINET. Not required.

125-2.12 Light Base and Transformer Housings. Not required.

125-2.13 ISOLATION TRANSFORMERS. Not required.

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.

125-3.2 TESTING. Not required.

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 AND IN-PAVEMENT 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.

METHOD OF MEASUREMENT

125-4.1 Reflective markers will be measured by the number installed as completed units in place, ready for operation, and accepted by the RPR.

BASIS OF PAYMENT

125-5.1 Payment will be made at the Contract unit price for each complete reflective marker, runway end identification light, precision approach path indicator, or abbreviated precision approach path indicator 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.

Payment will be made under:

Item L-125	Retroreflective Edge Marker - 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 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-28	Precision Approach Path Indicator (PAPI) Systems

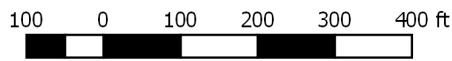
- AC 150/5345-39 Specification for L-853, Runway and Taxiway Retroreflective Markers
- AC 150/5345-42 Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
- AC 150/5345-44 Specification for Runway and Taxiway Signs
- AC 150/5345-46 Specification for Runway and Taxiway Light Fixtures
- AC 150/5345-47 Specification for Series to Series Isolation Transformers for Airport Lighting Systems
- AC 150/5345-51 Specification for Discharge-Type Flashing Light Equipment
- AC 150/5345-53 Airport Lighting Equipment Certification Program

Engineering Brief (EB)

- EB No. 67 Light Sources Other than Incandescent and Xenon for Airport and Obstruction Lighting Fixtures

END OF ITEM L-125

SOIL BORING LOGS



1:3,000



GeoStrata
Copyright, 2021

Legend

Approximate Boring Location

Armstrong Consultants
West Desert Airpark
Fairfield, Utah
Project Number 1644-001

Exploration Location Map

**Plate
A-2**

DATE: STARTED: 7/12/21
 COMPLETED: 7/12/21
 BACKFILLED: 7/12/21

Armstrong Consultants
 West Desert Airpark
 Fairfield, Utah
 Project Number 1644-001

GeoStrata Rep: A. Peay
 Rig Type: B-80 Mobile
 Boring Type: HSA

BORING NO: B-1
 Sheet 1 of 1

DEPTH	METERS	FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION			Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits		
							STATION	OFFSET	ELEVATION						Plastic Limit	Moisture Content	Liquid Limit
0		0				GP	UNDOCUMENTED FILL; Poorly Graded GRAVEL - grey, moist, gravels average less then 1 inch Lean CLAY - stiff, moist, brown								10	20	30
30		54				CL				6.7	89.9	33	20				
27		45				CL				21.8							
33		52				CL											
5						ML	Sandy SILT - stiff, moist, brown with white mottling										
13		19				ML				114.3	12.1						
22		31				ML				14.3							
10						CL	Lean CLAY - soft, moist, light brown										
11		14				CL				103.3	19.8						
							Bottom of Boring @ 11.5 Feet										

N - OBSERVED UNCORRECTED BLOW COUNT

N* - CORRECTED N1(60) EQUIVALENT SPT BLOW COUNT

2020 LOG OF BORING - PLATE (B) 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 8/5/21



Copyright (c) 2021, GeoStrata

SAMPLE TYPE

- ☒ - 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- ☒ - 3" O.D./2.48" I.D. SAMPLER
- ☒ - 3" O.D. THIN-WALLED SHELBY SAMPLER
- ☒ - GRAB SAMPLE
- ☒ - Modified California Sampler

NOTES:

WATER LEVEL

- ▼ - MEASURED
- ▽ - ESTIMATED

**Plate
B - 1**

DATE		STARTED: 7/12/21		COMPLETED: 7/12/21		BACKFILLED: 7/12/21		Armstrong Consultants West Desert Airpark Fairfield, Utah Project Number 1644-001				GeoStrata Rep: A. Peay Rig Type: B-80 Mobile Boring Type: HSA		BORING NO: B-2 Sheet 1 of 1				
DEPTH		METERS	FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION			Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits		
								STATION	OFFSET	ELEVATION						MATERIAL DESCRIPTION		
								10 20 30 40 50 60 70 80 90			10 20 30 40 50 60 70 80 90							
							GP	UNDOCUMENTED FILL; Poorly Graded GRAVEL - grey, moist, gravels average less than 1 inch										
							ML	SILT with sand - stiff to hard, moist, grey, sand is fine-grained			24	43						
							CL	Lean CLAY - stiff, moist, brown			19	32						
							CL	Sandy Lean CLAY - stiff to hard, moist, grey, sand is fine-grained			33	52	111.1	15.2	88.3	31	17	
							CL				24	36						
							CL				18	25	115.5	13.1	76.2	25	14	
							CL	Lean CLAY - stiff, moist, brown			12	15			18.7			
								Bottom of Boring @ 11.5 Feet										

N - OBSERVED UNCORRECTED BLOW COUNT

N* - CORRECTED N1(60) EQUIVALENT SPT BLOW COUNT



Copyright (c) 2021, GeoStrata

SAMPLE TYPE

- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3" O.D./2.48" I.D. SAMPLER
- 3" O.D. THIN-WALLED SHELBY SAMPLER
- GRAB SAMPLE
- Modified California Sampler

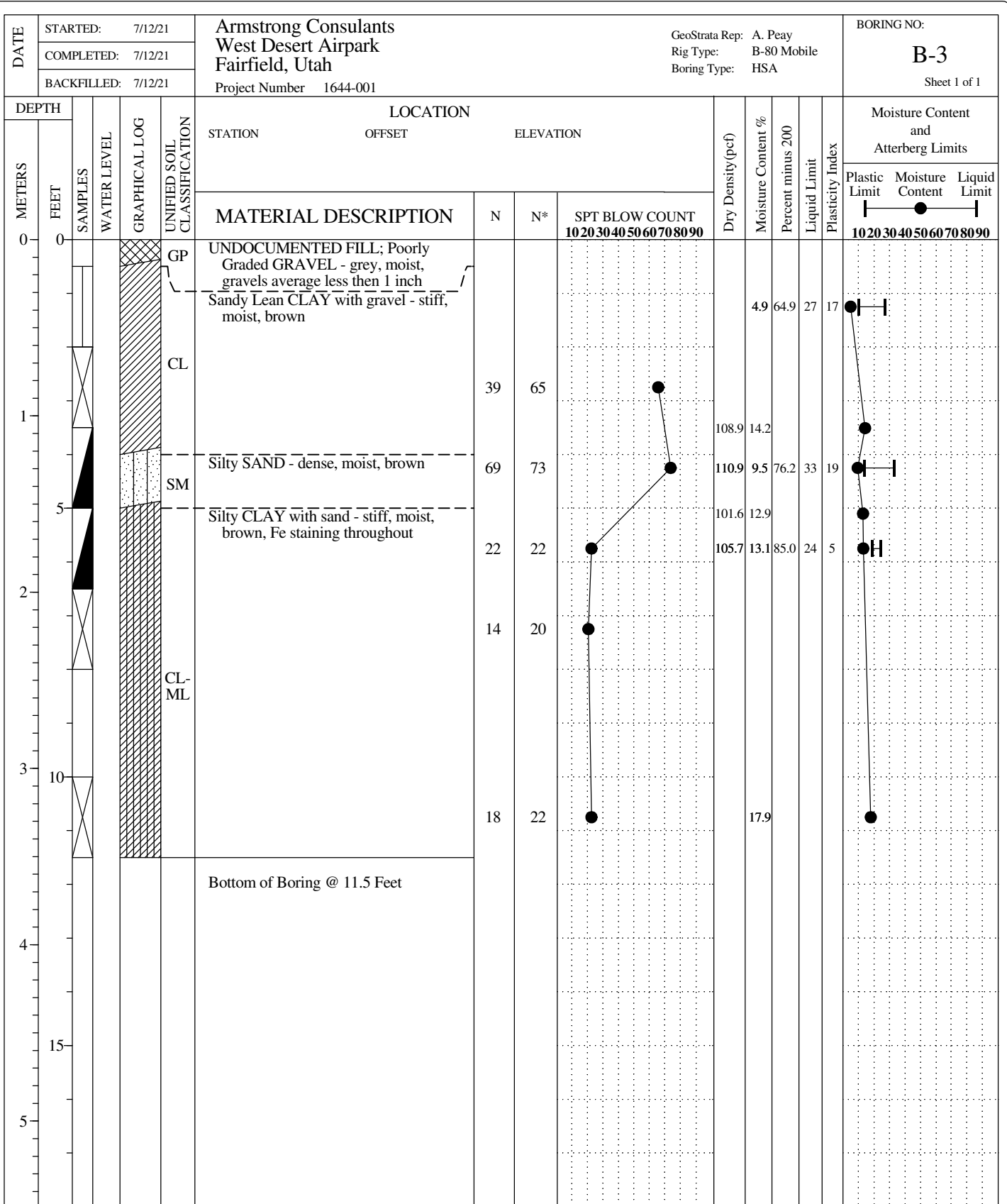
NOTES:

WATER LEVEL

- MEASURED
- ESTIMATED

Plate
B - 2

2020 LOG OF BORING - PLATE (B) 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 8/5/21



N - OBSERVED UNCORRECTED BLOW COUNT

N* - CORRECTED N1(60) EQUIVALENT SPT BLOW COUNT



Copyright (c) 2021, GeoStrata

- SAMPLE TYPE**
- ☒ - 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
 - ☒ - 3" O.D./2.48" I.D. SAMPLER
 - ☒ - 3" O.D. THIN-WALLED SHELBY SAMPLER
 - ☒ - GRAB SAMPLE
 - ☒ - Modified California Sampler

NOTES:

WATER LEVEL
 ▼ - MEASURED ▽ - ESTIMATED

Plate
B - 3

DEPTH		LOCATION			Moisture Content and Atterberg Limits																									
METERS	FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	STATION	OFFSET	ELEVATION	MATERIAL DESCRIPTION	N	N*	SPT BLOW COUNT	Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Plastic Limit	Moisture Content	Liquid Limit										
													<table style="width:100%; border-collapse: collapse;"> <tr> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> <td style="width: 10%;"></td> </tr> <tr> <td style="text-align: center;">10</td> <td style="text-align: center;">20</td> <td style="text-align: center;">30</td> <td style="text-align: center;">40</td> <td style="text-align: center;">50</td> <td style="text-align: center;">60</td> </tr> </table>												10	20	30	40	50	60
10	20	30	40	50	60																									
0	0				CL				TOPSOIL; Lean CLAY with sand - stiff to hard, moist, light brown, minor organics in upper .6 inches			10 20 30 40 50 60 70 80 90																		
					CL				Lean CLAY with sand - stiff to hard, moist, light brown					6.2	70.9	32	15													
					CL				- pinhole structures throughout, sand is fine-grained	49	82																			
					CL				Sandy Lean CLAY - stiff, moist, brown	44	69		102.7	13.1																
					CL					44	69		101.1	12.0	59.1	33	15													
					SC				Clayey SAND - dense, moist, brown	37	55		101.8	4.5																
					CL				Sandy Lean CLAY - stiff, moist, brown	37	55		99.6	10.2	48.9	34	17													
					CL					33	46		14.1	86.6	28	15														
					CL					13	16		17.6																	
									Bottom of Boring @ 11.5 Feet																					

N - OBSERVED UNCORRECTED BLOW COUNT
N* - CORRECTED N1(60) EQUIVALENT SPT BLOW COUNT

2020 LOG OF BORING - PLATE (B) 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 8/5/21

<p>Copyright (c) 2021, GeoStrata</p>	SAMPLE TYPE ▣ - 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER ▤ - 3" O.D./2.48" I.D. SAMPLER ▥ - 3" O.D. THIN-WALLED SHELBY SAMPLER ▦ - GRAB SAMPLE ▧ - Modified California Sampler	NOTES: WATER LEVEL ▼ - MEASURED ▽ - ESTIMATED	Plate B - 4
--------------------------------------	--	---	----------------------------------

DATE	STARTED: 7/12/21	Armstrong Consultants West Desert Airpark Fairfield, Utah Project Number 1644-001	GeoStrata Rep: A. Peay	BORING NO: B-5 Sheet 1 of 1
	COMPLETED: 7/12/21		Rig Type: B-80 Mobile	
	BACKFILLED: 7/12/21		Boring Type: HSA	

DEPTH		WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION			Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits										
METERS	FEET				SAMPLES	STATION	OFFSET						ELEVATION	N	N*	SPT BLOW COUNT	Plastic Limit	Moisture Content	Liquid Limit				
0	0			CL	TOPSOIL; Lean CLAY with sand - stiff to hard, moist, light brown, minor organics in upper .6 inches Lean CLAY with sand - stiff to hard, moist, light brown								10	20	30	40	50	60	70	80	90		
				CL	Lean CLAY - stiff, moist, brown																		
				CL	Lean CLAY - stiff, moist, medium brown, Fe staining throughout			22	35														
				CL	Lean CLAY - stiff, moist, brown			28	42														
				CL	Lean CLAY - stiff, moist, brown			20	28	117.8	14.3												
				CL	Lean CLAY - stiff, moist, brown			9	11	19.5	92.7	27	13										
					Bottom of Boring @ 11.5 Feet																		

N - OBSERVED UNCORRECTED BLOW COUNT
N* - CORRECTED N1(60) EQUIVALENT SPT BLOW COUNT

2020 LOG OF BORING - PLATE (B) 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 8/5/21



Copyright (c) 2021, GeoStrata

- SAMPLE TYPE**
- ☒ - 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
 - ☒ - 3" O.D./2.48" I.D. SAMPLER
 - ☒ - 3" O.D. THIN-WALLED SHELBY SAMPLER
 - ☒ - GRAB SAMPLE
 - ☒ - Modified California Sampler

NOTES:

WATER LEVEL

▼ - MEASURED ▽ - ESTIMATED

Plate
B - 5

DATE	STARTED: 7/12/21	Armstrong Consultants West Desert Airpark Fairfield, Utah Project Number 1644-001	GeoStrata Rep: A. Peay Rig Type: B-80 Mobile Boring Type: HSA	BORING NO: B-6 Sheet 1 of 1
	COMPLETED: 7/12/21			
	BACKFILLED: 7/12/21			

DEPTH		WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	LOCATION			Dry Density (pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits		
METERS	FEET				SAMPLES	STATION	OFFSET						ELEVATION	Plastic Limit	Moisture Content
MATERIAL DESCRIPTION					N	N*	SPT BLOW COUNT				10 20 30 40 50 60 70 80 90				
UNDOCUMENTED FILL; Poorly Graded GRAVEL - grey, moist, gravels average less than 1 inch							10 20 30 40 50 60 70 80 90								
Silty SAND - dense, moist, brown, sand is fine-grained, moderately cemented					18	32									
SM					27	45									
Sandy Lean CLAY - stiff, moist, brown with white mottling and carbonate stringers throughout					24	38									
CL					38	38		108.9	5.2						
					19	27		112.0	13.4	55.9	25	10			
					19	24		19.4	88.7	29	13				
Bottom of Boring @ 11.5 Feet															

N - OBSERVED UNCORRECTED BLOW COUNT

N* - CORRECTED N1(60) EQUIVALENT SPT BLOW COUNT

2020 LOG OF BORING - PLATE (B) 2020 GINT UPDATE TEMPLATE.GPJ GEOSTRATA.GDT 8/5/21



Copyright (c) 2021, GeoStrata

SAMPLE TYPE

- 2" O.D./1.38" I.D. SPLIT SPOON SAMPLER
- 3" O.D./2.48" I.D. SAMPLER
- 3" O.D. THIN-WALLED SHELBY SAMPLER
- GRAB SAMPLE
- Modified California Sampler

NOTES:

WATER LEVEL

- MEASURED
- ESTIMATED

Plate
B - 6

Unified Soil Classification Per ASTM D 2488

Primary Divisions		Group Symbol	Group Name		
COARSE-GRAINED SOILS more than 50% retained on the No. 200 Sieve	GRAVEL More than half of the coarse fraction is larger than the #4 sieve	Clean Gravel	GW Well Graded GRAVEL GP Poorly Graded GRAVEL		
		Gravel with Dual Classifications	GW-GM Well Graded GRAVEL with silt GP-GM Poorly Graded GRAVEL with silt		
			GW-GC Well Graded GRAVEL with clay GP-GC Poorly Graded GRAVEL with clay		
			GM Silty GRAVEL GC Clayey GRAVEL GC-GM Silty, Clayey GRAVEL		
		Gravel with Fines	SW Well Graded SAND SP Poorly Graded SAND		
			Sand with Dual Classifications	SW-SM Well Graded SAND with silt SP-SM Poorly Graded SAND with silt	
				SW-SC Well Graded SAND with clay SP-SC Well Graded SAND with clay	
		SM Silty SAND SC Clayey SAND SC-SM Silty, Clayey SAND			
		FINE-GRAINED SOILS 50% or more passes No. 200 Sieve	SILT & CLAY less than 50%	Inorganic	CL Lean CLAY ML SILT CL-ML Silty CLAY
	Organic				OL Organic CLAY or Organic SILT
	Inorganic				CH Fat CLAY MH Elastic SILT
			Organic	OH Organic CLAY or Organic SILT	
	Highly Organic Soils		PT Peat		

Exploration Log Key

Sample Symbols	Ground Water Symbol	
Auger Cuttings		Measured Groundwater Elevation
		Estimated Groundwater Elevation
California Sampler	Relative Density	SPT N (blows/ft)
		Very Loose 0 to 4 Loose 5 to 10 Med. Dense 11 to 30
Rock Core	Dense 31 to 50	Consistency
	Very Dense >51	
Bag or Block Sample	SPT N (blows/ft)	Very Soft 0 to 1
		Soft 2 to 4
Modified California Sampler	Med. Stiff 5 to 8	Stiff 9 to 15
	Very Stiff 16 to 30	
No Recovery	Hard 31 to 60	Very Hard >61
	Very Hard >61	
Split Spoon	Modifiers	
	Description	Percentage
Shelby Tube	Trace	less than 5
	Some	5 to 12
Dames and More Sampler	With	more than 12



Copyright GeoStrata, 2021

Soil Symbols and Description Key

Armstr0ng Consultants
West Desert Airpark
Fairfield, Utah
Project No.: 1644-001

Plate B-7

Boring No.	Sample Depth (feet)	USCS Soil Classification	Natural Moisture Content (%)	Natural Dry Density (pcf)	Optimum Moisture Content (%)	Maximum Dry Density (pcf)	Gradation			Atterberg		Consolidation			Collapse (%)	Swell (%)	CBR (%)	Sulfate Content (ppm)	Resistivity (Ω-cm)	pH
							Gravel (%)	Sand (%)	Fines (%)	LL	PI	Cc	Cr	OCR						
B-1	0.5	CL	6.7		21	100.4	0.0	10.1	89.9	33	20					5.9	<5.46	2000	8.49	
B-1	2	CL	21.8																	
B-1	5	CL	12.1	114.3																
B-1	6.5	ML	14.3																	
B-1	10	CL	19.8	103.3																
B-2	3.5	CL	15.2	111.1			0.0	11.7	88.3	31	17									
B-2	6.5	CL	13.1	115.5			23.8		76.2	25	14									
B-2	10	CL	18.7																	
B-3	0.5	CL	4.9		16	112	16.6	18.5	64.9	27	17					2.8	17.9	1800	8.29	
B-3	3.5	CL	9.5	110.9			0.0	23.8	76.2	33	19				1.45					
B-3	3.51	CL	14.2	108.9								0.068	0.02	9.1						
B-3	5	CL-ML	13.1	105.7			0.0	15.0	85.0	24	5				0.11					
B-3	5.1	CL-ML	12.9	101.6								0.184	0.037	8.7						
B-3	10	CL-ML	17.9																	
B-4	0.5	CL	6.2		13.6	114.8	2.5	26.6	70.9	32	15					5.7	6.15			
B-4	3.5	CL	12	101.1			0.0	40.9	59.1	33	15				0.16					
B-4	3.51	CL	13.1	102.7								0.184	0.037	5.5						
B-4	5	SC	10.2	99.6			0.0	51.1	48.9	34	17				0.01			1200	8.25	
B-4	5.1	SC	4.5	101.8								0.152	0.015	3						
B-4	6.5	CL	14.1				0.0	13.4	86.6	28	15									
B-4	10	CL	17.6																	
B-5	2	CL	11.3				0.0	12.0	88.0	29	13									
B-5	6.5	CL	14.3	117.8																
B-5	10	CL	19.5						92.7	27	13									
B-6	5	CL	13.4	112			8.8	35.3	55.9	25	10				0.16					
B-6	5.1	CL	5.2	108.9								0.203	0.02	8.7						
B-6	10	CL	19.4						88.7	29	13									

APPENDIX 1
UDOT State Specifications

SECTION 01501

MOBILIZATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Mobilization and preparatory work necessary to become ready to perform the work.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES Not Used

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS Not Used

1.6 GENERAL

- A. Includes the moving of personnel, equipment, supplies and incidentals to each work site before beginning the work.
- B. Includes the establishment of offices, buildings, and other facilities necessary for the work.
- C. Includes labor and operations that must be performed before beginning other items under the Contract.
- D. Includes removal of personnel, equipment, and supplies from each work site at the completion of the work.
- E. Includes work that is not included with other items under the Contract such as cleanup and restoration of disturbed areas.

PART 2 PRODUCTS Not Used

PART 3 EXECUTION Not Used

END OF SECTION

SECTION 01558

TEMPORARY PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials and procedures for installation of temporary pavement markings.

1.2 RELATED SECTIONS

- A. Section 02765: Pavement Marking Paint
- B. Section 02842: Delineators
- C. Section 02890: Retroreflective Sheeting

1.3 REFERENCES

- A. ASTM D 4592: Preformed Retroreflective Pavement Marking Tape for Limited Service Life.
- B. Utah MUTCD

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. Manufacturer's product data sheet and recommended installation instructions.

1.6 ACCEPTANCE

- A. Pavement marking paint and glass beads accepted according to Section 02765.

1.7 PAYMENT PROCEDURES

- A. Temporary Pavement Markings
 1. This work is considered incidental to other items of work and no separate measurement or payment will be made when there is no pay item.
 2. Include all costs in Traffic Control.

PART 2 PRODUCTS

2.1 PAVEMENT MARKING PAINT AND GLASS BEADS

- A. Refer to Section 02765.
 - 1. Price reductions for wet mil thickness do not apply.

2.2 PAVEMENT MARKING TAPE

- A. Refer to ASTM D 4592, Type I (Removable).
- B. Minimum reflective values – Refer to ASTM D 4592.

2.3 TEMPORARY RAISED PAVEMENT MARKERS

- A. Provide plastic raised pavement markers that have reflective material with clear covers as needed for the particular application.
 - 1. Supply marker body manufactured of polyurethane plastic in color specified for required type.
 - a. Width 4 inches, height 2 inches, thickness 0.06 inches.
 - 2. Retroreflective sheeting to be at least 1 in² and according to Section 02890 for retroreflective sheeting requirements.
 - 3. Provide clear polyvinyl chloride covers attached to marker body with heavy duty staples.
 - 4. Supply marker with a method of attaching to pavement surface.
- B. Raised Pavement Marker Types
 - 1. Type Y1 – Yellow body with yellow reflective sheeting on both sides.
 - a. Optional – Type B1, black body with yellow reflective sheeting on both sides.
 - 2. Type W1 – White body with white reflective sheeting on both sides.
 - a. Optional – Type B2, black body with white reflective sheeting on both sides.

PART 3 EXECUTION

3.1 GENERAL

- A. Apply temporary pavement markings along the entire length of any roadway surfaces opened to traffic.
 - 1. Apply edge markings where delineation is removed or nonexistent.
 - a. Refer to Section 02842 and Utah MUTCD Section 3B.07.

2. Use the same segment and cycle length of permanent markings for all temporary broken-line pavement markings.
- B. Use channelizing devices or other delineation as directed by the Engineer to indicate road user paths in work zones when it is not possible to provide a clear path with temporary pavement markings.

3.2 PAVEMENT MARKING PAINT AND GLASS BEADS

- A. Re-apply pavement marking paint at two week intervals to maintain markings that provide a clear path during night and twilight periods and wet pavement conditions.

3.3 PAVEMENT MARKING TAPE

- A. Apply pavement marking tape according to manufacturer's directions.
- B. Maintain or re-apply pavement marking tape to maintain markings that provide a clear path during night and twilight periods and wet pavement conditions.
- C. Inspect and replace immediately any loose, missing, or damaged pavement markings.
- D. Remove the tape immediately before paving.

3.4 TEMPORARY RAISED PAVEMENT MARKERS

- A. Attach raised pavement marker according to manufacturer's directions.
- B. Space raised pavement markers as follows:
 1. Solid line On 10 ft centers.
 2. Broken line Three on 5 ft centers spaced on a 40 ft cycle length.
- C. Inspect and replace immediately any loose, missing, or damaged markers.
- D. Remove markers immediately before paving.

END OF SECTION

SECTION 02056

EMBANKMENT, BORROW, AND BACKFILL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Embankment, backfill, and bridge approach embankments.

1.2 RELATED SECTIONS

- A. Section 03575: Flowable Fill

1.3 REFERENCES

- A. AASHTO M 145: Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
- B. AASHTO T 11: Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing
- C. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
- D. AASHTO T 99: Moisture-Density Relations of Soils Using a 2.5 kg (5.5-lb) Rammer and a 305 mm (12 inch) Drop
- E. AASHTO T 180: Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 inch) Drop
- F. UDOT Materials Manual of Instruction
- G. UDOT Minimum Sampling and Testing Requirements

1.4 DEFINITIONS

- A. Well-graded material – Material having an even distribution of different particle sizes. This even distribution of particles of different sizes results in a dense mass upon compaction.

1.5 SUBMITTALS

- A. Provide the following before delivering material to the project:
 - 1. Supplier and source of materials.

2. Gradation analysis. Refer to AASHTO T 27 and T 11.
 3. Soil classification when applicable. Refer to AASHTO M 145.
 4. Maximum Dry Density and Optimum Moisture Determination
 - a. Use AASHTO T 180 Method D for A-1 soils and AASHTO T 99 Method D for all other soils.
- B. Engineering proposal for alternate materials or trench configurations for drainage pipe bedding and pipe backfill as outlined in this Section, Article 2.8 C.

1.6 ACCEPTANCE

- A. Acceptance sampling and testing is according to UDOT Minimum Sampling and Testing Requirements.
- B. Engineer reserves the right to select and test material from any location at the construction site.
 1. Establish the limits of nonconforming material sampled non-randomly and correct.
- C. Density Requirements – Acceptance is on a lot-by-lot basis.
- D. Remove nonconforming material and replace with acceptable material.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide materials free of contamination from chemical or petroleum products for embankment and backfill placements. Materials may include recycled Portland Cement Concrete.
 1. Do not include asphalt pavement materials.

2.2 MATERIALS

- A. Borrow
 1. Classifications A-1-a through A-4. Refer to AASHTO M 145.
- B. Granular Borrow
 1. Classification A-1-a. Refer to AASHTO M 145.
 2. Non-plastic, well-graded, 3 inch maximum.
- C. Granular Backfill Borrow
 1. Classification A-1-a. Refer to AASHTO M 145.
 2. Well-graded, 2 inch maximum.

- D. Free-Draining Granular Backfill
 - 1. Meet the following gradation:

Table 1

Free Draining Granular Backfill Gradation	
Sieve Size	Percent Passing
1½ inch	90-100
1 inch	20-55
¾ inch	0-15
⅜ inch	0-5

- E. Embankment For Bridge
 - 1. Classification A-1. Refer to AASHTO M 145.
 - 2. 3 inch maximum.

2.3 EMBANKMENT

- A. Borrow or suitable roadway excavation materials excluding organic, frozen, or contaminated soils.

2.4 DRAINAGE PIPE BEDDING AND BACKFILL

- A. Drainage Pipe Bedding and Drainage Pipe Backfill
 - 1. Granular Backfill Borrow, Classification A-1. Refer to AASHTO M145.
 - a. Well-graded material.
 - b. Maximum aggregate size is 1½ inches for plastic pipe, 2 inches for all other pipes.
 - 2. Flowable fill. Refer to Section 03575.
 - a. Use only for drainage pipe backfill.
- B. Other materials or trench configurations for drainage pipe bedding and backfill may be used only upon approval of the Contractor’s engineering proposal. Proposals using this option may include the use of native material or uniformly graded materials enclosed in an appropriate drainage geotextile. Any proposal must include all of the following:
 - 1. Stamped drawings and specifications signed and sealed by a Professional Engineer licensed in the state of Utah.
 - 2. Evaluation of site specific conditions and surrounding soils, including potential for migration of fines.
 - 3. A structural evaluation of the pipe support system for the proposed pipe that includes the pipe structural capacity and the depth of fill.
 - 4. Complete bedding or backfill source information including gradation, soil classification, and laboratory testing reports.

PART 3 EXECUTION

3.1 GENERAL

- A. Complete clearing, grubbing, stripping, and stockpiling topsoil before placing material.
- B. Requirements when placing material during freezing or snowy conditions:
 - 1. Do not place embankment on frozen or snow-covered areas.
 - a. Remove snow and frozen material from embankments, foundations, and borrow areas and furnish embankment material that can be compacted to the specified density.
 - 1. Measure removed material and provide quantities to the Engineer.
 - 2. The Department does not pay for removed material, frozen embankment replacement, or replacement material for a working platform or foundation meeting specification requirements if unfrozen.
 - 2. Do not deliver or use frozen material.
- C. Use appropriate compaction equipment adjacent to pipes, abutments, back walls, approach slabs, wing walls, retaining walls, and other structures.
 - 1. Expand the width of the trench to accommodate necessary compaction equipment.
 - 2. Compact by hand areas where compaction equipment cannot compact the soil.
- D. Over-excavate unsuitable material as directed by the Engineer.
- E. Do not use unsuitable material for embankment or backfill placement.
- F. Density Requirements
 - 1. Borrow, Granular Borrow, Granular Backfill Borrow, Embankment for Bridge, and Drainage Pipe Bedding
 - a. Meet minimum density test average of 96 percent of maximum laboratory density with no single determination lower than 92 percent.
 - 1) Use AASHTO T 180 Method D for A-1 soils and AASHTO T 99 Method D for all other soils.
 - 2) Maintain appropriate moisture for compaction during processing.

2. Drainage Pipe Backfill
 - a. Meet minimum density test average of 92 percent maximum laboratory density with no single determination less than 90 percent.
 - 1) Use AASHTO T 180 Method D for A-1 soils.
 - 2) Maintain appropriate moisture for compaction during processing.
 - b. Meet the pavement section material density requirement for pipes that encroach into the pavement section or use flowable fill.
3. Meet 100 percent of the developed field density for material with more than 30 percent retained on the $\frac{3}{4}$ inch sieve.
 - a. The Department develops a field density compaction curve according to UDOT Materials Manual of Instruction Section 989.
4. Free-Draining Granular Backfill
 - a. Meet 100 percent of the developed field density.
 - 1) The Department develops a field density compaction curve according to UDOT Materials Manual of Instruction Section 989.

3.2 EMBANKMENT AND BORROW PLACEMENT

- A. Place roadway excavation or borrow or both in embankment section with the highest quality material in the top portion of the embankment.
- B. Scarify and compact the top 8 inches of the surface of the working platform or foundation to at least 90 percent of maximum laboratory density when the embankment height is 6 ft or less.
- C. Break and scarify all underlying concrete pavement surfaces so that pieces do not exceed 1 ft² before placing embankment over an existing concrete pavement surface that is outside the limits of removal or excavation shown.
 1. Remove other pavement surfaces that are not Portland Cement Concrete.
- D. Maintain Drainage
 1. Grade and maintain the roadway to ensure adequate drainage.
 2. Maintain drainage pipes and drainage ditches or provide temporary facilities when interrupting items such as irrigation systems, sewers, and under-drains.

- E. Place an initial layer to act as a working platform over soft, wet ground when approved by the Engineer.
 - 1. Density requirements do not apply to the working platform.
 - 2. Meet density requirements for embankment placed above the working platform.
- F. Do not place initial layer of embankment until Engineer inspects and accepts the working platform or foundation.
- G. Spread embankment materials uniformly in layers not exceeding 1 ft (uncompacted depth) and compact to the density requirements.
 - 1. Reduce the lift thickness or modify operations if tests show unsatisfactory density.
- H. Finish subgrade surface within ± 0.2 ft of line and grade.
- I. Do not use rock or broken concrete materials over 1 ft in any dimension.
- J. Distribute larger particles so space exists for placing and compacting embankment material.
- K. Do not place rocks larger than 4 inches or broken concrete within 1 ft of the subgrade surface.
- L. Do not use compacting equipment that causes shear failure in the embankment.

3.3 GRANULAR BORROW, GRANULAR BACKFILL BORROW, AND BACKFILL PLACEMENT

- A. Finish surface within ± 0.1 ft of line and grade.
- B. Compact material in maximum 6 inch layers (uncompacted depth) to the density requirement.
- C. Backfill for structures such as bridges, foundations, box culverts, drains, and other structures.
 - 1. Place Embankment unless otherwise shown.

3.4 DRAINAGE PIPE FOUNDATION, BEDDING, AND BACKFILL PLACEMENT

- A. Place in 6 inch layers (uncompacted depth) and compact to the density requirement.

- B. Place uniform layers of drainage pipe backfill on both sides of the pipe and compact to the density requirement before placing successive lifts.
- C. Fully compact the haunch areas.

3.5 EMBANKMENT FOR BRIDGE PLACEMENT

- A. Construct bridge approach embankments from the existing ground up with the specified material to the limits defined in this Section and according to GW Series Standard Drawings.
 - 1. Approach Embankments
 - a. Place embankment beneath the bridge except riprap or other described materials used for MSE walls.
 - b. Place embankment from the bridge abutment centerline station to a point measured at least 150 ft away from the abutment along the approach roadway centerline and on the inside of abutments.
 - c. Use the described material throughout the length of the walls where retaining walls are located beyond this delineation.
 - 2. Intersecting Roadway Embankments
 - a. Place embankment from approximate edge of approach roadway at least 60 ft along intersecting roadway centerline.
 - 3. Adjoining Embankments
 - a. Place embankment at least 10 ft outward from edge of approach roadway pavement when adjoining embankment is not an approach embankment.
- B. Do not place initial layer of embankment until foundation or working platform is verified by the Engineer.
- C. Spread embankment materials uniformly in layers not exceeding 1 ft (uncompacted depth) and compact to the specified density requirements before placing the next layer. Reduce the lift thickness if tests show unsatisfactory density.
- D. Finish surface within ± 0.2 ft of line and grade.

3.6 FREE-DRAINING GRANULAR BACKFILL PLACEMENT

- A. Compact material in 1 ft maximum layers to the density requirement.
- B. Finish surface within ± 0.2 ft of line and grade.

END OF SECTION

SECTION 02231

SITE CLEARING AND GRUBBING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Clear, grub, remove, and dispose of trees, stumps, and debris within the designated limits of the roadways, channels, easements, and other designated areas.

1.2 RELATED SECTIONS

- A. Section 01355: Environmental Compliance
- B. Section 01571: Temporary Environmental Controls
- C. Section 02221: Remove Structure and Obstruction

1.3 REFERENCES **Not Used**

1.4 DEFINITIONS

- A. Clear – Remove and dispose of trees, stumps, logs, limbs, sticks, vegetation, debris, and other material on the natural ground surface.
- B. Grub – Remove and dispose of roots, buried logs, debris, organic matter, and other deleterious materials under the ground surface.

1.5 SUBMITTALS

- A. Copies of disposal permits, agreements, or both.

1.6 PAYMENT PROCEDURES

- A. Site Clearing and Grubbing when no bid item is included in the proposal:
 - 1. This work is considered incidental to other items of work and no separate measurement or payment will be made.
 - 2. Include all costs in other items of work.

PART 2 PRODUCTS Not Used

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify with the Engineer the vegetation or objects to be removed.
- B. Review work procedures with the Engineer.
- C. Schedule work carefully with consideration for property owners and general public.
- D. Refer to Section 01571 for temporary environmental measures.

3.2 VEGETATION REMOVAL

- A. Grub the areas 2 ft below natural ground, within the limits of clearing, of all stumps, roots, buried logs, and all other underground obstructions.
- B. Stumps, roots, and non-perishable solid objects may remain in cleared areas where the embankment is:
 - 1. 2 ft or more above the natural ground.
 - 2. At least 2 ft away outside the slope stake lines.
- C. Completely grub stumps and roots where a structure is to be constructed, piles are to be driven, or unsuitable material is to be removed.

3.3 BACKFILLING

- A. Backfill all stump holes, cuts, depressions, and other holes resulting from clearing and grubbing within areas to receive embankment.
 - 1. Compact backfilled areas to the density of the surrounding ground.
- B. Measure and pay separately for materials used for backfilling under Roadway Excavation or Borrow.
- C. Consider Roadway Excavation and Borrow as incidental to the work when these items are not included in the bid proposal.
 - 1. No separate measurement or payment made in this case.

3.4 DISPOSAL

- A. Dispose of material. Refer to Section 01355.
- B. Do not dispose of material within the designated roadbed.
- C. Outside of the Right-of-Way
 - 1. Acceptable when done according to prevailing laws including environmental laws, ordinances, regulations, and rules.
- D. Inside the Right-of-Way
 - 1. Bury material at locations specified by or acceptable to the Engineer.
 - 2. Use material to widen embankments and flatten embankment side slopes as approved by the Engineer.
 - 3. Cover disposed material with at least 2 ft of earth and grade to drain properly.
 - 4. Reduce wood to chips a maximum of ½ inch thick for mulching cut and fill slopes.
 - a. Chips may be buried or distributed uniformly on the ground surface and mixed with the underlying earth so the mixtures will not sustain burning.

3.5 TREE REMOVAL

- A. Refer to Section 02221.

3.6 PROTECTION

- A. Land monuments, property markers, or official datum points
 - 1. Protect until their removal is approved.
 - 2. Reference for re-establishment before removing.
- B. Protect trees from damage to roots and branches if they are designated to remain.
- C. Protect other vegetation and objects designated to remain.

END OF SECTION

SECTION 02721

UNTREATED BASE COURSE (UTBC)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Production, construction, and compaction of UTBC used for pavements, shoulders, and incidental construction.

1.2 RELATED SECTIONS

- A. Section 01572: Dust Control and Watering

1.3 REFERENCES

- A. AASHTO T 11: Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
- B. AASHTO T 19: Bulk Density ("Unit Weight") and Voids in Aggregate
- C. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
- D. AASHTO T 89: Determining the Liquid Limit of Soils
- E. AASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils
- F. AASHTO T 96: Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- G. AASHTO T 180: Moisture-Density Relations of Soils Using a 4.54 kg (10 lb) Rammer and 457 mm (18 in) Drop
- H. AASHTO T 193: The California Bearing Ratio
- I. AASHTO T 255: Total Evaporable Moisture Content of Aggregate by Drying
- J. AASHTO T 335: Determining the Percent of Fracture in Coarse Aggregate
- K. UDOT Minimum Sampling and Testing Requirements

1.4 DEFINITIONS **Not Used**

1.5 SUBMITTALS

- A. Written report for approval for each aggregate class and source, a minimum of five working days before placement. Include the following:
 - 1. Aggregate suitability. Refer to this Section, Part 2.
 - 2. Name of supplier and location of source.
 - 3. Maximum Dry Density and Optimum Moisture Content and associated test result data. Refer to AASHTO T 180, Method D.
 - 4. Job mix gradation including single values for each sieve size, No. 4 and finer. The target values must be within the gradation limits of Table 2.

- B. Job-mix gradation changes
 - 1. Refer to this Section, Article 3.1.

1.6 ACCEPTANCE

- A. Sampling and testing of material is according to UDOT Minimum Sampling and Testing Requirements.

- B. Type I Placement – Pavement Section
 - 1. Use Class A aggregate, Table 1.
 - 2. The Engineer takes random samples from the grade and tests for moisture, gradation, and laboratory density and performs in-place density determinations.
 - 3. Meet gradation limits and applicable tolerances of Table 2 for each gradation test. Evaluate each subplot separately and do not average with other sublots.
 - 4. Meet minimum density test average of 97 percent of maximum laboratory density with no test less than 94 percent.

- C. Type II Placement – Incidental includes placement for Curb, Curb and Gutter, Driveways, Pedestrian Access Ramps, Sidewalk, Waterways, Flatwork, and other items of work in the contract to which UTBC is included and not measured or paid for separately.
 - 1. Use Class A aggregate, Table 1.
 - 2. The Engineer takes random samples from the grade and tests for moisture, gradation, and laboratory density and performs in-place density determinations.
 - 3. Meet gradation limits and applicable tolerances of Table 2 for each gradation test. Each subplot will be evaluated separately and not averaged with other sublots.

4. Meet minimum density test average of 95 percent of maximum laboratory density with no test less than 92 percent.
- D. Type III Placement – Shoulder
 1. Use Class A or B aggregate, Table 1.
 2. Adjust moisture content before compaction.
 - E. Material not meeting the gradation requirements may be allowed to remain in-place at the discretion of the Engineer provided density requirements are met. Additional lots may not be placed until the deficiencies are addressed and corrected.
 - F. Correct material that does not meet the specified criteria by scarifying, placing additional material, re-mixing, reshaping, and re-compacting when determined by the Engineer.
 - G. Do not place additional material on any unaccepted layer.

PART 2 PRODUCTS

2.1 AGGREGATES

- A. Well-graded, clean, hard, tough, durable, and sound mineral aggregates consisting of crushed stone, crushed gravel, or crushed slag, free of organic matter and contamination from chemical or petroleum products, according to Table 1.

Table 1

Aggregate Properties			
	Aggregate Class		
	A	B	
Dry Rodded Unit Weight	Not less than 75 lb/ft ³		AASHTO T 19
Liquid Limit/Plastic Index	Non-plastic	PI ≤ 6	AASHTO T 89 AASHTO 90
Aggregate Wear	Not to exceed 50 percent		AASHTO T 96
Gradation	Table 2		AASHTO T 11 AASHTO T 27
CBR with a 10 lb surcharge measured at 0.20 inch penetration	70% Minimum	N/A	AASHTO T 193
Two Fractured Faces	50% Min	N/A	AASHTO T 335

- B. Establish the job mix (target) gradation for the $\frac{3}{4}$ inch sieve and finer within the gradation limits.
1. The Job Mix Gradation Tolerance is the allowable deviation from the job mix (target) gradation on the applicable sieves.
 2. All other percents passing will be within the gradation limits. Refer to AASHTO T 11 and AASHTO T 27.

Table 2

Gradation Limits		
Sieve Size	Job Mix Gradation Target Band	Job Mix Gradation Tolerance
1½ inch	100	
1 inch	90 - 100	±9.0
$\frac{3}{4}$ inch	70 - 85	±9.0
$\frac{1}{2}$ inch	65 - 80	±9.0
$\frac{3}{8}$ inch	55 - 75	±9.0
No. 4	40 - 65	±7.0
No. 16	25 - 40	±5.0
No. 200	7 - 11	±3.0

Percent passing based on total aggregate (dry weight) and fine and coarse aggregate with approximately the same bulk specific gravities.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Mixing – Provide moisture content of ± 2 percent of optimum at the time of placement. Refer to AASHTO T 180, Method D and AASHTO T 255.
- B. Procedures for Changing the Job-Mix Gradation
1. Submit changes in writing 24 hours before placement for approval by the Engineer.
- C. Placing – Place in layers of uniform thickness and compact each layer to a thickness not to exceed a 6 inch depth. Do not place on any frozen surface. Refer to Section 01572.
- D. Finishing – Uniform line and grade with surface deviations no more than $\frac{3}{8}$ inch in 10 ft in any direction.
1. Profile Tolerance – Correct any profile deviations greater than $\frac{3}{8}$ inch.
 - a. Rework minimum of 4 inch lift to achieve homogeneous density.
 - b. Determine limits of correction based on extent of deviation.

- c. Continue finishing until existing deviation is less than $\frac{3}{8}$ inch.
- E. Compaction – Maintain optimum moisture content \pm 2 percent.
 - 1. Use appropriate compaction equipment adjacent to abutments, backwalls, approach slabs, wing walls, retaining walls, and other structures.
 - 2. Use a minimum of two passes with a roller for Type III placement or as directed by the Engineer.

END OF SECTION

SECTION 02741

HOT MIX ASPHALT (HMA)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. A surface course of one or more layers of HMA comprised of aggregate, asphalt binder, hydrated lime, and other additives.
- B. Option to incorporate Reclaimed Asphalt Pavement (RAP) materials into HMA pavement.

1.2 RELATED SECTIONS

- A. Section 01456: Materials Dispute Resolution
- B. Section 02701: Pavement Smoothness
- C. Section 02742S: Project Specific Surfacing Requirements
- D. Section 02745: Asphalt Material
- E. Section 02746: Hydrated Lime
- F. Section 02748: Prime Coat/Tack Coat

1.3 REFERENCES

- A. AASHTO M 323: Superpave Volumetric Mix Design
- B. AASHTO R 35: Superpave Volumetric Design for Hot-Mix Asphalt (HMA)
- C. AASHTO T 19: Bulk Density ("Unit Weight") and Voids in Aggregate
- D. AASHTO T 89: Determining the Liquid Limit of Soils
- E. AASHTO T 90: Determining the Plastic Limit and Plasticity Index of Soils
- F. AASHTO T 96: Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

- G. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- H. AASHTO T 112: Clay Lumps and Friable Particles in Aggregate
- I. AASHTO T 176: Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- J. AASHTO T 195: Determining Degree of Particle Coating of Asphalt Mixtures
- K. AASHTO T 209: Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
- L. AASHTO T 255: Total Evaporable Moisture Content of Aggregate by Drying
- M. AASHTO T 304: Uncompacted Void Content of Fine Aggregate
- N. AASHTO T 335: Determining the Percentage of Fracture in Coarse Aggregate
- O. UDOT Materials Manual of Instruction
- P. UDOT Minimum Sampling and Testing Requirements
- Q. UDOT Quality Management Plans

1.4 DEFINITIONS

- A. Longitudinal Joint – Any new asphalt lift abutting an existing paving lift, exceeding 200 feet in length and excluding intersections. This includes joints created by echelon paving and new asphalt placed against a milled asphalt edge.
- B. Lot – The number of tons of HMA placed in a Production Day.
- C. Minor Target Change – A change from the verified mix design gradation target on a maximum of two sieves with the following limitations.
 - 1. The maximum change in the target gradation on the #8 or any coarser sieve is limited to 3 percent passing per sieve.
 - 2. The maximum change in the target gradation on the #16 or #50 sieves is 2 percent passing per sieve.

3. The maximum change in the target gradation on the #200 sieve is 0.5 percent passing.
 4. No target change may violate the mix design requirements in this section.
- D. Overband – an 8 inch protective asphalt coating sealing the longitudinal joint of final riding surface, as proposed by the contractor and approved by the Engineer
- E. Production Day – A 24 hour period in which HMA is being placed.
- F. RAP – Recycled Asphalt Pavement. Crushed or milled asphalt materials that have been removed from pavements.
- G. Thin Overlay Pavement – An overlay where the sum of the thickness of the HMA lifts is less than two inches.

1.5 SUBMITTALS

- A. Mix design for approval at least 10 working days before paving according to the UDOT Materials Manual of Instruction 960.
- B. Changes in job mix design
1. Submit a written request for any proposed change in the job-mix gradation.
 - a. Allow at least 12 hours for approval before incorporating a minor target change into production.
 - b. Allow at least six working days for verification and approval of any other change.
 2. Include documentation supporting correlation between suggested target changes and mix design volumetric requirements. Department acceptance test results or Contractor QC test data or both are acceptable.
 3. Submit samples according to the UDOT Materials Manual of Instruction 960 for a volumetric mix design verification for anything other than approved minor target changes. This includes changes in the aggregate source, asphalt binder source, or asphalt binder grade.
- C. Corrective action plan for approval according to this Section, Article 3.3, paragraph B and Article 3.4, paragraph A4b.
- D. Mat joint layout plan to the Engineer for review at least 10 calendar days before placement.

1.6 ACCEPTANCE

- A. Acceptance sampling and testing of material is according to UDOT Minimum Sampling and Testing Requirements.

- B. Gradation and asphalt binder content
 - 1. The Engineer evaluates a lot on the test results of four samples with the following exceptions:
 - a. Compute incentive/disincentive using the test results from three samples if only three samples can be taken for the production day.
 - b. Combine test results with the next day of production if at least three random samples cannot be taken. Take one sample for each 500 tons, or portion thereof, from the following day's production.
 - c. Add the lot to the previous day's production for the final day's production if three random samples cannot be taken.
 - d. The lot may be increased to include up to three production days when agreed upon in advance by both the Contractor and the Engineer when less than 900 tons are anticipated per production day.
 - 2. Evaluate the lot using the number of tests "n" in Table 3.
 - 3. The Engineer informs the Contractor of the time and place of sampling not more than 15 minutes before sampling.

- C. Density and Thickness
 - 1. Obtain cores from the mat and longitudinal joint within two contract days after the pavement is placed. Refer to UDOT Materials Manual of Instruction 984.
 - a. The Engineer marks coring location for in-place mat density and longitudinal joint density cores.
 - b. Move transversely to a point 1 ft from the edge of the pavement for in-place mat density if the random location for coring falls within 1 ft of the edge of the overall pavement section (outer part of shoulders).
 - c. Fill core holes with HMA or high AC content cold mix and compact.
 - d. The Department witnesses the coring operation, takes possession of the cores immediately, and begins testing the cores within 24 hours for density acceptance.

2. Density Requirements
 - a. The target for in-place density for the mat is 93.5 percent of Theoretical Maximum Specific Gravity except for thin overlay pavements.
 - b. The target for in-place density for the longitudinal joint is 91.5 percent of the Theoretical Maximum Specific Gravity (Gmm).
 - 1) Use the average of both Gmm's if two different sides or values exist for the cores taken.
 - c. The target for in-place density is 92.5 percent of Theoretical Maximum Specific Gravity for Thin overlay pavement projects.
 - 1) Do not take longitudinal joint cores for thin overlay pavement.
 - d. Use the average of the Theoretical Maximum Specific Gravity tests for each lot.
 - e. Acceptance for in-place mat and longitudinal joint density may be based on establishing a rolling pattern for items such as bridge decks, utility work, traffic signals, detours, lane leveling, driveways, other handwork, or small projects with plan quantities less than 500 tons.
3. Thickness Requirements are based only on mat cores. The thickness requirement may be waived when matching up to existing pavement, curb and gutter for Pavement in or next to intersections.
 - a. The Department accepts a lot for thickness when:
 - 1) The average thickness is not more than $\frac{1}{2}$ inch greater or $\frac{1}{4}$ inch less than the total design thickness specified.
 - 2) No individual subplot shows a deficient thickness of more than $\frac{3}{8}$ inch.
 - b. Excess Thickness – The Engineer may allow excess thickness to remain in place or may order its removal.
 - 1) The Department pays for 50 percent of the mix for material in excess of the $+\frac{1}{2}$ inch tolerance when excess thickness is allowed to remain in place.
 - c. Deficient Thickness – Place additional material where lots or sublots are deficient in thickness.
 - 1) The Department pays for material necessary to reach specified thickness.
 - 2) The Department pays for 50 percent of the mix for additional material over specified thickness necessary to achieve minimum lift thickness.
 - 3) Minimum compacted lift is 3 times the nominal maximum aggregate size.

- d. Thickness tolerances established above do not apply to leveling courses. Check final surfaces in stage construction.
 - e. Check thickness regularly with a depth probe and take corrective action as necessary for thin overlay pavement.
4. Longitudinal Joint
- a. The edge of a new asphalt mat may be removed for the purpose of meeting longitudinal joint density requirements.
 - 1) The material wasted is still included in the payment.
 - 2) Up to 3 inches for a confined edge is allowed.
 - 3) Up to 6 inches for an unconfined edge is allowed.
- D. The Department applies one Incentive/Disincentive for the lowest dollar value for Gradation/Asphalt Content, one Incentive/Disincentive for In-Place Mat Density, and one Incentive/Disincentive for Longitudinal Joint Density. The Engineer computes Incentives/Disincentives as follows for each lot. Refer to Section 02701 for smoothness requirements.
- 1. Compute incentive/disincentive for Gradation/Asphalt Binder and In-place Mat Density and Longitudinal Joint Density according to Table 1.
 - 2. Base the incentive/disincentive on Percent within Limit (PT) computation using Tables 2, 3, and 4.
 - 3. Use lowest single value combined for gradation (each of the sieves) and asphalt binder content for calculating the gradation/asphalt binder content incentive/disincentive.
 - 4. Use Tables 2, 3, and 4 to determine PT for in-place Mat Density and Longitudinal Joint Density.
 - 5. Meet PT of 88 or greater for in-place mat density or the Department does not pay incentives on gradation/asphalt binder content.
 - 6. The Department pays/assesses the longitudinal joint density incentive/disincentive per ton of HMA placed adjacent to, and on the hot side of the longitudinal joint for each lift:
 - a. The incentive/disincentive will be calculated from the average of the core densities taken from all abutting joints if the HMA mat has a longitudinal joint on more than one side.
 - 7. The following work is not eligible for incentive:
 - a. Items such as utility work, traffic signals, detours, lane leveling, and driveways.
 - b. Small projects with plan quantities of HMA less than 500 tons.

- E. The Department rejects lots:
 - 1. According to Table 1.
 - 2. The Engineer may accept a reject lot. Refer to Section 01456.
 - a. A price reduction of 35 percent of the pay item or \$20 per ton, whichever is greater, will be assessed.
 - b. The lot will not be eligible for any incentive.

- F. The Engineer may elect to accept material on visual inspection for work such as utility work, traffic signals, detours, lane leveling, and driveways, other hand work, or small projects with plan quantities less than 500 tons.
 - 1. Lots accepted on visual inspection are not eligible for Incentive/Disincentive.
 - 2. The Engineer reserves the option of conducting any acceptance tests necessary to determine that the material and workmanship meets the project requirements.
 - 3. Acceptance for mat density and longitudinal joint density may be based on establishing and maintaining a roller pattern to obtain maximum density without over-stressing the pavement.

Table 1

Incentive/Disincentive for Asphalt Binder Content, and Mat Density	
PT Based on Min. Four Samples	Incentive/Disincentive (Dollars/Ton)
>99	2.00
96-99	1.50
92-95	1.00
88-91	0.00
84-87	-0.26
80-83	-0.60
76-79	-0.93
72-75	-1.27
68-71	-1.60
64-67	-1.93
60-63	-2.27
<60	Reject
Incentive/Disincentive for Gradation	
PT Based on Min. Four Samples	Incentive/Disincentive (Dollars/Ton)
>99	2.00
96-99	1.50
92-95	1.00
88-91	0.00
84-87	-0.26
80-83	-0.60
76-79	-0.93
72-75	-1.27
68-71	-1.60
64-67	-1.93
60-63	-2.27
56-59	-5.00
52-55	-10.00
<52	Reject
Incentive/Disincentive for Longitudinal Joint Density	
PT Based on Min Four Samples	Incentive/Disincentive (Dollars/Ton)
>99	2.00
96-99	1.50
92-95	1.00
88-91	0.00
84-87	-0.26
80-83	-0.60
76-79	-0.93
72-75	-1.27
68-71	-1.60
64-67	-1.93
60-63	-2.27
56-59	-2.60
52-55	-5.00
<52	The \$5 penalty and Overband Longitudinal Joint if Final Surface Lift

Table 2

Upper and Lower Limit Determination	
Parameter	UL and LL
¾ inch sieve for 1 inch HMA ½ inch sieve for ¾ inch HMA ⅜ inch sieve for ½ inch HMA No. 4 sieve for ⅜ inch HMA	Target Value ± 6.0%
No. 8 sieve	Target Value ± 5.0%
No.50 sieve	Target Value ± 3.0%
No. 200 sieve	Target Value ± 2.0%
Asphalt Binder Content	Target Value ± 0.35%
Mat Density	Lower Limit Target Value - 2.0% Upper Limit Target Value + 4.0%
Longitudinal Joint Density	Lower Limit Target Value - 2.0% Upper Limit Target Value + 6.0%

Table 3

Enter table in the appropriate “number of tests” column and round down to the nearest value.

Quality Index Values (QU or QL) for Estimating Percent Within Limits										
PU or PL	n=3	n=4	n=5	n=6	n=7	n=8	n=10	n=12	n=15	n=20
100	1.16	1.50	1.75	1.91	2.06	2.15	2.29	2.35	2.47	2.56
99	1.16	1.47	1.68	1.79	1.89	1.95	2.04	2.09	2.14	2.19
98	1.15	1.44	1.61	1.70	1.77	1.80	1.86	1.89	1.93	1.97
97	1.15	1.41	1.55	1.62	1.67	1.69	1.74	1.77	1.80	1.82
96	1.15	1.38	1.49	1.55	1.59	1.61	1.64	1.66	1.69	1.70
95	1.14	1.35	1.45	1.49	1.52	1.54	1.56	1.57	1.59	1.61
94	1.13	1.32	1.40	1.44	1.46	1.47	1.49	1.50	1.51	1.53
93	1.12	1.29	1.36	1.38	1.40	1.41	1.43	1.43	1.44	1.46
92	1.11	1.26	1.31	1.33	1.35	1.36	1.37	1.37	1.38	1.39
91	1.10	1.23	1.27	1.29	1.30	1.31	1.32	1.32	1.32	1.33
90	1.09	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.27	1.27
89	1.08	1.17	1.20	1.21	1.21	1.21	1.21	1.21	1.22	1.22
88	1.07	1.14	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.13	1.13	1.13	1.13	1.13
86	1.05	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.05	1.05	1.04	1.04	1.04	1.04	1.04
84	1.02	1.02	1.02	1.01	1.01	1.01	1.00	1.00	1.00	1.00
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96
82	0.98	0.96	0.95	0.94	0.94	0.93	0.93	0.92	0.92	0.92
81	0.96	0.93	0.92	0.91	0.90	0.90	0.89	0.89	0.89	0.88
80	0.94	0.90	0.88	0.87	0.86	0.86	0.85	0.85	0.85	0.85
79	0.92	0.87	0.85	0.84	0.83	0.83	0.82	0.82	0.82	0.81
78	0.89	0.84	0.82	0.81	0.80	0.79	0.79	0.78	0.78	0.78
77	0.87	0.81	0.79	0.78	0.77	0.76	0.76	0.75	0.75	0.75
76	0.84	0.78	0.76	0.75	0.74	0.73	0.72	0.72	0.72	0.72
75	0.82	0.75	0.73	0.72	0.71	0.70	0.69	0.69	0.69	0.68
74	0.79	0.72	0.70	0.68	0.67	0.67	0.66	0.66	0.66	0.65
73	0.77	0.69	0.67	0.65	0.64	0.64	0.62	0.62	0.62	0.62
72	0.74	0.66	0.64	0.62	0.61	0.61	0.60	0.59	0.59	0.59
71	0.71	0.63	0.60	0.59	0.58	0.58	0.57	0.56	0.56	0.56
70	0.68	0.60	0.58	0.56	0.55	0.55	0.54	0.54	0.54	0.53
69	0.65	0.57	0.55	0.54	0.53	0.52	0.51	0.51	0.51	0.50
68	0.62	0.54	0.52	0.51	0.50	0.50	0.48	0.48	0.48	0.48
67	0.59	0.51	0.49	0.48	0.47	0.47	0.46	0.45	0.45	0.45
66	0.56	0.48	0.46	0.45	0.44	0.44	0.43	0.42	0.42	0.42
65	0.53	0.45	0.43	0.42	0.41	0.41	0.40	0.40	0.40	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34
62	0.43	0.36	0.34	0.33	0.33	0.33	0.32	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.30	0.29	0.29	0.29	0.28
60	0.36	0.30	0.28	0.27	0.26	0.26	0.25	0.25	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.23	0.23	0.23

Hot Mix Asphalt (HMA)
02741 – 10 of 20

2022 Standard Specifications
Latest Revision: [January 1, 2017](#)

PU/PL	n=3	n=4	n=5	n=6	n=7	n=8	n=10	n=12	n=15	n=20
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.15	0.15
55	0.18	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 4

Term	Explanation
Target Value (TV)	The target values for gradation and asphalt binder content are given in the Contractor's volumetric mix design. See this Section, article 1.6 for density target values.
Average (AVE)	The sum of the lot's test results for a measured characteristic divided by the number of test results—the arithmetic mean.
Sample Standard Deviations	The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE, divided by the number of test results minus one.
Upper Limit (UL)	The value above the TV of each measured characteristic that defines the upper limit of acceptable production. (Table 2)
Lower Limit (LL)	The value below the TV of each measured characteristic that defines the lower limit of acceptable production (Table 2)
Upper Quality Index (QU)	$QU = (UL - AVE)/s$
Lower Quality Index (QL)	$QL = (AVE - LL)/s$
Percentage of Lot Within UL (PU)	Determined by entering Table 3 with QU.
Percentage of Lot Within LL (PL)	Determined by entering Table 3 with QL.
Total Percentage of Lot Within UL and LL (PT)	$PT = (PU + PL) - 100$
Incentive/Disincentive	Determined by entering Table 1 with PT or PL.

All values for AVE, s, QU, and QL will be calculated to at least four decimal places and carried through all further calculations. Rounding to lower accuracy is not allowed.

1.7 DISPUTE RESOLUTION

- A. Refer to Section 01456 when disputing the validity of the Department's acceptance tests.

PART 2 PRODUCTS

2.1 ASPHALT BINDER

- A. Project Specific Surfacing Requirements – Refer to Section 02742S.
- B. Asphalt Material – Refer to Section 02745.

2.2 AGGREGATE

- A. Crusher processed virgin aggregate material consisting of crushed stone, gravel, or slag.
- B. Refer to Table 5 to determine the suitability of the aggregate.
 - 1. Coarse aggregates
 - a. Retained on No. 4 sieve
 - 2. Fine aggregates
 - a. Clean, hard grained, and angular
 - b. Passing the No. 4 sieve

Table 5

Aggregate Properties – HMA			
Test Method	Test No.	75 Design Gyration and Greater	Less Than 75 Design Gyration
One Fractured Face	AASHTO T 335	95% minimum	85% min (1 inch and $\frac{3}{4}$ inch) 90% min ($\frac{1}{2}$ inch and $\frac{3}{8}$ inch)
Two Fractured Face	AASHTO T 335	90% minimum	80% min (1 inch and $\frac{3}{4}$ inch) 90% min ($\frac{1}{2}$ inch and $\frac{3}{8}$ inch)
Fine Aggregate Angularity	AASHTO T 304	45 minimum	45 minimum
Flakiness Index	UDOT MOI 933 (Based on $\frac{3}{8}$ inch sieve and above)	17% maximum	17% maximum
L.A. Wear	AASHTO T 96	35% maximum	40% maximum
Sand Equivalent	AASHTO T 176 (Pre-wet method)	60 minimum	45 minimum
Plasticity Index	AASHTO T 89 and T 90	0	0
Unit Weight	AASHTO T 19	minimum 75 lb/cu ft	minimum 75 lb/cu ft
Soundness (sodium sulfate)	AASHTO T 104	16% maximum loss with five cycles	16% maximum loss with five cycles
Clay Lumps and Friable Particles	AASHTO T 112	2% maximum	2% maximum
Natural Fines	N/A	0%	10% maximum

C. Meet gradation requirements in Table 6.

Table 6

Aggregate Gradations (Percent Passing by Dry Weight of Aggregate)					
Sieve Size	1 inch	$\frac{3}{4}$ inch	$\frac{1}{2}$ inch	$\frac{3}{8}$ inch	
Control Sieves	1½ inch	100.0			
	1 inch	90.0 - 100.0	100.0		
	$\frac{3}{4}$ inch	<90	90.0 - 100.0	100.0	
	$\frac{1}{2}$ inch		<90	90.0 – 100.0	
	$\frac{3}{8}$ inch			<90	
	No. 4			< 90	
	No. 8	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0
	No. 200	1.0 - 7.0	2.0 - 8.0	2.0 – 10.0	2.0 – 10.0

2.3 HYDRATED LIME

- A. Meet the requirements of Section 02746.

2.4 RECLAIMED ASPHALT PAVEMENT (RAP) (OPTIONAL)

- A. Do not adjust the asphalt binder grade if the lower end is already a PG XX-34.
- B. Do not adjust the asphalt binder grade when RAP content is not more than 15 percent by total weight of the hot mix and RAP asphalt binder content is not more than 15 percent of the total asphalt binder content by weight.
- C. Adjust asphalt binder grade according to AASHTO M 323 when RAP asphalt binder content is between 15 to 25 percent of the asphalt binder weight.
 - 1. Select one grade softer than the grade specified. Do not adjust the asphalt binder grade if the lower end is already a PG XX-34.
 - 2. Provide test reports indicating that the PG grade and quantity of the recovered asphalt binder is consistent throughout the stockpile.
 - 3. Limit RAP to 25 percent of the total weight of the hot mix and RAP binder to 25 percent of the total binder.
- D. RAP aggregate is required to meet Table 5 with exception of Sand Equivalent. Refer to AASHTO T 176.

2.5 VOLUMETRIC MIX DESIGN

- A. Perform Superpave Volumetric Mix Design according to UDOT Materials Manual of Instruction 960 and the following:
 - 1. Incorporate hydrated lime into all designs. Refer to Section 02746.
 - 2. Comply with Table 7 and Table 8.
- B. Obtain Department approval for the mix design. Refer to the UDOT Materials Manual of Instruction 960.
 - 1. Do not begin paving until approved.
- C. Mix Design Changes
 - 1. The Department may allow up to two minor target changes per project without penalty to contractor. The Department charges \$1,000 for each additional minor target change.

2. The Department allows up to two volumetric mix design verifications, (including field verifications), per project. The Department charges \$3,000 for each additional laboratory or field verification required. This includes all laboratory or field volumetric mix design verifications required due to contractor initiated target changes.
3. The Engineer will review each change and provide written notice of approval or rejection of each mix design change.

Table 7

Volumetric Design Gyration				
20 Years Design ESALS (Million)	Compaction Parameters			Voids Filled with Asphalt (VFA) (%)
	N_{initial} /% of G_{mm}[*]	N_{design} /% of G_{mm}[*]	N_{max} /% of G_{mm}[*]	
0.3	6 / ≤ 91.5	50 / 96.5	75 / ≤ 98	70 – 80 **
0.3 to < 3	7 / ≤ 90.5	75 / 96.5	115 / ≤ 98	70 – 80
3 to < 30	8 / ≤ 89	100 / 96.5	160 / ≤ 98	70 – 80
≥ 30	9 / ≤ 89	125 / 96.5	205 / ≤ 98	70 – 80

* G_{mm}: Theoretical maximum specific gravity of mix. Refer to AASHTO T 209.

** Use 67 percent for the lower limit VFA for 1-inch nominal maximum size mixture.

Table 8

Volumetric Design Requirements	
HMA design mixing and compaction temperatures	Provided by the Engineer
Dust Proportion Range	0.6 - 1.40
Voids in Mineral Aggregate (VMA) at N _{design} AASHTO R 35.9.2 using G _{sb} Oven Dry. Equation based on percent of total mix.	12.0% - 13.0% for 1 inch 13.0% - 14.0% for ¾ inch 14.0% - 15.0% for ½ inch 15.0% - 16.0% for ⅜ inch
Hamburg Wheel Tracker UDOT MOI 990	75 Design Gyration and Greater Maximum 10 mm impression at 20,000 passes. Less than 75 Design Gyration Maximum 10 mm impression at 10,000 passes

2.6 PRIME COAT/TACK COAT

- A. Refer to Section 02748.

PART 3 EXECUTION

3.1 HMA

- A. Dry aggregate to an average moisture content of not more than 0.2 percent by weight.
 - 1. May be verified by AASHTO T 255.
 - 2. Adjust burners to avoid damage or soot contamination of the aggregate.
- B. Treat aggregate with hydrated lime. Refer to Section 02746.
 - 1. Method A or B
 - 2. The Department applies a deduction for mix produced by a non-certified supplier to cover the costs of inspection.
 - a. The deduction is applied according to the UDOT Quality Management Plan 514 Hot-Mix Asphalt.
- C. Coat with asphalt binder 100 percent of the particles passing and 98 percent of the particles retained on the No. 4 sieve.
 - 1. May be verified by AASHTO T 195.
 - 2. Discontinue operation and make necessary corrections if material is not properly coated.
- D. Maintain temperature of the HMA between the limits identified on the Volumetric Mix Design Verification Letter for mixing and compacting.
 - 1. The Department rejects materials heated over the identified limits.
 - 2. Remove all material rejected by the Department for overheating.
- E. Minimum compacted lift thickness is 3 times the nominal maximum aggregate size.

3.2 HMA PLANT

- A. Provide
 - 1. Positive means to determine the moisture content of aggregate.
 - 2. Positive means to sample all material components.
 - 3. Sensors to measure the temperature of the HMA at discharge.
 - 4. The ability to maintain mix discharge temperature according to the mix design.

- B. Asphalt Binder Storage Tanks
 - 1. Provide a positive means for separating and identifying asphalt grades when multiple products are used in mix production.
 - 2. Provide a positive means of sampling the asphalt binder.
 - a. The Engineer determines a common sampling point where multiple products are used in mix production.

3.3 CEASE PRODUCTION

- A. Cease production when any two out of three consecutive lots meet one of the following criteria:
 - 1. A net disincentive
 - 2. Air voids at N_{des} averaged for each lot are less than 2.5 or greater than 4.75 percent
 - 3. VMA at N_{des} averaged for each lot are not within Target Value \pm 1.25 percent
- B. Submit a corrective action plan for approval before production continues indicating the changes in production procedures that will be implemented to correct the deficiencies.
 - 1. Address the specific issues contributing to the cease production.
 - 2. Obtain approval of the revised plan before production continues.
- C. The Engineer may require a new mix design.
- D. The Engineer may require Hamburg Wheel-Track testing for up to 5 lots after the cease production order.
 - 1. Sample randomly from behind the paver for up to 5 lots after the cease production order.
 - 2. Failure to meet the requirements of Table 8 results in rejection of the lot.

3.4 LABORATORY CORRELATION

- A. Perform split-sample, paired t -testing with the Department based on project quality control testing using Department LQP qualified lab.
 - 1. Perform split-sample, paired t analysis on all mix acceptance tests and tests related to volumetric properties.
 - 2. Perform paired t analysis as defined in the UDOT Materials Manual of Instruction, Appendix C.
 - 3. Continue paired t -testing until at least two consecutive production days meet $\alpha = 0.05$ for a two tailed distribution.

4. Resolve discrepancies in lab results within the first five production days.
 - a. Cease production if the requirements for two consecutive days of the first five days cannot be met.
 - b. Submit a corrective action plan to the Engineer before production continues indicating the changes in procedures that will be implemented to correct the deficiencies.
 - 1) Both Contractor and Department labs must make paired *t* test results available within 24 hours of sampling.

3.5 SURFACE PREPARATION

- A. Locate, reference, and protect all utility covers, monuments, curb and gutter, and other components affected by the paving operations.
- B. Remove all moisture, dirt, sand, leaves, and other objectionable material from the prepared surface before placing the tack coat and mix.
- C. Complete spot leveling before placing pavement courses.
 1. Place, spread, and compact leveling mix on portions of the existing surface.
 2. Fill and compact any localized potholes more than 1 inch deep.
 3. Allow compacted mix to cool sufficiently to below 150 degrees F to provide a stable structural platform before placing additional lifts of HMA.
- D. Apply tack coat to all paved surfaces before applying a leveling course or pavement lift as required in Section 02748.
- E. Allow sufficient cure time for prime coat/tack coat before placing HMA.

3.6 SURFACE PLACEMENT

- A. Provide a compactable sloped edge adjacent to the next lane to be paved when full-width or Echelon paving is impractical and more than one pass is required.
 1. Coat edge with tack coat according to Section 02748 at a residual rate of 0.05 gal/yd².
 2. Echelon paving is the preferred method for constructing a longitudinal joint.
 3. Refer to Section 01554 and DD and TC Series Standard Drawings for pavement edge slope required to safely maintain traffic.

- B. Adjust the production of the mixing plant and material delivery until a steady paver speed is maintained.
- C. Construct straight joints, offset longitudinal joints 6 to 12 inches in succeeding courses.
 - 1. Construct all joints within 1 ft of the centerline, the lane line or the center of the lane.
 - 2. Tack the longitudinal edge before placing the adjacent pass.
- D. Offset transverse construction joints at least 6 ft longitudinally.
- E. Do not allow construction vehicles, general traffic, or rollers to pass over the uncompacted end or edge of freshly placed mix until the mat temperature drops to a point where damage or differential compaction will not occur.
- F. Taper the end of a course subjected to traffic at approximately 50:1 (horizontal to vertical).
 - 1. Remove the portion of the pass that contains the tapered end before placing fresh mix.
 - 2. Tack the contact surfaces before fresh mix is placed against the compacted mix.
- G. Use a motor grader, spreader box, or other approved spreading methods for projects under 180 yd², irregular areas, or for miscellaneous construction such as detours, sidewalks, and leveling courses.

3.7 COMPACTION

- A. Use a small compactor or vibratory roller at structures in addition to normal rolling.
- B. Operate in a transverse direction next to the back wall and approach slab.

3.8 LIMITATIONS

- A. Do not place on frozen base or during adverse climatic conditions such as precipitation or when roadway surface is icy or wet.
- B. Use a release agent that does not dissolve asphalt and is satisfactory to the Engineer for all equipment and hand tools used to mix, haul, and place the HMA.

- C. Place HMA from April 15 through October 15, and when the air temperature in the shade and the roadway surface temperature is above 50 degrees F.
1. The Department determines if it is feasible to place HMA outside these dates and temperature limits.
 2. Obtain authorization from the Engineer before paving outside these requirements.

END OF SECTION

SECTION 02745

ASPHALT MATERIAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Asphalt materials binders, emulsions and crack sealant for pavements.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. AASHTO M 81: Cutback Asphalt (Rapid-Curing Type)
- B. AASHTO M 82: Cutback Asphalt (Medium-Curing Type)
- C. AASHTO M 140: Emulsified Asphalt
- D. AASHTO M 208: Cationic Emulsified Asphalt
- E. AASHTO M 226: Viscosity Graded Asphalt Cement
- F. AASHTO M 282: Joint Sealants, Hot-Poured, Elastomeric-Type, for Portland Cement Concrete Pavements
- G. AASHTO M 320: Performance Graded Asphalt Binder
- H. AASHTO R 28: Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
- I. AASHTO T 44: Solubility of Bituminous Materials
- J. AASHTO T 48: Flash and Fire Points by Cleveland Open Cup
- K. AASHTO T 49: Penetration of Bituminous Materials
- L. AASHTO T 50: Float Test for Bituminous Materials
- M. AASHTO T 51: Ductility of Bituminous Materials
- N. AASHTO T 59: Emulsified Asphalt

- O. AASHTO T 201: Kinematic Viscosity of Asphalts (Bitumens)
- P. AASHTO T 228: Specific Gravity of Semi-Solid Asphalt Materials
- Q. AASHTO T 240: Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
- R. AASHTO T 300: Force Ductility of Asphalt Materials
- S. AASHTO T 301: Elastic Recovery Test of Asphalt Materials by Means of a Ductilometer
- T. AASHTO T 313: Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
- U. AASHTO T 314: Determining the Fracture Properties of Asphalt Binder in Direct Tension
- V. AASHTO T 315: Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
- W. AASHTO T 316: Viscosity Determination of Asphalt Binder Using Rotational Viscometer
- X. ASTM D 2006: Method for Characteristic Groups in Rubber Extender and Processing Oils by the Precipitation Method.
- Y. ASTM D 2007: Characteristic Groups in Rubber Extender and Processing Oils and Other Petroleum Derived Oils by the Clay Gel Absorption Chromatographic Method
- Z. ASTM D 2026: Cutback Asphalt (Slow Curing Type)
- AA. ASTM D 4402: Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
- BB. ASTM D 5329: Sealants and Fillers, Hot-Applied, For Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements
- CC. ASTM D 5801: Toughness and Tenacity of Bituminous Materials
- DD. California Test Methods
- EE. UDOT Materials Manual of Instruction
- FF. UDOT Minimum Sampling and Testing Requirements (MS&TR)

GG. UDOT Quality Management Plan

1.4 DEFINITIONS

- A. Binder lot – Refer to MS&TR 02745.
- B. Compliance Limit – The limit for acceptance without price reductions, accounting for testing variability, for the listed properties.
- C. Composite Price Reduction – The sum of price reductions for all individual properties associated with a single asphalt binder sample.
- D. Rejection Limit – The limit for acceptance with price reductions. Material not meeting these limits will be rejected and removed and replaced.

1.5 SUBMITTALS

- A. A vendor prepared bill of lading for information showing the following for each material shipment:
 - 1. Type and grade of material
 - 2. Type and amount of additives used, if applicable
 - 3. Destination
 - 4. Consignee's name
 - 5. Date of Shipment
 - 6. Railroad car or truck identification
 - 7. Project number
 - 8. Loading temperature
 - 9. Net weight in tons or net gallons corrected to 60 degrees F, when requested
 - 10. Specific gravity
 - 11. Bill of lading number
 - 12. Manufacturer of asphalt material

1.6 ACCEPTANCE

- A. The Department accepts, rejects, or applies price reductions to all mix lots for performance-graded asphalt binder (PGAB) lots according to the compliance and rejection limits of Table 1, the Minimum Sampling and Testing Requirements, UDOT Quality Management Plan 509, and the associated mix specification.
 - 1. Rejected mix will be covered according to the associated mix specification including removal or if left in place the associated disincentive dollar amount for the rejected mix.

2. Material not meeting the compliance limit, but within the rejection limit, the price reduction applied to the mix pay item price is calculated as follows:

$$\text{Price Reduction (\%)} = 25 * \frac{(\text{Compliance Limit} - \text{Test Result})}{(\text{Compliance Limit} - \text{Rejection Limit})}$$

3. The composite price reduction will be calculated by summing the price reduction for each parameter if more than one parameter lies outside specification limits.
 - a. The mix material will be rejected if the composite price reduction exceeds 25%.
- B. The maximum composite price reduction from the tested samples is applied to the mix in the binder lot if multiple samples from the binder lot are tested.
- C. Adjacent samples in the preceding, current, or subsequent lots may be tested to assess the extent and limit the amount of mix to be rejected if a binder lot is rejected.

Table 1

Specification, Compliance, and Rejection Limits for Performance-Graded Asphalt Binders (Applied to the Mix)			
Property	Specification Limit	Compliance Limit	Rejection Limit
G*/sin δ of the original PGAB at high grade temp, (kPa) Rule of 86 or lower	1.00 Min	0.84 Min	0.70 Min
G* of the original PGAB at high grade temp, (kPa)	1.30 Min	1.25 Min	1.11 Min
δ (phase angle) of the original PGAB at high grade temperature, (degrees C). Rule of 92 Binders Rule of 98 Binders	74.0 Max 71.0 Max	75.0 Max 72.0 Max	77.0 Max 74.0 Max
G*/sin δ of the RTFO Residue, (kPa)	2.20 Min	1.87 Min	1.53 Min
G*/sin δ of the PAV Residue, (kPa)	5000 Max	5250 Max	5700 Max
Stiffness of the PAV Residue at the specified low grade temperature +10°C, (MPa)	300 Max	311 Max	355 Max
Slope (m-value) of the Creep Curve at the specified low grade temperature +10°C	0.300 Min	0.295 Min	0.266 Min
Failure Strain of PAV Residue in Direct Tension at the specified low grade temperature +10°C, (%) Rule of 92, 98, or 104 Binders	1.500 Min	1.400 Min	1.200 Min
Failure Stress of PAV Residue in Direct Tension at the specified low grade temperature +10°C, (MPa) Rule of 92, 98, or 104 Binders	4.00 Min	4.00 Min	3.50 Min
Elastic Recovery of RTFO Residue, (%) Rule of 92 Binders Rule of 98 Binders Rule of 104 Binders	65 Min 70 Min 75 Min	60 Min 65 Min 70 Min	50 Min 55 Min 60 Min

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Each shipment of asphalt material must:
1. Be uniform in appearance and consistency.
 2. Show no foaming when heated to the specified loading temperature.

- B. Do not supply shipments contaminated with other asphalt grades or materials.

1.8 GRADE OF MATERIAL

- A. The Engineer determines the grade of material to be used based on the supply source designated by the Contractor when the bid proposal lists more than one grade of asphalt material.

PART 2 PRODUCTS

2.1 PERFORMANCE GRADED ASPHALT BINDER (PGAB)

- A. Use a qualified supplier according to the UDOT Quality Management Plan 509, Asphalt Binder.
- B. Refer to AASHTO M 320 for all PGABs having algebraic differences less than 92 degrees between the high and low design temperatures.
- C. Refer to AASHTO M 320 modified by Tables 2, 3, 4, 5, 6, 7, 8 and 9 for all PGABs having algebraic differences equal to or greater than 92 degrees between the high and low design temperatures.

Table 2

PG58-34		
<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 58° C, G*, kPa	1.30 Min.
	@ 58° C, phase angle, degrees	74.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T 240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 58° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	65 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100° C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 16° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -24° C, S, MPa	300 Max.
	@ -24° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -24° C, Failure Strain, %	1.5 Min.
	@ -24° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

Table 3

PG64-28		
<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 64° C, G*, kPa	1.30 Min.
	@ 64° C, phase angle, degrees	74.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T 240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 64° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	65 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 22° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -18° C, S, MPa	300 Max.
	@ -18° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -18° C, Failure Strain, %	1.5 Min.
	@ -18° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

Table 4

PG64-34		
<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 64° C, G*, kPa	1.30 Min.
	@ 64° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T-240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 64° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	70 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 19° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -24° C, S, MPa	300 Max.
	@ -24° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -24° C, Failure Strain, %	1.5 Min.
	@ -24° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

Table 5

PG70-22		
<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*, kPa	1.30 Min.
	@ 70° C, phase angle, degrees	74.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T 240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@70°C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	65 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 28° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -12° C, S, MPa	300 Max.
	@ -12° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -12° C, Failure Strain, %	1.5 Min.
	@ -12° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

Table 6

PG70-28		
<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*, kPa	1.30 Min.
	@ 70° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T 240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	70 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 25° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -18° C, S, MPa	300 Max.
	@ -18° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -18° C, Failure Strain, %	1.5 Min.
	@ -18° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

Table 7

PG70-34		
<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*, kPa	1.30 Min.
	@ 70° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135 °C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T 240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 70° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	75 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 22° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -24° C, S, MPa	300 Max.
	@ -24° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -24° C, Failure Strain, %	1.5 Min.
	@ -24° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

Table 8

PG76-22		
<u>Original Binder</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*, kPa	1.30 Min.
	@ 76° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
<u>RTFO Residue, AASHTO T 240</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	70 Min.
<u>PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28</u>		
Dynamic Shear Rheometer, AASHTO T 315	@ 31°C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -12° C, S, MPa	300 Max.
	@ -12° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -12° C, Failure Strain, %	1.5 Min.
	@ -12° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

Table 9

PG76-28		
Original Binder		
Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*, kPa	1.30 Min.
	@ 76° C, phase angle, degrees	71.0 Max.
Rotational Viscometer, AASHTO T 316	@ 135° C, Pa.s	3 Max.
Flash Point, AASHTO T 48	°C	260 Min.
RTFO Residue, AASHTO T 240		
Dynamic Shear Rheometer, AASHTO T 315	@ 76° C, G*/sinδ, kPa	2.20 Min.
Elastic Recovery, AASHTO T 301 mod (a)	%	75 Min.
PAV Residue, 20 hours, 2.10 MPa, 100 °C, AASHTO R 28		
Dynamic Shear Rheometer, AASHTO T 315	@ 28° C, kPa	5,000 Max.
Bending Beam Rheometer, AASHTO T 313	@ -18° C, S, MPa	300 Max.
	@ -18° C, m-value	0.300 Min.
Direct Tension Test, AASHTO T 314	@ -18° C, Failure Strain, %	1.5 Min.
	@ -18° C, Failure Stress (b), MPa	4.0 Min.
(a) Modify paragraph 4.5 as follows: Stop the ductilometer after 20 cm has been reached and within 2 seconds. Sever the specimen at its center with a pair of scissors.		
(b) No allowances will be given for passing at a colder grade.		

2.2 ASPHALTIC CEMENT, LIQUID ASPHALTS, AND REJUVENATING AGENTS

- A. Refer to AASHTO M 226, Table 2 with the following modifications:
- Delete and replace ductility at 77 degrees F (25 degrees C) with ductility at 39.2 degrees F (4 degrees C) using the values specified below.

AC - 2.5
50+

AC - 5
25+

AC - 10
15+

AC - 20
5+

- B. Cationic and Anionic Emulsified Asphalt
- All standard Slow Setting (SS, CSS), Quick Setting (QS, CQS) Medium Setting (MS, CMS), and Rapid Setting (RS, CRS) grades including all High-Float designations (HF).
 - Supply under the Approved Supplier Certification System (ASC).
 - Refer to and meet AASHTO M 208 and M 140.
- C. Meet the requirements of one of these tables:
- Table 10 – Cationic Rapid Setting Emulsified Polymerized Asphalt (CRS-2P)
 - Table 11 – Latex Modified Cationic Rapid Setting Emulsified Asphalt (LMCRS-2)
 - Table 12 – Cationic Medium Setting Emulsified Asphalt (CMS-2S)
 - Table 13 – High Float Medium Setting Emulsified Asphalt (HFMS-2)

5. Table 14– High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2P)
 6. Table 15 – High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2SP)
 7. Table 16 – High Float Rapid Setting Emulsified Polymerized Asphalt (HFRS-2P).
 8. Table 17 –Cationic Rapid Setting Emulsified Asphalt (CRS-2A, B)
- D. Curing Cut-Back Asphalt
1. Refer to specification ASTM D 2026 for slow curing (SC).
 2. Refer to specification AASHTO M 82 for medium curing (MC).
 3. Refer to specification AASHTO M 81 for rapid curing (RC).
- E. Meet the requirements for Emulsified Asphalt Pavement Rejuvenating Agent:
1. Table 18 – Type A
 2. Table 19 – Type B
 3. Table 20 – Type B Modified
 4. Table 21– Type C
 5. Table 22 – Type D

Table 10

Cationic Rapid Setting Emulsified Polymerized Asphalt (CRS-2P)			
Tests	Test Method	Min.	Max.
Emulsion			
Viscosity , SF, 140° F (60° C), s (Project-site Acceptance/Rejection Limits)	AASHTO T 59	100	400
Settlement (a) 5 days, percent	AASHTO T 59		5
Storage Stability Test (b) 1 d, 24 h, percent	AASHTO T 59		
Demulsibility (c) 35 ml, 0.8% sodium dioctyl Sulfosuccinate, percent	AASHTO T 59	40	
Particle Charge Test	AASHTO T 59	Positive	
Sieve Test, percent	AASHTO T 59		0.10
Distillation			
Oil distillate, by volume of emulsion, percent			0
Residue (d), percent		68	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	80	150
Ductility, 39.2° F (4° C), 5 cm/min, cm	AASHTO T 51	35	
Toughness, lb-in	ASTM D 5801	75	
Tenacity, lb-in	ASTM D 5801	50	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
<p>(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than a five-day time unless the purchaser requires the test.</p> <p>(b) The 24-hour (1-day) storage stability test may be used instead of the five day settlement test.</p> <p>(c) The demulsibility test is made within 30 days from date of shipment.</p> <p>(d) Distillation is determined by AASHTO T 59 with modifications to include a $350 \pm 5^\circ \text{F}$ ($177 \pm 3^\circ \text{C}$) maximum temperature to be held for 15 minutes.</p>			
Modify the asphalt cement before emulsification.			

Table 11

Latex Modified Cationic Rapid Setting Emulsified Asphalt (LMCRS-2)			
Tests	Test Method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	140	400
Settlement (a) 5 days, percent	AASHTO T 59		5
Storage Stability Test (b) 1 d, 24 h, percent	AASHTO T 59		1
Demulsibility (c) 35 ml, 0.8% sodium Dioctyl Sulfosuccinate, percent	AASHTO T 59	40	
Particle Charge Test	AASHTO T 59	Positive	
Sieve Test, percent	AASHTO T 59		0.3
Distillation			
Oil distillate, by volume of emulsion, percent			0
Residue (d), percent		65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	40	200
Torsional Recovery (e)		18	
(a) The test requirement for settlement may be waived when the emulsified asphalt is used in less than a five-day time unless the purchaser requires the test. (b) May use the 24-hour (1-day) storage stability test instead of the five-day settlement test. (c) Make the demulsibility test within 30 days from date of shipment. (d) Determine distillation by AASHTO T 59, with modifications to include a 350 ± 5°F (177±3°C) maximum temperature to be held for 15 minutes. (e) CA 332 (California Test Method)			
Co-mill latex and asphalt during emulsification			

Table 12

Cationic Medium Setting Emulsified Asphalt (CMS-2S)		
Tests	Test Method	Specification
Emulsion		
Viscosity, SF, 122° F (50° C), s	AASHTO T 59	50 - 450
Percent residue	AASHTO T 59	60 min
Storage Stability Test, 1d, 24h, percent	AASHTO T 59	1 max
Sieve, percent	AASHTO T 59	0.10 max
Particle charge	AASHTO T 59	Positive
Oil Distillate, percent by volume of emulsion	AASHTO T 59	5-15
Residue		
Penetration, 77° F (25° C), 100g, 5 sec, dmm	AASHTO T 59	100-250
Solubility, percent	AASHTO T 59	97.5 min.

Table 13

High Float Medium Setting Emulsified Asphalt (HFMS-2)			
Tests	Test Method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits	AASHTO T 59	70	300
Storage Stability Test, 1d, 24 h, percent	AASHTO T 59		1.0
Sieve Test , percent	AASHTO T 59		0.1
Distillation			
Oil Distillate, by volume of emulsion, percent	AASHTO T 59	NA	NA
Residue, percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100g, 5 s, dmm	AASHTO T 49	50	200
Float Test, 140° F (60° C), s	AASHTO T 50	1,200	
Solubility in Trichloroethylene, percent	AASHTO T 44	97.5	
Ductility, 77° F (25° C) 5cm/min, cm	AASHTO T 51	40	

Table 14

High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2P) (a)			
Tests	Test method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	100	450
Storage Stability Test, 1 d, 24 h, percent	AASHTO T 59		1.0
Sieve Test, percent	AASHTO T 59		0.1
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		7
Residue (b), percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	70	300
Float Test, 140° F (60° C), s	AASHTO T 50	1,200	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
Elastic Recovery, 77° F (25° C), percent	AASHTO T 301	50	
<p>(a) Supply an HFMS-2P (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with at least 3.0% polymer by weight of the asphalt cement before emulsification. The emulsion must be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor after standing undisturbed for at least 24 hours.</p> <p>(b) Determine the distillation by AASHTO T 59, with modifications to include a 350 ± 5° F (177 ± 3° C) maximum temperature to be held for 15 minutes.</p>			

Table 15

High Float Medium Setting Emulsified Polymerized Asphalt (HFMS-2SP) (a)			
Tests	Test method	Min.	Max.
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	50	450
Storage Stability Test, 1 d, 24 h, percent	AASHTO T 59		1
Sieve Test, percent	AASHTO T 59		0.1
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		7
Residue (b), percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	150	300
Float Test, 140°F (60°C), s	AASHTO T 50	1200	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
Elongation Recovery(c), 77° F (25° C), percent	AASHTO T 301	50	
<p>(a) Supply an HFMS-2SP (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with at least 3.0% polymer by weight of the asphalt cement before emulsification. The emulsion must be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor after standing undisturbed for at least 24 hours.</p> <p>(b) Determine the distillation by AASHTO T 59, with modifications to include a $350 \pm 5^\circ \text{ F}$ ($177 \pm 3^\circ \text{ C}$) maximum temperature to be held for 15 minutes.</p> <p>(c) Report only when penetration is greater than 300 dmm.</p>			

Table 16

High Float Rapid Setting Emulsified Polymerized Asphalt (HFRS-2P) (a)			
Tests	Test method	Min.	Max.
Emulsion			
Viscosity, SF @ 122° F (50° C), s (Project Site Acceptance/Rejection Limits)	AASHTO T 59	50	450
Storage Stability Test (b) 1 d, 24 h, percent	AASHTO T 59		1
Demulsibility 0.02 N Ca Cl ₂ , percent	AASHTO T 59	40	
Sieve Test, percent	AASHTO T 59		0.1
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		3
Residue (b), percent	AASHTO T 59	65	
Residue from Distillation Test			
Penetration, 77° F (25° C), 100 g, 5 s, dmm	AASHTO T 49	70	150
Float Test, 140° F (60° C), s	AASHTO T 50	1,200	
Solubility in trichloroethylene, percent	AASHTO T 44	97.5	
Elastic Recovery, 77° F (25° C), percent	AASHTO T 301	58	
<p>(a) Supply an HFMS-2SP (anionic, polymerized, high-float) as an emulsified blend of polymerized asphalt cement, water, and emulsifiers. Polymerize the asphalt cement with at least 3.0% polymer by weight of the asphalt cement before emulsification. The emulsion must be smooth and homogeneous throughout with no white, milky separation, pumpable, and suitable for application through a distributor after standing undisturbed for at least 24 hours.</p> <p>(b) Determine the distillation by AASHTO T 59, with modifications to include a 350 ± 5°F (177±3°C) maximum temperature to be held for 15 minutes.</p>			

Table 17

Cationic Rapid Setting Emulsified Asphalt (CRS-2A,B)			
Tests	Test Method	Min	Max
Emulsion			
Viscosity, SF, 122° F (50° C), s (Project Site Rejection/Acceptance Limits)	AASHTO T 59	140	400
Storage stability test, 24 h, percent	AASHTO T 59		1
Demulsibility, 35 mL 0.8 percent Sodium Dioctyl Sulfosuccinate, percent	AASHTO T 59	40	
Particle charge test	AASHTO T 59		Positive
Sieve test, percent	AASHTO T 59		0.10
Distillation			
Oil distillate, by volume of emulsion, percent	AASHTO T 59		0
Residue, percent	AASHTO T 59	65	
Use PG58-22 and PG64-22 as base asphalt cement for CRS-2A, B, respectively. Specification for high temperature performance – original and RTFO G*/sinδ within 3° C of grade.			

Table 18

Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type A		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	15 Min 40 Max
Residue , percent W (a)	AASHTO T 59	60 Min. 65 Max.
Miscibility Test (b)	AASHTO T 59	No Coagulation
Sieve Test, percent W (c)	AASHTO T 59	0.20 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Light Transmittance , %	UDOT MOI 8-973	30 Max.
Cement Mixing	AASHTO T 59	2 Max.
Residue from Distillation (a)		
Viscosity, 140° F (60° C), mm ² /s	ASTM D 4402	150 - 300
Flash Point, COC, ° F (° C)	AASHTO T 48	385 Min.
Asphaltenes, percent W	ASTM D 2006	0.4 Min. 0.75 Max.
Maltene Distribution Ratio (PC + A ₁)/(S + A ₂) (d)	ASTM D 2006	0.3 Min. 0.6 Max
Saturated Hydrocarbons, S (d)	ASTM D 2006	21 Min. 28 Max.
PC/S Ratio (d)	ASTM D 2006	1.5 Min.
(a) AASHTO T 59, Evaporation Test, modified as follows: Heat a 50 gram sample to 300°F until foaming ceases, then cool immediately and calculate results. (b) AASHTO T 59, modified as follows: Use a 0.02 Normal Calcium Chloride solution in place of distilled water. (c) AASHTO T 59, modified as follows: Use distilled water in place of a two percent sodium oleate solution. (d) Chemical composition by ASTM Method D-2006-70: PC= Polar Compounds, A ₁ = First Acidaffins A ₂ = Second Acidaffins, S = Saturated Hydrocarbons		

Table 19

Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type B		
Tests	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	25 - 150
Residue, percent W	AASHTO T 59 (mod) (a)	62 Min.
Sieve Test, percent W	AASHTO T 59	0.10 Max.
5-day Settlement	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Pumping Stability (b)		Pass
Residue from Distillation (a)		
Viscosity @ 140° F (60° C), mm ² /s	AASHTO T 201	2,500 - 7,500
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	98 Min.
Flash Point, COC	AASHTO T 48	204° C, Min.
Asphaltenes, percent W	ASTM D 2007	15 Max.
Saturates, percent W	ASTM D 2007	30 Max.
Aromatics, percent W	ASTM D 2007	25 Min.
Polar Compounds, percent W	ASTM D 2007	25 Min.
(a)	Determine the distillation by AASHTO T 59 with modifications to include a 300 ± 5° F (149 ± 3° C) maximum temperature to be held for 15 minutes.	
(b)	Test pumping stability by pumping 475 ml of Type B diluted 1 part concentrate to 1 part water, at 77° F (25° C) through a ¼ inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material.	
Type B – an emulsified blend of lube oil or lube oil extract and petroleum asphalt.		

Table 20

Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type B Modified		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	50 - 200
Residue(a), percent W	AASHTO T 59	62 Min.
Sieve Test, percent W	AASHTO T 59	0.20 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
Pumping Stability (b)		Pass
Residue from Distillation (a)		
Viscosity (c) 275° F (135° C), cP	ASTM D 4402	150 - 300
Penetration, 77° F (25° C), dmm	AASHTO T 49	180 Min.
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	98 Min.
Flash Point, COC, ° F (° C)	AASHTO T 48	400(204) Min.
Asphaltenes, percent W	ASTM D 2007	20 - 40
Saturates, percent % W	ASTM D 2007	20 Max.
Polar Compounds, percent W	ASTM D 2007	25 Min.
Aromatics, percent W	ASTM D 2007	20 Min.
PC/S Ratio	ASTM D 2007	1.5 Min.
(a) Determine the distillation by AASHTO T 59 with modifications to include a 300±5°F (149 ± 3° C) maximum temperature to be held for 15 minutes. (b) Pumping stability is tested by pumping 475 ml of Type B diluted 1 part concentrate to 1 part water, at 77° F (25° C) through a ¼ inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material. (c) Brookfield Thermocel Apparatus-LV model. ≥ 50 rpm with a #21 spindle, 7.1 g residue, at > 10 torque		
As required by the Asphalt Emulsion Quality Management Plan 508, UDOT Minimum Sampling and Testing Requirements, the supplier certifies that the base stock contains at least 15% by weight of Gilsonite Ore. Use the HCL precipitation method as a qualitative test to detect the presence of Gilsonite.		

Table 21

Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type C		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	10 - 100
Residue (a), percent W (Type C supplied ready to use 1:1 or 2:1.	AASHTO T 59	30 Min. 1:1 40 Min. 2:1
Sieve Test, percent W (b)		0.10 Max.
5-day Settlement, percent W	AASHTO T 59	5.0 Max.
Particle Charge	AASHTO T 59	Positive
pH (May be used if particle charge test is inconclusive)		2.0 - 7.0
Pumping Stability (c)		Pass
Tests of Residue from Distillation (a)		
Viscosity, 275° F (135° C), mm ² /s	AASHTO T 201	475 - 1,500
Solubility in 1,1,1 Trichloroethylene, percent	AASHTO T 44	97.5 Min.
RTFO mass loss, percent W	AASHTO T 240	2.5 Max.
Specific Gravity	AASHTO T 228	0.98 Min.
Flash Point, COC	AASHTO T 48	232° C, Min.
Asphaltenes, percent W	ASTM D 2007	25 Min., 45 Max.
Saturates, percent W	ASTM D 2007	10 Max.
Polar Compounds, percent W	ASTM D 2007	30 Min.
Aromatics, percent W	ASTM D 2007	15 Min.
(a) Determine the distillation by AASHTO T 59 with modifications to include a 300 ± 5° F (149 ± 3° C) maximum temperature to be held for 15 minutes. (b) Test method identical to AASHTO T 59 except that distilled water is used in place of 2% sodium oleate solution. (c) Test pumping stability by pumping 475 ml of Type diluted 1 part concentrate to 1 part water, at 77° F (25° C) through a ¼ inch gear pump operating at 1750 rpm for 10 minutes with no significant separation or coagulation in pumped material.		
As required by the Asphalt Emulsion Quality Management Plan Section 508 , UDOT Minimum Sampling and Testing Requirements,, the supplier certifies that the base stock contains at least 10% by weight of Gilsonite ore. Use the HCL precipitation method as a qualitative test to detect the presence of Gilsonite.		

Table 22

Emulsified Asphalt Pavement Rejuvenating Agent Concentrate Type D		
Property	Test Method	Limits
Viscosity, SF, 77° F (25° C), s	AASHTO T 59	30 - 90
Residue, (b) percent W	AASHTO T 59	65
Sieve Test, percent W	AASHTO T 59	0.10 Max.
pH		2.0 - 5.0
Residue from Distillation (b)		
Viscosity, 140° F (60° C), cm ² /s	AASHTO T 201	300 - 1200
Viscosity, 275° F (135° C), mm ² /s	AASHTO T 201	300 Min.
Modified Torsional Recovery (a) percent	CA 332 (Mod)	40 Min.
Toughness, 77° F (25° C), in-lb	ASTM D 5801	8 Min.
Tenacity, 77° F (25° C), in-lb	ASTM D 5801	5.3 Min.
Asphaltenes, percent W	ASTM D 2007	16 Max.
Saturates, percent W	ASTM D 2007	20 Max.
(a) Torsional recovery measurement to include first 30 seconds.		
(b) Determine the distillation by AASHTO T 59 with modifications to include a 300 ± 5° F (149 ± 3° C) maximum temperature to be held for 15 minutes.		

2.3 HOT-POUR CRACK SEALANT FOR ASPHALT PAVEMENT

- A. Combine a homogenous blend of materials to produce a sealant according to properties and tests in Table 23.
- B. Packaging and Marking – Supply sealant pre-blended, pre-reacted, and pre-packaged in lined boxes weighing no more than 30 lb.
 1. Use a dissolvable lining that will completely melt and become part of the sealant upon subsequent re-melting.
 2. Deliver the sealant in the manufacturer's original sealed container.
 - a. Clearly mark each container with the manufacturer's name, trade name of sealant, batch or lot number, and recommended safe heating and application temperatures.

Table 23

Hot-Pour Asphalt Pavement Crack Sealant			
Application Properties			
Workability	Pour readily and penetrate 0.25 inch and wider cracks for the entire application temperature range recommended by the manufacturer.		
Curing	No tracking caused by normal traffic after 45 minutes from application.		
Asphalt Compatibility ASTM D 5329, Section 14.	No failure in adhesion. No formation of an oily ooze at the interface between the sealant and the asphalt pavement or softening or other harmful effects on the asphalt pavement.		
Material Handling	Follow the manufacturer's safe heating and application temperatures.		
Test Method	Property	Minimum	Maximum
AASHTO T 51	Ductility, modified, 1cm/min, 39.2° F (4° C), cm	30	
UDOT method 967	Cold Temperature Flexibility	no cracks	
AASHTO T 300 (a)	Force-Ductility, lb force		4
ASTM D 5329	Flow 140°F (60° C), 5 hrs 75° angle, mm		3
AASHTO M 282 (b)	Tensile-Adhesion, modified	300%	
AASHTO T 228	Specific Gravity, 60° F (15.6° C)		1.140
ASTM D 5329	Cone Penetration, 77° F (25° C), 150 g, 5 sec., dmm		90
ASTM D 5329	Resilience, 77° F (25° C), 20 sec., percent	30	
ASTM D 4402	Viscosity, 380°F (193.3°C), SC4-27 spindle, 20 rpm, Cp		2,500
ASTM D 5329	Bond, Non-Immersed as specified in AASHTO M 282		Pass
(a)	Maximum of 4 lb force during the specified elongation of 30 cm @ 1 cm/min, 39.2° F (4° C).		
(b)	Delete Bond, Non-Immersed modification in AASHTO M 282. Perform tensile-adhesion test according to ASTM D 5329.		

PART 3 EXECUTION Not Used

END OF SECTION

SECTION 02748

PRIME COAT/TACK COAT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials and procedures for applying prime and tack coat.
- B. Blotter materials and procedures for absorbing excess asphalt as required.

1.2 RELATED SECTIONS

- A. Section 01554: Traffic Control
- B. Section 02721: Untreated Base Course
- C. Section 02745: Asphalt Material

1.3 REFERENCES

- A. AASHTO M 208: Cationic Emulsified Asphalts
- B. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
- C. AASHTO T 201: Kinematic Viscosity of Asphalts

1.4 DEFINITIONS

- A. Cutback Asphalt – Asphalt product using a solvent to reduce viscosity. MC-70 and MC-250 as used in this Section, article 2.1 refer to Medium Cure (MC). The number following “MC” describes the viscosity of the product during application, higher numbers indicating higher viscosity (thicker). Do not dilute these products. These products meet the requirements of Section 02745.

- B. Emulsified Asphalt – A group of asphalt products using water and soap (emulsifier) to reduce viscosity. These products consist of approximately 60 percent asphalt and 40 percent emulsifier.
 - 1. Refer to Section 02745 for the exact ratio as well as other properties.
 - a. The product is called a “straight” or a “concentrate” emulsion in this condition.
 - 2. CSS 1h and CQS 1h as used in this Section, Article 2.1 refer to Cationic Slow Set and Quick Set respectively.
 - a. The 1h designation refers to the residual binder grade as “hard” or an AC-20.
 - 3. A diluted product may be used to better control distribution when the residual application rate is small (0.03 gal/yd²).
 - a. The product will be referred to as a 1:1 or 2:1 dilute meaning 2 parts emulsion to 1 part water for the latter case when this is done.
- C. Prime coat – Liquid asphalt to a prepared subgrade or untreated base course.
- D. Tack coat – Emulsified asphalt to the existing surface or new pavement surface and intermediate lifts.

1.5 SUBMITTALS

- A. Material invoice or bill of lading.

PART 2 PRODUCTS

2.1 PRIME COAT

- A. MC-70 or MC-250. Refer to Section 02745.
- B. Blotter material – Granular materials, Table 1 when tested according to AASHTO T 27.

Table 1

Granular Materials	
Sieve Size	Percent Passing
No. 4	90 to 100
No. 10	25 to 80
No. 200	0 to 15

2.2 TACK COAT

- A. CQS-1h or CSS-1h emulsified asphalt. Refer to AASHTO M 208 and Section 02745.
 - 1. Select emulsion according to the time constraints required for Maintenance of Traffic (MOT) and the ability to fully cure before allowing traffic on the roadway.
 - a. Residual asphalt content to be approximately 60 percent.
 - 1) Dilute at terminal only.
 - 2) Do not change dilution before obtaining approval from the Engineer.
- B. Tack coat for paving fabrics is a PG 58-22 or PG 64-22.
- C. Do not use an emulsion or cutback in paving fabric placement.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

- A. Prime Coat
 - 1. Shape the surface to the required grade and section.
 - 2. Keep the surface free from ruts, corrugations, or other irregularities.
 - 3. Compact the surface according to Section 02721.
- B. Tack Coat
 - 1. Clean the surface of all materials that prevent the tack coat from bonding to the existing surface such as mud, dirt, leaves, and water.
 - 2. Cover all tacked surface areas with surfacing materials the same day the tack coat is applied.

3.2 APPLICATION

- A. Apply at the following rates:
 - 1. Prime Coat – 0.5 gal/yd²
 - 2. Tack Coat – Refer to Table 2.

Table 2

Application Rate (gal/yd ²)				
Existing Pavement Condition	Residual	Undiluted	1: 1 Dilute	2:1 Dilute
New HMA	0.03	0.05	0.10	0.08
Oxidized HMA	0.05	0.09	0.18	0.13
Milled HMA	0.07	0.12	0.24	0.18
Milled PCCP	0.07	0.12	0.24	0.18
PCCP	0.05	0.09	0.18	0.13

Residual – Asphalt binder content needed on the pavement.

Undiluted and 1:1 and 2:1 Dilute. Adjust the application rate if emulsion is not 60 percent residual asphalt.

3. Obtain approval for the quantities, rate of application, temperatures, and areas to be treated before any application. Application rates may vary according to field conditions.
- B. Do not apply prime coat or tack coat:
 1. On a wet surface or where surface conditions prevent proper adhesion.
 2. When the surface temperature is below 50 degrees F.
 3. When weather conditions prevent proper adhesion.
 - C. Protect all structures including items such as guardrails and guide posts from being spattered or marred.
 - D. Use a pressure distributor to apply the asphalt in a uniform, continuous spread.
 - E. Keep the viscosity between 50 and 100 centistokes. Refer to AASHTO T 201.
 - F. Immediately apply another application to under primed surface.
 - G. Apply tack coat between all lifts of Hot Mix Asphalt and to all surfaces, including vertical that will come in contact with Hot Mix Asphalt.
 1. Apply prime coat to protect the grade from damage.
 - H. Spread blotter material if the prime coat does not penetrate.
 1. Use the quantities required to absorb the excess asphalt.
 - I. Allow prime or tack coat to fully cure before allowing traffic on paving.

3.3 TRAFFIC CONTROL

- A. Refer to Section 01554.
- B. Maintain the prime coat/tack coat until the next course is placed.
- C. Keep all traffic off the prime coat until it has cured and dried.

END OF SECTION

SECTION 02765

PAVEMENT MARKING PAINT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Furnish acrylic water-based pavement marking paint. Refer to this Section, Article 2.2 for resin requirement.
- B. Apply to hot mix asphalt or portland cement concrete pavement as longitudinal lines, transverse markings, contrast lines, and other related markings.
- C. Remove pavement markings.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. AASHTO M 247: Glass Beads Used in Traffic Paints
- B. ASTM D 562: Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
- C. ASTM D 1155: Roundness of Glass Spheres
- D. ASTM D 1475: Density of Liquid Coatings, Inks, and Related Products
- E. ASTM D 1644: Nonvolatile Content of Varnishes
- F. ASTM D 2205: Selection of Tests for Traffic Paints
- G. ASTM D 2743: Traffic Paint Vehicle Solids by Spectroscopy and Gas Chromatography
- H. ASTM D 2805: Hiding Power of Paints by Reflectometry
- I. ASTM D 3723: Pigment Content of Water-Emulsion Paints by Low-Temperature Ashing
- J. ASTM D 3960: Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings

- K. ASTM D 5381: X-Ray Fluorescence (XRF) Spectroscopy of Pigments and Extenders
- L. ASTM E 1347: Color and Color-Difference Measurement by Tristimulus (Filter) Colorimetry
- M. Environmental Protection Agency Testing Methods
- N. Federal Specification
- O. Federal Standards
- P. Manual on Uniform Traffic Control Devices (MUTCD)
- Q. UDOT Materials Manual of Instruction
- R. UDOT Minimum Sampling and Testing Requirements
- S. UDOT Quality Management Plans

1.4 DEFINITIONS

- A. Longitudinal Markings – pavement markings that are generally placed parallel and adjacent to the flow of traffic such as lane lines, center lines, edge lines, channelizing lines, and others.
- B. Transverse Markings – pavement markings that are generally placed perpendicular and across the flow of traffic such as shoulder markings; word, symbol, and arrow markings; stop lines; crosswalk lines; speed measurement markings; parking space markings; and others.
- C. Long-term stationary – work that occupies a location more than 3 days.

1.5 SUBMITTALS

- A. Documentation of the manufacturer and production batch identification for the paint used.

1.6 ACCEPTANCE

- A. Provide fixtures such as ball valves, gate valves, or others on paint truck for the purposes of obtaining field samples.

- B. The Department will:
 - 1. Accept pavement marking paint from qualified manufacturer supplied samples.
 - 2. Sample from the applicator's yard, at the Department's discretion for acceptance.

- C. Stop all agitation before sample is drawn.

- D. The Engineer will:
 - 1. Visually inspect longitudinal lines and transverse markings to verify compliance with the required dimensions.
 - 2. Inspect at the end of each production day or more frequently as required.
 - 3. Verify quantities applied by either of the following methods:
 - a. Measuring both paint and bead tanks before and after application.
 - b. Witnessing the meter readings before and after application.
 - 1) A printout of meter readings instead of witnessing may be accepted at the Engineer's discretion.
 - 4. Sample in the field according to the UDOT Quality Management Plan 513, Pavement Marking Paint and the UDOT Minimum Sampling and Testing Requirements.

- E. Repaint any line or legend failing to meet bead application rates and dimensional requirements.
 - 1. Do not remove earlier application.

- F. Price Reductions
 - 1. Price reductions for pavement markings installed below the specified wet mil thickness are outlined in Table 1.

Table 1

Price Reduction for Wet Mil Thickness	
	Pay Factor
Less than 2 percent below the specified mil thickness	1.00
Less than 10 percent below the Specified wet mil thickness	0.75
Less than 15 percent below the Specified wet mil thickness	0.50
15 percent or more below the Specified wet mil thickness	0.00 *

* Repaint pavement markings at no cost to the Department. Do not remove earlier application.

2. The Department will apply price reductions for applied pavement markings that do not meet the requirements of Table 4 when the batch is sampled at the applicator's yard for quality verification according to UDOT Quality Management Plan 513, Pavement Marking Paint.
 - a. Apply the lowest pay factor from Tables 2 and 3.
3. The Department will require repainting for pavement markings more than five percentage points below total solids, pigment, or non-volatile vehicle properties from Table 4 when the project is sampled for quality verification according to Minimum Sampling and Testing Requirements.

Table 2

Price Reduction for Total Solids, Pigment and Non-Volatile Vehicle	
	Pay Factor
Less than 0.5 percent below or above the specified percentage	1.00
Less than 1.0 percent below the specified percentage	0.95
Less than 2.0 percent below the specified percentage	0.85
2.0 percent or more below the specified percentage	0.00 *

* Repaint pavement markings at no cost to the Department. Do not remove earlier application.

Table 3

Price Reductions for remaining requirements of Table 4	
	Pay Factor
Less than 0.2 percent deficient	1.00
Less than 1 percent deficient	0.90
Less than 2 percent deficient	0.80
Less than 3 percent deficient	0.70
Less than 4 percent deficient	0.60
Less than 5 percent deficient	0.50
5 percent or more below specified quantitative requirements	0.00 *

* Repaint pavement markings at no cost to the Department. Do not remove earlier application.

PART 2 PRODUCTS

2.1 PAINT

A. Meet the requirements for Acrylic Water Based Paint specified in Table 4.

Table 4

Paint Requirements				
Property	White	Yellow	Black	Test
Pigment – Percent by weight, minimum	62.0	62.0	62.0	ASTM D 3723
Total Solids – Percent by weight, minimum	77.0	77.0	77.0	ASTM D 1644
Nonvolatile vehicle – Percent by weight vehicle, minimum*	43.0	43.0	43.0	ASTM D 3723 ASTM D 1644
Viscosity, KU @ 77 degrees F	80 – 95	80 – 95	80 – 95	ASTM D 562
Density, lb/gal, minimum	14.0	14.0	14.0	ASTM D 1475
Volatile Organic Content (VOC) – g/L, maximum	100	100	100	ASTM D 3960
Titanium Dioxide Content, lb/gal	1.0 min	0.2 max	N/A	ASTM D 5381
Color Definition	37875	33538	N/A	Federal Standard 595B
Directional Reflectance Minimum	90.0	50.0	N/A	ASTM E 1347
Dry Opacity – Minimum (5 mils wet)	0.95	0.95	N/A	ASTM D 2805

* Binder – 100 percent acrylic cross-linking polymer, by weight, as determined by infrared analysis and other chemical analysis available to the Department. Refer to ASTM D 2205.

B. No-Pick-Up Time

- Paint may not smear or track three minutes after application to the roadway using standard application equipment, at the mil thickness required, and with an ambient shaded temperature of at least 50 degrees F.

C. Additional Requirements

- Free of lead, chromium, or other related heavy metals. Refer to ASTM D 5381.
- Refer to ASTM D 2743 and ASTM D 5381 for tests used to verify paint samples meet ASTM requirements.

2.2 GLASS SPHERES (BEADS) USED IN PAVEMENT MARKING PAINT

- A. Heavy metal concentration: Manufacturer must provide a certificate of compliance stating that all beads contain no more than the amounts listed for the following materials as determined by testing performed according to EPA test methods 3052 and 6010C.
1. Other suitable x-ray fluorescence spectrometry analysis methods may be used to screen samples of glass spheres for arsenic, antimony and lead content.

Table 5

Heavy Metal Materials	
Material	Level (ppm, total)
Arsenic	200
Antimony	200
Lead	200

- B. Longitudinal Lines – Refer to AASHTO M 247, Specific Properties, with the following exceptions:
1. Gradation:

Table 6

Gradation	
Sieve Size	Accumulated Percent Passing
No. 18	65 – 80
No. 30	30 – 50
No. 50	0 – 5

2. Coating – Dual coating for optimum adhesion and embedment.
3. Roundness – 80 percent true spheres below the number 30 sieve. Refer to ASTM D 1155
4. Color/Clarity – Colorless/clear and free of carbon residue.
5. Refractive Index – Minimum 1.51 by oil immersion method.
6. Air Inclusions – Less than 5 percent by visual inspection.
7. Hardness – Beads above the number 30 sieve exhibit an average hardness of C70.5 when measured using the Rockwell C scale method and using a minimum sample of 100 beads.
8. Crushing Strength – Beads above the number 30 sieve exhibit an average crushing strength of 60,000 psi when measured by the L/D^2 method and with a minimum sample of 100 beads.
9. Chemical Resistance – Beads resistant to hydrochloric acid, water, calcium chloride, and sodium sulfide. TT-B Federal Specification 1325C sections 4.3.6 to 4.3.9.

C. Transverse Markings – Refer to AASHTO M 247, Specific Properties, with the following exceptions:

1. Gradation:

Table 7

Gradation	
Sieve Size	Accumulated Percent Passing
No. 20	90 – 95
No. 30	45 – 70
No. 50	5 – 25
No. 80	0 – 5

2. Coating – Dual coating for optimum adhesion and embedment.
3. Roundness – The glass beads will have at least 75 percent true spheres.
4. Refractive index – Minimum 1.51 by oil immersion method.
5. Air Inclusions – Less than 10 percent by visual inspection.
6. Have at least 80 percent true spheres.

D. Beads used in Temporary Pavement Markings. Meet the above or AASHTO M 247 Type II uniform gradation.

PART 3 EXECUTION

3.1 PREPARATION

A. Line Control

1. Establish control points at 100 ft intervals on tangent and at 50 ft intervals on curves.
2. Maintain the line within 2 inches of the established control points and mark the roadway between control points as needed.
 - a. Remove paint that is not placed within tolerance of the established control points and replace. Refer to this Section, Article 3.4.
 - b. Maintain the line dimension within 10 percent of the width and length dimensions defined in Standard Drawings.

B. Remove dirt, loose aggregate, curing compounds, and other foreign material and follow manufacturer's recommendations for surface preparation.

3.2 APPLICATION

A. Use Qualified Applicators as identified in UDOT Quality Management Plan 513, Pavement Marking Paint.

- B. Apply Pavement marking paint at the following wet mil thickness:
1. 20-25 wet mils for all longitudinal markings.
 2. **Approximate** application rate for required mil thickness requirements:
 - a. 4 inch Solid Line – From 190 to 240 ft/gal
 - b. 4 inch Broken Line – From 760 to 960 ft/gal
 - c. 8 inch Solid Line – From 95 to 120 ft/gal. Use the following calculation to determine wet mil thickness if approximation is outside the range for the desired line type.

Calculation – Determine wet mil thickness

$$4 \text{ inch Solid Line – Wet mils} = \frac{4812.516 \text{ ft}^3/\text{gal mil/ft}}{X \text{ ft/gal}}$$

$$4 \text{ inch Broken Line – Wet mils} = \frac{19250.064 \text{ ft}^3/\text{gal mil/ft}}{X \text{ ft/gal}}$$

$$8 \text{ inch Solid Line – Wet mils} = \frac{2406.258 \text{ ft}^3/\text{gal mil/ft}}{X \text{ ft/gal}}$$

Where:

X = application rate. (Meter readings or dipping tanks).

- C. Refer to Table 1 for price reduction of pavement markings that are less than required wet mils in thickness.
- D. No additional payment for pavement markings placed in excess of required wet mils in thickness or exceeding dimensional requirements outlined in this Section, Article 3.2 paragraph B.
- E. Glass Sphere (Beads) – Apply at least 8 lb/gal of paint, the full length and width of line and pavement markings.
 1. Calibrate bead guns and measure bead distribution according to UDOT Materials Manual of Instruction 932, Procedure for Sampling and Accepting Pavement Marking Paint and Beads.
 2. Do not apply glass beads to contrast lines (black paint).
- F. Begin striping operations no later than 24 hours after notification by the Engineer.
 1. Apply two applications on new bituminous surfaces.
 - a. Verify timing of second application with the Engineer.

- G. Apply lines and pavement markings only when the air and pavement temperature are:
 - 1. 50 degrees F and rising for Acrylic Water Based Paint.
 - a. Non-grooved lines and markings applied at temperatures below 50 degrees F are temporary and must be repainted, when temperature conditions are met.
 - 1) Do not remove earlier application.
 - b. Grooved lines and markings applied below 50 degrees F must be removed and reapplied when temperature conditions are met.
- H. Comply with TC Series Standard Drawings.

3.3 CONTRACTOR QUALITY CONTROL

- A. Adhere to the requirements of UDOT Quality Management Plan 513, Pavement Marking Paint

3.4 REMOVE PAVEMENT MARKINGS

- A. Use equipment specifically designed for removal of pavement marking material.
- B. Use one of these removal methods
 - 1. High pressure water spray
 - 2. Sand blasting
 - 3. Shot blasting
- C. Do not use grinding without approval from the Engineer.
 - 1. The Engineer will consult with the Region Traffic Operations Engineer before issuing approval.
- D. Do not eliminate or obscure existing striping, instead of removal, by covering with black paint or any other covering.
 - 1. The Engineer may approval for use of black paint or other obscuring material prior to installation for work durations shorter than “long term stationary” as defined in this Section, Article 1.4 and in the Temporary Traffic Control section of the MUTCD.

END OF SECTION

SECTION 02768

PAVEMENT MARKING MATERIALS

(Warranty Specification)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Pavement Marking Tape, Pavement Marking Epoxy, Methyl-Methacrylate, and Thermoplastic legends.

1.2 RELATED SECTIONS **Not Used**

1.3 REFERENCES

- A. Code of Federal Regulations, Title 40, Chapter 1, Subchapter C, part 59

1.4 DEFINITIONS **Not Used**

1.5 SUBMITTALS

- A. A warranty letter to the Engineer and the Department Engineer for Maintenance stating that the manufacturer guarantees the product against material and installation defects incurred under traffic for the service life.
 - 1. The guarantee period starts on the date of Physical Completion.
 - 2. Include in the letter:
 - a. State Project Designation
 - b. State Project Name
 - c. Quantities
 - d. Surface type
 - e. Material type
 - 3. Defects (performance failures) include:
 - a. Loss of retro-reflectivity
 - b. Loss of presence.
 - 4. The guarantee covers 100 percent of the pavement marking materials and installation costs.
 - 5. Removal and replacement of the pavement marking for failed segment.
 - 6. The Department will notify the manufacturer of defects to be repaired during the guarantee period.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. According to manufacturer's recommendations.

PART 2 PRODUCTS

2.1 PAVEMENT MARKING TAPE

- A. Preformed adhesive tape with a raised profile for longitudinal lines on all pavement surfaces.
- B. Preformed adhesive tape with a flat or raised profile for legends and symbols on all pavement surfaces.
- C. Minimum service life for the following applications under all traffic volumes and wear conditions:

Table 1

TYPE	ELEVATION (ft above mean sea level)	INSTALLATION METHOD	MIN. SERVICE LIFE
Longitudinal lines	0 to 5499	Hot inlay	48 months
Longitudinal lines	0 to 5499	Grooved	72 months
Longitudinal lines	5500 or more	Grooved	48 months
Legends and symbols	All	All	24 months

- D. Performance measures for retro-reflectivity and presence.
 - 1. Minimum retro-reflectivity
 - a. White longitudinal lines 125 millicandelas
 - b. Yellow longitudinal lines 125 millicandelas
 - c. Legends and symbols 125 millicandelas
 - 2. Minimum presence level – 90 percent of the longitudinal line on any 1,000 ft segment or 90 percent of the legend and symbol must be present.
 - 3. Failure to meet any of the specified performance measures on at least 90 percent of the longitudinal line in any 1,000 ft segment or 90 percent of a legend or symbol is considered a complete failure of that marking and requires complete replacement by the manufacturer.

2.2 PAVEMENT MARKING EPOXY

- A. Use 100 percent lead free, two-component (resin and hardener) epoxy system for longitudinal lines, legends, and symbols for all pavement surfaces.
- B. Minimum service life for the following applications under all traffic volumes and wear conditions:
 - 1. Type 1 - Fast dry
 - a. Longitudinal – Center, skip, and edge lines 24 months
 - b. Legends and symbols 12 months
 - 2. Type 2 - Slow dry
 - a. Longitudinal – Center, skip, and edge lines 48 months
 - b. Legends and symbols 24 months
- C. Performance measures for retro-reflectivity and presence.
 - 1. Minimum retro-reflectivity
 - a. White longitudinal lines 125 millicandelas
 - b. Yellow longitudinal lines 125 millicandelas
 - c. Legends and symbols 125 millicandelas
 - 2. Minimum presence level – 90 percent of the longitudinal line on any 1,000 ft segment or 90 percent of the legend and symbol must be present.
 - 3. Failure to meet any of the specified performance measures on at least 90 percent of the longitudinal line in any 1,000 ft segment or 90 percent of a legend or symbol is considered a complete failure of that marking and requires complete replacement by the manufacturer.
- D. Use beads according to manufacturer’s recommendations.

2.3 METHYL METHACRYLATE

- A. Use a two-component pavement marking system compliant with Federal and State VOC regulations used for longitudinal lines, legends, and symbols and for use on all pavement surfaces.
- B. Minimum surface life for the following applications under all traffic volumes and wear conditions:
 - 1. Longitudinal lines 48 months
 - 2. Legends and symbols 18 months
- C. Performance Measures for retro-reflectivity and presence.
 - 1. Minimum retro-reflectivity
 - a. White Longitudinal markings 125 millicandelas

- b. Yellow Longitudinal markings 125 millicandelas
- c. Legends and Symbols 125 millicandelas
- 2. Minimum presence level – 90 percent of the longitudinal line on any 1,000 ft segment or 90 percent of the legend and symbol must be present.
- 3. Failure to meet any of the specified performance measures on at least 90 percent of the longitudinal line in any 1,000 ft segment or 90 percent of the legend or symbol is considered a complete marking failure and requires complete replacement by the manufacturer.

D. Use beads according to manufacturer’s recommendations.

2.4 PREFORMED THERMOPLASTIC HEAT FUSED PAVEMENT MARKING MATERIALS

- A. Use for legends and symbols only, on all pavement surfaces.
- B. Heat-fused preformed and sprayed pavement marking materials.
- C. Minimum service life for legends and symbols under all traffic volumes and wear conditions is 24 months.
- D. Performance measures for retro-reflectivity and presence.
 - 1. Minimum level of retro-reflectivity – 125 millicandelas
 - 2. Minimum presence – 90 percent of the each legend or symbol must be present.
 - 3. Failure to meet any of the specified performance measures on at least 90 percent of the legend or symbol is considered a complete failure of that legend or symbol and requires complete replacement by the manufacturer.

2.5 HOT MELT THERMOPLASTIC PAVEMENT MARKING MATERIALS

- A. Use for longitudinal lines only, on all pavement surfaces.
- B. Minimum service life for long lines – 24 months.
 - 1. Applies under all traffic volumes and wear conditions.
- C. Performance measures for retro-reflectivity and presence.
 - 1. Minimum retro-reflectivity – 125 millicandelas.
 - 2. Minimum presence – 90 percent of each legend or symbol present.
 - 3. Failure to meet any of the specified performance measures on at least 90 percent of the legend or symbol is considered a complete failure and requires complete replacement by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

- A. Prepare pavement surface according to manufacturer's recommendations.

3.2 APPLICATION

- A. Apply pavement marking materials according to manufacturer's recommendations.

END OF SECTION

SECTION 02789

ASPHALT SLURRY SEAL COAT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Products and procedures for mixing and spreading a properly proportioned mixture of fine graded aggregate, mineral filler, emulsified asphalt, and water.
- B. Products and procedures for cured slurry with a homogeneous appearance, firm surface adhesion, and skid resistant texture.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. AASHTO M 17: Mineral Filler for Bituminous Paving Mixtures
- B. AASHTO M 29: Fine Aggregate for Bituminous Paving Mixtures
- C. AASHTO M 208: Cationic Emulsified Asphalt
- D. AASHTO T 11: Material Finer than 75 µm (No. 200) Sieve in Mineral Aggregate
- E. AASHTO T 27: Sieve Analysis of Fine and Coarse Aggregates
- F. AASHTO T 96: Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- G. AASHTO T 104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- H. AASHTO T 176: Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- I. AASHTO T 278: Surface Frictional Properties Using the British Pendulum Tester
- J. AASHTO T 279: Accelerated Polishing of Aggregates Using the British Wheel

- K. ISSA A105 Guidelines
- L. UDOT Quality Management Plan
- M. UDOT Minimum Sampling and Testing Requirements

1.4 DEFINITIONS Not Used

1.5 SUBMITTALS

- A. Mix Design and test results to the Engineer 10 days before beginning construction.
 - 1. Meet the requirements of this Section, Article 2.7.
 - 2. Include target gradation for combined aggregate and mineral filler.
- B. Test reports for aggregate.
 - 1. Meet the requirements of this Section, Article 2.2.
- C. Manufacturer's Certificate of Compliance for Mineral Filler.
- D. Verification that the emulsified asphalt supplier adheres to UDOT Quality Management Plan 508 Asphalt Emulsion.
 - 1. Certificate of analysis/compliance from the manufacturer for each shipment.

1.6 ACCEPTANCE

- A. Sampling and testing of material is according to UDOT Minimum Sampling and Testing Requirements.
- B. Meet the Target Tolerance of Table 1.

PART 2 PRODUCTS

2.1 EMULSIFIED ASPHALT

- A. Use a cationic emulsified asphalt grade CQS-1h according to AASHTO M 208.
- B. Verify that the shipment is the same as the mix design.
- C. Refer to UDOT Quality Management Plan 508 Asphalt Emulsion.

2.2 AGGREGATE

- A. Use 100 percent manufactured sand, slag, crushed fines, or a combination. Refer to AASHTO M 29.
- B. Use aggregate that is clean and free from organic matter or other detrimental substances.
- C. Use an aggregate blend with a sand equivalent of 45 or more. Refer to AASHTO T 176.
- D. Meet a minimum polishing value of 31. Refer to AASHTO T 278 and AASHTO T 279.
- E. Use aggregate with 35 percent or less loss by abrasion. Refer to AASHTO T 96.
- F. Meet 15 percent soundness maximum using Na₂ SO₄. Refer to AASHTO T 104.

2.3 MINERAL FILLER

- A. Use Portland Cement, hydrated lime, or aluminum sulfate. Refer to AASHTO M 17.

2.4 COMBINED AGGREGATE AND MINERAL FILLER

- A. Use a job mix or target gradation within the gradation band. Base the mix design on this gradation. The percent passing each sieve after the target gradation has been submitted will not vary by more than the target tolerance and still remain within the gradation band in Table 1. Refer to AASHTO T 11 and AASHTO T 27.

Table 1

Gradation		
Sieve Size	Gradation Band (% Passing)	Target Tolerance
¾ inch	100	
No. 4	70-90	+/- 5%
No. 8	45-70	+/- 5%
No. 16	28-50	+/- 5%
No. 30	19-34	+/- 5%
No. 50	12-28	+/- 4%
No. 100	7-18	+/- 3%
No. 200	5-15	+/- 2%

2.5 WATER

- A. Potable and free from harmful salts and contaminants.

2.6 ADDITIVES

- A. Use additives as required to accelerate or retard the break-set of the slurry seal or to improve the resulting finished surface.
1. Determine the initial additive quantities by the mix design for the slurry mix or individual materials.
 2. Obtain Engineer approval.

2.7 SLURRY SEAL MIX DESIGN

- A. Use a Department approved laboratory conforming to the ISSA A105 tested listed in Table 2.
1. Use the same materials and aggregate gradation to be used on the project.

Table 2

TESTS		
ISSA TEST NO.	DESCRIPTION	SPECIFICATION
ISSA TB 106	Slurry Seal Consistency	2cm Minimum 3cm Maximum
ISSA TB-139 For quick-traffic systems	Wet Cohesion 30 Minutes Minimum (Set) Wet Cohesion 60 Minutes Minimum	12 kg-cm Minimum 20 kg-cm Minimum
ISSA TB 109 For heavy-traffic areas only	Excess Asphalt by LWT Sand Abrasion	50 g/ft ² Maximum (538 g/m ² Maximum)
ISSA TB-114	Wet Stripping	Pass (90% Minimum)
ISSA TB-100	Wet-Track Abrasion Loss, One-hour Soak	75 g/ft ² (807 g/m ²)
ISSA TB-113	Mix Time**	Controllable to 180 Seconds Minimum

** Perform the mixing test and set-time test at the highest temperatures expected during construction.

2.8 EQUIPMENT

- A. Use only a machine designed and manufactured specifically for blending, mixing, and placing slurry seal.
 - 1. Mix the material in a self-propelled, slurry seal mixing machine of either truck-mounted or continuous-run design.
 - a) Continuous-run machines – Equipped to self-load materials while continuing to lay slurry seal.
 - b) Either type machine – Accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving mixer and to discharge the mixed product on a continuous-flow basis.
 - 2. Maintain sufficient storage capacity within the machine for aggregate, emulsified asphalt, mineral filler, control additive, and water to maintain an adequate supply to the proportioning controls.
- B. Calibrate each mixing unit in the presence of the Engineer before a machine is used on a project

PART 3 EXECUTION

3.1 LIMITATIONS

- A. Do not apply slurry seal during rain, when road surface moisture is present, or during other adverse weather conditions.
- B. Do not apply slurry seal if either the pavement or air temperature is below 50 degrees F and falling.
 - 1. Slurry seal may be applied when both the pavement and air temperatures are above 45 degrees F and rising.
- C. Do not apply slurry seal when the temperature is projected below 33 degrees F within 24 hours of placing slurry seal.
- D. Cease slurry seal operations when weather or other conditions prolong opening road surface to traffic beyond two hours.
- E. Keep traffic off roadway surface until the slurry seal has cured.

3.2 STOCKPILE

- A. Construct individual 500-ton stockpiles of slurry seal aggregates.
 - 1. Engineer approves stockpiles at least one and at most seven days before use.

- B. Notify the Engineer at least seven calendar days before slurry seal placement in order for the initial stockpiles to be sampled and tested for acceptance.
- C. Obtain the Engineer's written acceptance of all stockpiles before use in slurry seal.
- D. Remove material not meeting specifications from the stockpile area.
- E. The Department will retest corrected material for acceptance.

3.3 PREPARATION

- A. Clean the surface of all dirt, sand, dust, oil, and other objectionable material immediately before applying the slurry.
- B. Allow cracks to dry thoroughly before applying slurry seal when using water to clean the surface.
- C. Protect manholes, valve boxes, drop inlets, and other service utility entrances before surfacing.

3.4 APPLICATION

- A. Pre-wet the entire surface by fogging ahead of the slurry box.
 - 1. Do not over apply, causing free water to sit on the pavement in front of the slurry box.
- B. Carry a sufficient amount of slurry in all parts of the spreader at all times so that full width and complete coverage is obtained with no streaks or narrow spots.
 - 1. Avoid overloading the spreader.
- C. Apply slurry mixture of proper consistency at an average rate of 18 to 22 lb/yd² of dry aggregate.
- D. Do not add additional water for any reason, once the mixture has been placed onto the road surface.
- E. Remove and replace the slurry if any of the following occurs:
 - 1. Lumping, balling, or unmixed aggregates.
 - 2. Separation of the coarse aggregate from the emulsion and fines.
 - 3. Settling of the coarse aggregate to the bottom of the mix.
 - 4. Excessive breaking of emulsion inside the spreader box.
 - 5. Streaking caused by oversized aggregate.

3.5 FINISHING DETAILS

- A. Do not create build-up when constructing longitudinal and transverse joints.
- B. Place slurry seal adjacent to concrete pavements or concrete curb and gutter with a straight longitudinal edge.
 - 1. Do not allow over-lap on these areas.
 - 2. Remove slurry seal placed on concrete.
- C. Maintain straight lines at all locations.
- D. Place slurry seal at side streets and intersections out to right-of-way line.
- E. Use hand squeegees to spread slurry in areas that cannot be reached with slurry seal machine.
 - 1. Lightly dampen areas before mix placement.
 - 2. Provide complete and uniform coverage.
 - 3. Avoid unsightly appearance from hand work.
 - 4. Use the same type of finish in hand worked areas as applied by the spreader box.
- F. Use construction paper or comparable products so all beginning and ending joint lines from each construction pass are straight.

END OF SECTION

SECTION 02890

RETROREFLECTIVE SHEETING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Retroreflective sheeting materials for traffic signs and traffic control devices.

1.2 RELATED SECTIONS Not Used

1.3 REFERENCES

- A. ASTM B 209: Aluminum and Aluminum-Alloy Sheet and Plate
- B. ASTM D 4956: Retroreflective Sheeting for Traffic Control
- C. Code of Federal Regulations (CFR)
- D. Construction of Roads and Bridges on Federal Highway Projects FP-03

1.4 DEFINITIONS

- A. Retroreflective Sheeting
 - 1. Sheeting – The retroreflective or non-reflective material that comprises the background, legend (word messages and symbols), and border.
 - 2. Sheeting Components – The matched component products required for the manufacture of highway signs consist of the sheeting, cutout letters and borders, adhesives, inks, and overlay films. Failure of the sheeting inks or overlay films, provided, sold, or recommended for use, constitute a failure of the entire sign and replacement under manufacturer's warranty replacement obligations. All components and warranties will be compatible with substrates used by the Department, including Aluminum ASTM B 209 5052 - H 38 or 6061-T6.
 - 3. Permanent Signs - Include sign installations that are in their final configuration and that are expected to have a multi-year life. Examples include freeway guide signs, regulatory signs, warning signs, barrier markers, crash cushion markers, and delineation.

4. Work Zone Standard Signs – MUTCD and Department standard application signs including but not limited to Road Work Ahead, Work Zone Speed Limit, Flagger Symbols, Business Access, and Regulatory signing within the work zone.
5. Work Zone Project Specific Signs – Signs that have legends specific to the project and that cannot be reused on a future project. Examples include: “Alder Street closed from 1st to 2nd Avenue – use Birch Street” or project notification signs. These are typically used for only one construction season.
6. Flexible Work Zone Devices – Include such devices as roll up signs, cones, tall cones, and flags with retroreflective sheeting.
7. Work Zone Channelization Devices – Include such devices as drums, vertical panels, barricades, tubular markers, and pavement marking tabs.

1.5 SUBMITTALS

- A. Manufacturer’s Product Data and Specifications.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Retroreflective Sheeting
 1. Meet Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects FP-03.
 2. Conform to 23 CFR 655 Subpart F for Standard Highway Colors for Ordinary and Fluorescent Sheeting.
 3. Meet ASTM D 4956 Standard Specification for Retroreflective Sheeting for Traffic Control.
- B. Non-reflective Sheeting – As specified and according to the recommendation of the retroreflective sheeting manufacturer.
- C. Use matched component cutout legends, symbols, and borders.
- D. Use only acrylic EC film to achieve color. Do not use vinyl EC film to achieve color.

2.2 PERMANENT APPLICATIONS

- A. Traffic Signs and Traffic Control Devices
 1. Meet or exceed the minimum requirements of ASTM Type XI.
 2. Use fluorescent sheeting for orange, yellow and yellow-green.

- B. Miscellaneous Signs
 1. Use ASTM Type I for Adopt a Highway and Sponsor a Highway signs.
 2. Use ASTM Type I for Memorial signs.
 3. Use fluorescent pink retroreflective sheeting for Traffic Incident Management Area signs.

2.3 WORK ZONE APPLICATIONS

- A. Work Zone Signing
 1. Standard signs
 - a. Meet or exceed the minimum requirements of ASTM Type XI.
 - b. Use fluorescent retroreflective sheeting for orange, yellow, and yellow-green.
 2. Project specific signs
 - a. Meet or exceed the minimum requirements of ASTM Type III high intensity prismatic sheeting.
 - b. Use fluorescent retroreflective sheeting for orange, yellow, and yellow-green.
 3. Traffic incident management area signs
 - a. Use fluorescent pink.
- B. Flexible signs, cones, tall cones, and sign flags
 1. Use ASTM Type VI with minimum Coefficient of Retroreflection as shown in Table 1.

Table 1

Coefficient of Retroreflection (Candelas/Lux/Square Meter)						
Observation Angle	Entrance Angle	White	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange	Fluorescent Pink
0.2°	- 4°	500	400	300	200	180
0.2°	+ 30°	200	160	120	80	72
0.5°	- 4°	225	180	135	90	80
0.5°	+ 30°	85	68	51	34	30
1.0°	- 4°	50	40	30	20	18
1.0°	+ 30°	20	16	12	8	7

- C. Channelization Devices
 1. Vertical panels, barricade Types I, II, and III, and directional indicator barricades.
 - a. Meet or exceed the minimum requirements of ASTM Type XI.
 - b. Use of standard orange acceptable.

2. Meet or exceed the minimum requirements of ASTM Type V for temporary raised pavement markers.
3. Meet or exceed the minimum requirements of ASTM Type IV with the minimum requirements of the Coefficient of Retroreflection as shown in Table 2 and the minimum requirements of the Color Specification Limits (daytime) of Table 3 for all other channelization devices.

Table 2

Coefficient of Retroreflection (Candelas/Lux/Square Meter)			
Observation Angle	Entrance Angle	White	Fluorescent Orange
0.2°	- 4°	335	135
0.2°	+ 30°	200	80
0.5°	-4°	95	30
0.5°	+ 30°	65	25
1.0°	-4°	12	4
1.0°	+ 30°	7	3

Table 3

Color Specification Limits (daytime)										
Color	Chromaticity Coordinates								Luminance Factor (Y%)	
	1		2		3		4		Min	Max
x	y	X	Y	x	Y	x	y			
White	0.303	0.306	0.368	.0366	0.340	0.393	0.274	0.329	27	--
Fluorescent Orange	0.645	0.355	0.562	0.348	0.506	0.404	0.570	0.429	20	

4. Use fluorescent retroreflective sheeting for orange and yellow.
5. Do not obscure retroreflective sheeting with paint or other materials.

PART 3 EXECUTION

3.1 PREPARATION

- A. Do not reverse screen sign larger than 7 ft²/color.
- B. Establish proper orientation of the sheeting for all traffic signs and traffic control devices.

1. Verify cutout legends, symbols, and borders have the same sheeting orientation as background sheeting.

3.2 INSTALLATION

- A. Permanent sign and sheeting identification
 1. Affix to each sign a 1 inch high, two-digit number representing the fabrication year to the front lower left corner of each sign. Use numbers of contrasting color to sheeting color. Represent the year 2012 as "12", and so forth.
 2. Affix to each sign a 2 inch x 2 inch impermeable, non-fading weather-resistant, self-adhesive label. Attach label where it will not obscure sheeting. The label contains the month and year of manufacture, Contractor's name, and type of sheeting.

END OF SECTION