

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 16.17

COLD MILLING OF BITUMINOUS PAVEMENTS

08/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SYSTEM DESCRIPTION
 - 1.2.1 Cold-Milling Machine
 - 1.2.2 Cleaning Equipment
 - 1.2.3 Straightedge
- 1.3 QUALITY ASSURANCE
 - 1.3.1 Grade
 - 1.3.2 Surface Smoothness
 - 1.3.3 Traffic Control
- 1.4 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

PART 3 EXECUTION

- 3.1 PREPARATION OF SURFACE
- 3.2 MILLING OPERATION
- 3.3 GRADE AND SURFACE-SMOOTHNESS TESTING
 - 3.3.1 Grade-Conformance Tests
 - 3.3.2 Surface-Smoothness Tests
- 3.4 REMOVAL OF MILLED MATERIAL

-- End of Section Table of Contents --

SECTION 32 01 16.17

COLD MILLING OF BITUMINOUS PAVEMENTS
08/08

PART 1 GENERAL

1.1 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 C136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

1.2 SYSTEM DESCRIPTION

Maintain in a satisfactory working condition equipment, tools, and machines used in the performance of the work.

1.2.1 Cold-Milling Machine

Provide a cold-milling machine which is self-propelled, capable of milling the pavement to a specified depth and smoothness and of establishing grade control; with means of controlling transverse slope and dust produced during the pavement milling operation. The machine shall have the ability to remove the millings or cuttings from the pavement and load them into a truck. The milling machine shall not cause damage to any part of the pavement structure that is not to be removed.

1.2.2 Cleaning Equipment

Provide cleaning equipment suitable for removing and cleaning loose material from the pavement surface.

1.2.3 Straightedge

Furnish and maintain at the site, in good condition, one 12 foot straightedge or other suitable device for each milling machine, for testing the finished surface. Make straightedge available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal, with blades of box or box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on the pavement.

1.3 QUALITY ASSURANCE

1.3.1 Grade

Conform the finished milled surfaces to the lines, grades, and cross sections indicated. The finished milled-pavement surfaces shall vary not more than 1/4 inch from the established plan grade line and elevation. Finished surfaces at a juncture with other pavements shall coincide with

the finished surfaces of the abutting pavements. The deviations from the plan grade line and elevation will not be permitted in areas of pavements where closer conformance with planned grade and elevation is required for the proper functioning of appurtenant structures involved.

1.3.2 Surface Smoothness

Finished surfaces shall not deviate from the testing edge of a straightedge more than 1/4 inch in the transverse or longitudinal direction.

1.3.3 Traffic Control

Provide all necessary traffic controls during milling operations.

1.4 ENVIRONMENTAL REQUIREMENTS

Milling shall not be performed when there is accumulation of snow or ice on the pavement surface.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Clean the pavement surface of excessive dirt, clay, or other foreign material immediately prior to milling the pavement, if it will be recycled.

3.2 MILLING OPERATION

A minimum of seven days notice is required, prior to starting work, for the Contracting Officer to coordinate the milling operation with other activities at the site. Make sufficient passes so that the designated area is milled to the grades and cross sections indicated. The milling shall proceed with care and in depth increments that will not damage the pavement below the designated finished grade. Repair or replace, as directed, items damaged during milling such as manholes, valve boxes, utility lines, pavement that is torn, cracked, gouged, broken, or undercut. The milled material shall be removed from the pavement and loaded into trucks. Removed material shall have a minimum of 95 percent by weight passing a 1 inch sieve when tested in accordance with ASTM C136.

3.3 GRADE AND SURFACE-SMOOTHNESS TESTING

3.3.1 Grade-Conformance Tests

Test the finished milled surface of the pavement for conformance with the plan-grade requirements and for acceptance by the Contracting Officer by running lines of levels at intervals of 25 feet longitudinally and 25 feet transversely to determine the elevation of the completed pavement. Correct variations from the designated grade line and elevation in excess of the plan-grade requirements as directed. Skin patching for correcting low areas will not be permitted. Remove and replace the deficient low area. Remove sufficient material to allow at least 1 inch of asphalt concrete to be placed.

3.3.2 Surface-Smoothness Tests

After completion of the final milling, the finished milled surface will be tested by the Government with a straightedge. Other approved devices may be used, provided that when satisfactorily and properly operated, such devices reveal all surface irregularities exceeding the tolerances specified. Correct surface irregularities that depart from the testing edge by more than 1/4 inch. Skin patching for correcting low areas will not be permitted. Remove and replace the deficient low area. Remove sufficient material to allow at least 1 inch of asphalt concrete to be placed.

3.4 REMOVAL OF MILLED MATERIAL

Material that is removed shall become the property of the Contractor and removed from the site.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 19.61

RESEALING OF JOINTS IN RIGID PAVEMENT

04/06

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 DELIVERY, STORAGE, AND HANDLING
- 1.4 ENVIRONMENTAL REQUIREMENTS
- 1.5 TRAFFIC CONTROL
- 1.6 EQUIPMENT
 - 1.6.1 Joint Cleaning Equipment
 - 1.6.1.1 Routing Tool
 - 1.6.1.2 Concrete Saw
 - 1.6.1.3 Sandblasting Equipment
 - 1.6.1.4 Air Compressor
 - 1.6.1.5 Vacuum Sweeper
 - 1.6.1.6 Hand Tools
 - 1.6.2 Joint Sealing Equipment
 - 1.6.2.1 Equipment for Silicone Sealant
- 1.7 SAFETY PROVISIONS

PART 2 PRODUCTS

- 2.1 MATERIALS
 - 2.1.1 Joint Sealant
 - 2.1.1.1 Single Component Cold-Applied Silicone
 - 2.1.2 Primers
 - 2.1.3 Bond Breakers
 - 2.1.3.1 Blocking Media

PART 3 EXECUTION

- 3.1 JOINT PREPARATION
 - 3.1.1 Removal of Existing Material
 - 3.1.2 Refacing of Joints
 - 3.1.2.1 Joint Widening (Except Expansion Joints)
 - 3.1.3 Final Cleaning of Joints
 - 3.1.4 Bond Breaker
 - 3.1.4.1 Blocking Media (Backer Rod) (Except for Expansion Joints)
 - 3.1.5 Rate of Progress
 - 3.1.6 Disposal of Debris
- 3.2 PREPARATION OF SEALANT
 - 3.2.1 Cold-Applied, Two Component Type
- 3.3 INSTALLATION OF SEALANT
 - 3.3.1 Test Section
 - 3.3.2 Time of Application
 - 3.3.3 Sealing the Joints
- 3.4 FIELD QUALITY CONTROL

- 3.4.1 Sampling Joint Seal
- 3.4.2 Joints
- 3.4.3 Joint Seal Test Section
- 3.4.4 Joint Sealer
- 3.5 ACCEPTANCE

-- End of Section Table of Contents --

SECTION 32 01 19.61

RESEALING OF JOINTS IN RIGID PAVEMENT
04/06

PART 1 GENERAL

1.1 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 C603	(2004; R 2008) Extrusion Rate and Application Life of Elastomeric Sealants
ASTM C639	(2001; R 2011) Rheological (Flow) Properties of Elastomeric Sealants
ASTM C661	(2006; R 2011) Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer
ASTM C679	(2003; E 2009; R 2009) Tack-Free Time of Elastomeric Sealants
ASTM C719	(2013) Adhesion and Cohesion of Elastomeric Joint Sealants Under Cyclic Movement (Hockman Cycle)
ASTM C792	(2004; R 2008) Effects of Heat Aging on Weight Loss, Cracking, and Chalking of Elastomeric Sealants
ASTM C793	(2005; R 2010) Effects of Accelerated Weathering on Elastomeric Joint Sealants
ASTM D412	(2006a; R 2013) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-1401	(Rev C; Am 1; Notices 1, 2) Sealant, Joint, Non-Jet-Fuel-Resistant, Hot-Applied, for Portland Cement and Asphalt Concrete Pavements
FS SS-S-200	(Rev E; Am 1; Notice 1) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

NDDOT (2008) North Dakota Standard Specifications
for Road and Bridge Construction, current
edition

1.2 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00
SUBMITTAL PROCEDURES:

SD-03 Product Data

Joint sealant

Submit catalog cuts, specifications, material Safety Data Sheets
and other information documenting conformance to contract
requirements.

SD-04 Samples

Joint filler

Joint backer rod

Joint sealant

Furnish for testing a five gallon sample of each joint seal with
associated primer to the Contracting Officer a minimum of 60 days
prior to its use on the job. Each container shall be factory
sealed and must contain a factory applied label showing the
following information:

Name of sealant

Identification of component, or primer

Specification number and type

Manufacturer's name

Manufacturer's lot and batch number

Date of Manufacture (month and year)

Shelf life retest date (month and year)

List of hazardous components

Quantity of material in container (volume)

Storage instructions

Instructions for use

SD-06 Test Reports

Joint sealant

SD-07 Certificates

Equipment list

SD-08 Manufacturer's Instructions

Joint sealant

Instructions shall include, but not be limited to: storage requirements, ambient temperature and humidity ranges, and moisture condition of joints for successful installation; requirements for preparation of joints; safe heating temperature; mixing instructions; installation equipment and procedures; application and disposal requirements; compatibility of sealant with filler material; curing requirements; and restrictions to be adhered to in order to reduce hazards to personnel or to the environment. Submit instructions at least 30 days prior to use.

1.3 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to the site for visible damage, and unload and store with a minimum of handling. Joint materials shall be delivered in original sealed containers and shall be protected from freezing or overheating. Provide jobsite storage facilities capable of maintaining temperature ranges within manufacturer's recommendations.

1.4 ENVIRONMENTAL REQUIREMENTS

Work shall not proceed when weather conditions detrimentally affect the quality of cleaning joints or applying joint sealants. Joint preparation and sealing shall proceed only when weather conditions are in accordance with manufacturer's instructions. During installation, surfaces shall be dry and sealant and bond breakers shall be protected from moisture.

1.5 TRAFFIC CONTROL

Do not permit vehicular or heavy equipment traffic on the pavement in the area of the joints being sealed during the protection and curing period of the joint sealant. At the end of the curing period, traffic may be permitted on the pavement when approved.

1.6 EQUIPMENT

Submit an equipment list and description of the equipment to be used and a statement from the supplier of the joint sealant that the proposed equipment is acceptable for installing the specified sealant. Equipment for heating, mixing, and installing joint seals shall be in accordance with the instructions provided by the joint seal manufacturer. Furnish equipment, tools, and accessories necessary to clean existing joints and install liquid joint sealants. Maintain machines, tools, and other equipment in proper working condition.

1.6.1 Joint Cleaning Equipment

1.6.1.1 Routing Tool

To remove old sealant from joints, select rectangular shaped routing tool that is adjustable to varying widths and depths required. The equipment shall be capable of maintaining accurate cutting depth and width control.

The joint plow shall be equipped with a spring or hydraulic mechanism to release pressure on the tool prior to spalling the concrete.

1.6.1.2 Concrete Saw

Self-propelled power saw with diamond saw blades designed for sawing, refacing, widening, or deepening existing joints as specified without damaging the sides, bottom, or top edge of joints. Blades may be single or gang type with one or more blades mounted in tandem for fast cutting. Select saw adequately powered and sized to cut specified opening with not more than two passes of the saw through the joint.

1.6.1.3 Sandblasting Equipment

Commercial type capable of removing residual sealer, oil, or other foreign material. Equipment shall include an air compressor, hose and nozzles of proper size, shape, and opening. Attach an adjustable guide that will hold the nozzles aligned with the joint to effectively and efficiently clean without damage to concrete edges. Adjust height, angle of inclination, or size of nozzles to sandblast joint faces and not bottom of joint.

1.6.1.4 Air Compressor

Portable air compressor capable of operating the sandblasting equipment and capable of blowing out sand, water, dust adhering to sidewalls of concrete, and other objectionable materials from the joints. The compressor shall furnish air at a pressure not less than 90 psi and a minimum rate of 150 cubic feet of air per minute at the nozzles and be free of oil.

1.6.1.5 Vacuum Sweeper

Self-propelled, vacuum pickup sweeper capable of completely removing loose sand, water, joint material, and debris from pavement surface.

1.6.1.6 Hand Tools

When approved, hand tools such as brooms and chisels may be used in small areas for removing old sealant from joints and repairing or cleaning the joint faces.

1.6.2 Joint Sealing Equipment

Joint sealing equipment shall be of a type required by the joint seal manufacturer's installation instructions. Equipment shall be capable of installing sealant to the depths, widths and tolerances indicated. When malfunctions are noted, joint sealing shall not proceed until they are corrected.

1.6.2.1 Equipment for Silicone Sealant

Equipment for silicone sealant shall be air powered pump, components, and hoses as recommended by the sealant manufacturer. Hoses and seals shall be lined to prevent moisture penetration and withstand pumping pressures. Equipment shall be free of contamination from previously used or other type sealant.

1.7 SAFETY PROVISIONS

In accordance with the provisions of the contract respecting "Accident

Prevention," the Contractor shall take appropriate measures to control worker exposure to toxic substances during the work. Provide personnel protective equipment as required. Material Safety Data Sheets shall be available on the site.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Joint Sealant

2.1.1.1 Single Component Cold-Applied Silicone

Silicone sealant shall be self leveling, non-acid curing, and meet the following requirements:

<u>TEST</u>	<u>TEST METHOD</u>	<u>REQUIREMENTS</u>
Weight Loss	ASTM C792 Modified (see note 1 below)	10 percent max.
Flow	ASTM C639 (Type I)	smooth and level
Extrusion Rate	ASTM C603	30 sec. max.
Tack Free Time	ASTM C679	5 hours max.
Hardness (Shore 00) (see note 2 below)	ASTM C661	30 - 80
Tensile Stress at 150 Percent Elongation (see note 2 below)	ASTM D412 (Die C)	30 psi max.
Percent Elongation (see note 2 below)	ASTM D412 (Die C)	700 min.
Accelerated Weathering	ASTM C793	pass 5000 hours
Bond and Movement Capability	ASTM C719	pass 10 cycles at <u>plus</u> 50 percent movement (no adhesion or cohesion failure)
Flame Resistance	FS SS-S-200	pass
Notes:		
1. Percent weight loss of wet (uncured) sample after placing in forced-draft oven maintained at 158 degrees <u>plus</u> 1 degrees F for two hours.		
2. Specimen cured 21 days at 73 degrees <u>plus</u> 1 degree F and 50 percent <u>plus</u> 5 percent humidity.		

ACCELERATED WEATHERING FACTORY TEST REPORT. For the Accelerated Weathering test, in lieu of testing of actual joint sealant to be used on the project, a report of a factory test, performed within two years of contract award,

may be submitted.

2.1.2 Primers

Select concrete primer recommended by the manufacturer of the proposed liquid joint sealant.

2.1.3 Bond Breakers

2.1.3.1 Blocking Media

Compressible, nonshrinkable, nonreactive with joint sealant and nonabsorption type such as plastic backer rod, free of oils or bitumens. Blocking media shall be consistent with the joint seal manufacturer's installation instructions and be at least 25 percent larger in diameter than the width of the cleaned and re-faced joints as shown.

PART 3 EXECUTION

3.1 JOINT PREPARATION

Unless otherwise indicated, remove existing material, saw, clean and reseal joints. Do not proceed with final cleaning operations by more than one working day in advance of sealant. Thoroughly clean joints by removing existing joint sealing compound, bond-breakers, dirt, and other foreign material with the equipment specified herein, but not limited thereto. Cleaning procedures which damage joints or previously repaired patches by chipping or spalling will not be permitted. Remove existing sealant to the required depth as indicated. Precise shape and size of existing joints vary, and conditions of joint walls and edges vary and include but are not limited to rounding, square edges, sloping, chips, voids, depressions, and projections.

3.1.1 Removal of Existing Material

Remove from the joint the existing sealants by using the specified routing tool. After cutting free the existing sealant from both joint faces, remove sealant to the depth required to accommodate the bond breaking material and to maintain the specified depth for the new sealant. For expansion joints, remove existing sealant to a depth of not less than the indicated depth of one inch. When existing preformed expansion-joint material is more than one inch below the surface of the pavement, remove existing sealant to the top of the preformed joint filler. For joints other than expansion joints, remove in-place sealant to the depth as indicated. At the completion of routing operations, clean pavement surface with vacuum sweeper and clean the joint opening by blowing with compressed air. Protect previously cleaned joints from being contaminated by subsequent cleaning operations.

3.1.2 Refacing of Joints

Reface concrete joint walls. Refacing shall be by power-driven concrete saw specified herein to remove residual sealant and a minimum of concrete. Removal shall provide exposure of newly clean concrete. Remove burrs and irregularities from sides of joint faces. Immediately after sawing each joint, thoroughly clean saw cut and adjacent concrete surface. Flush with water under pressure, simultaneously blowing water out with compressed air until debris is removed from the joint. Protect adjacent previously cleaned joint spaces from receiving water and debris during the cleaning operation.

3.1.2.1 Joint Widening (Except Expansion Joints)

Saw joints having grooves less than 3/8 inch wide and less than one inch deep to a minimum width of 3/8 inch and to the minimum depth, of 1 1/2 inches.

3.1.3 Final Cleaning of Joints

3.1.4 Bond Breaker

At the time the joints receive the final cleaning and are dry, install bond breaker material as indicated with a steel wheel or other approved device.

3.1.4.1 Blocking Media (Backer Rod) (Except for Expansion Joints)

Plug or seal off the lower portion of the groove by installing the specified blocking media as indicated.

3.1.5 Rate of Progress

The final stages of joint preparation, which include placement of bond breakers, if required, shall be limited to only that length of joint that can be resealed during the same workday.

3.1.6 Disposal of Debris

Sweep from pavement surface to remove excess joint material, dirt, water, sand, and other debris by vacuum sweepers or hand brooms. Remove the debris immediately off the project site.

3.2 PREPARATION OF SEALANT

3.2.1 Cold-Applied, Two Component Type

Reject materials which contain water, hard caking of separated constituents, nonreversible jell, or other unsatisfactory conditions such as settlement of constituents into a soft mass that cannot be readily and uniformly remixed in the field with simple tools. In conformance with the manufacturer's recommendations, mix individual components in separate shipping containers before transferring components to appropriate reservoirs of application equipment. Thoroughly mix components to ensure homogeneity of components and incorporation of constituents at time of transfer. When necessary, for remixing prior to transfer, warm components to a temperature not exceeding 90 degrees F by placing components in heated storage or by other approved methods. In no case shall components be heated by direct flame or in single-walled, non-oil-bath heating kettles.

3.3 INSTALLATION OF SEALANT

3.3.1 Test Section

Install a test section of 200 linear feet at the start of the sealing operation for each type sealant to be used. Test section shall meet contract requirements. The Contracting Officer shall be notified upon completion of the test section.

3.3.2 Time of Application

After approval of the test section, seal joints immediately following final cleaning and placing of bond breakers. Commence sealing joints when walls are dust free and dry, and when weather conditions meet joint seal manufacturer's instructions. If the above conditions cannot be met, or when rains interrupts sealing operations, reclean and permit the joints to dry prior to installing the sealant.

3.3.3 Sealing the Joints

Do not install joint sealant until joints to be sealed have been inspected and approved. Install bond breaker just prior to pouring sealant. Fill the joints with sealant from bottom up until joints are uniformly filled solid from bottom to top using the specified equipment for the type of sealant required. Fill joints to 1/4 inch below top of pavement within tolerances as indicated, and without formation of voids or entrapped air. Except as otherwise permitted, tool the sealant immediately after application to provide firm contact with the joint walls and to form the indicated sealant profile below the pavement surface. Remove excess sealant that has been inadvertently spilled on the pavement surface. Check sealed joints frequently to assure that newly installed sealant is cured to a tack-free condition within 5 hours. Protect new sealant from rain during curing period.

3.4 FIELD QUALITY CONTROL

3.4.1 Sampling Joint Seal

Obtain a one gallon sample of each type of joint seal on the project from material used for each 10,000 linear feet or less of joints sealed. Store samples according to joint seal manufacturer's instructions. Retain samples until final acceptance of the work by the Contracting Officer.

3.4.2 Joints

Inspect and approve joints which have been cleaned and have backer rods or bond breaking tape installed prior to sealing.

3.4.3 Joint Seal Test Section

Inspect joint seal test section. Correct deficiencies and obtain approval of test section by the Contracting Officer prior to installing joint seals.

3.4.4 Joint Sealer

Inspect installed joint seals for conformance to contract requirements, joint seal manufacturer's instructions, and the test section. Obtain approval for each joint seal installation.

3.5 ACCEPTANCE

Reject joint sealer that fails to cure properly, or fails to bond to joint walls, or reverts to the uncured state, or fails in cohesion, or shows excessive air voids, blisters, surface defects, swelling, or other

deficiencies, or is not properly recessed within indicated tolerances. Remove rejected sealer and reclean and reseal joints in accordance with the specification. Perform removal and reseal work promptly by and at the expense of the Contractor.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 01 29.61

PARTIAL DEPTH PATCHING OF RIGID PAVING

11/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 QUALITY ASSURANCE
 - 1.3.1 Preconstruction Testing Of Materials
 - 1.3.1.1 Cement
 - 1.3.1.2 Aggregate
 - 1.3.1.3 Proprietary Cementitious Products
 - 1.3.2 Equipment; Approval, Maintenance, and Safety
- 1.4 DELIVERY, STORAGE, AND HANDLING
 - 1.4.1 Cement
 - 1.4.2 Aggregate
 - 1.4.3 Other Materials
- 1.5 Project/Site Conditions

PART 2 PRODUCTS

- 2.1 MATERIALS
 - 2.1.1 Coarse Aggregate
 - 2.1.1.1 Composition
 - 2.1.1.2 Quality
 - 2.1.1.3 Particle Shape
 - 2.1.1.4 Gradation
 - 2.1.1.5 Alkali Silica Reactivity
 - 2.1.2 Fine Aggregate
 - 2.1.2.1 Composition
 - 2.1.2.2 Particle Shape and Quality
 - 2.1.2.3 Grading
 - 2.1.2.4 Alkali Silica Reactivity
 - 2.1.3 Admixtures
 - 2.1.3.1 Air-Entraining Admixtures
 - 2.1.3.2 Chemical Admixtures
 - 2.1.4 Cement
 - 2.1.4.1 Portland Cement Mix Design
 - 2.1.5 Curing Materials
 - 2.1.5.1 Burlap
 - 2.1.5.2 Pigmented Liquid Membrane-Forming Compound
 - 2.1.5.3 Waterproof Sheet Materials
 - 2.1.6 Joint Sealant
 - 2.1.7 Joint Filler
 - 2.1.8 Water
- 2.2 Neat Cement Grout
 - 2.2.1 Sand-Cement Grout Bonding Course

PART 3 EXECUTION

- 3.1 PREPARATION OF EXISTING PAVEMENT
 - 3.1.1 Preparation of Existing Surfaces
 - 3.1.2 Preparation of Joints Adjacent to Spalls
 - 3.1.3 Disposal of Debris
 - 3.1.4 Bonding Coat
 - 3.1.4.1 Neat Cement Grout
- 3.2 BATCHING, MIXING AND PROPORTIONING
 - 3.2.1 Equipment
 - 3.2.2 Conveying
 - 3.2.3 Facilities for Sampling
 - 3.2.4 Mix Proportions
 - 3.2.5 Measurement
 - 3.2.6 Workability
- 3.3 PLACING
 - 3.3.1 Portland Cement Concrete
 - 3.3.2 Joints
- 3.4 FIELD QUALITY CONTROL
 - 3.4.1 General Requirements
 - 3.4.2 Specimens for Strength Tests
 - 3.4.2.1 Test Results
 - 3.4.2.2 Acceptance
- 3.5 FINISHING
- 3.6 CURING
 - 3.6.1 Moist Curing
 - 3.6.2 Waterproof-Paper Blankets or Impermeable Sheets
 - 3.6.3 Membrane-Forming Curing Compound
- 3.7 FINISH TOLERANCE
- 3.8 PAVEMENT PROTECTION
- 3.9 JOINTS

-- End of Section Table of Contents --

SECTION 32 01 29.61

PARTIAL DEPTH PATCHING OF RIGID PAVING
11/08

PART 1 GENERAL

1.1 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 M 85	(2012) Standard Specification for Portland Cement
AASHTO M 182	(2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
AASHTO SDDP-1-OL	(2003) Shop Detail Drawing Presentation Guidelines

ASTM INTERNATIONAL (ASTM)

ASTM C1059/C1059M	(1999; R 2008) Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
ASTM C1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2012) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C1581/C1581M	(2009a) Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage
ASTM C1602/C1602M	(2012) Standard Specification for Mixing

	Water Used in Production of Hydraulic Cement Concrete
ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C173/C173M	(2012) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C192/C192M	(2013) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2013) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C469/C469M	(2010) Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C494/C494M	(2013) Standard Specification for Chemical Admixtures for Concrete
ASTM C531	(2000; R 2012) Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing, and Polymer Concretes
ASTM C666/C666M	(2003; R 2008) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685/C685M	(2011) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881/C881M	(2010) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882/C882M	(2013) Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear

- ASTM C94/C94M (2013a) Standard Specification for Ready-Mixed Concrete
- ASTM D1751 (2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- ASTM D1752 (2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
- ASTM D75/D75M (2009) Standard Practice for Sampling Aggregates

U.S. ARMY CORPS OF ENGINEERS (USACE)

- COE CRD-C 300 (1990) Specifications for Membrane-Forming Compounds for Curing Concrete

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

- 29 CFR 1910 Occupational Safety and Health Standards

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

- NDDOT SS 2008)Standard Specifications for Road and Bridge Construction

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Mix Design

SD-04 Samples

- Absorbent curing material
- Joint filler
- Joint sealant

SD-05 Design Data

Concrete Mix Design

SD-06 Test Reports

- Laboratory Test Results
- Aggregates gradation
- Cement
- Concrete slump
- Concrete air content
- Concrete strength (cylinder)
- mixer calibration and efficiency

SD-07 Certificates

Cement
Aggregate
Admixtures
Absorbent curing material
pigmented liquid membrane-forming compound
Waterproof Sheet
Joint filler
Joint sealant

1.3 QUALITY ASSURANCE

1.3.1 Preconstruction Testing Of Materials

Submit proposed concrete mix design at least 30 days prior to placement. Provide mix design evaluation and certification by an approved engineering testing laboratory, and indicate the weight of each ingredient of the mixture, aggregate gradation, slump, air content, water-cement ratio, and 7-day and 28-day compressive strength test results. Include a complete list of materials including admixtures and applicable reference specifications. Place no concrete prior to approval of the proposed mix design. No deviation from the approved mix design is permitted without prior approval.

Within 24 hours of physical completion of laboratory testing, submit copies of test results for approval.

1.3.1.1 Cement

Test cement as prescribed in the referenced specification under which it is furnished. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specification.

1.3.1.2 Aggregate

Take aggregate gradation samples for laboratory testing in conformance with ASTM D75/D75M.

1.3.1.3 Proprietary Cementitious Products

At least 30 days before the material is used, submit certified copies of test results for the specific lots or batches to be used on the project, not more than 6 months old prior to use in the work.

Manufacturer's certifications may be submitted rather than laboratory test results for proprietary cementitious products. Include in the instructions details for substrate preparation, mixing, placing, finishing, curing and testing of the material. Include a minimum of three case histories documenting the use of the product in a similar freeze-thaw environment. Certify compliance with the appropriate specification referenced herein. Place no materials without prior approval from the Contracting Officer.

1.3.2 Equipment; Approval, Maintenance, and Safety

Provide and use only dependable and well maintained equipment that is appropriate to accomplish the work specified. Allow sufficient time for assembly of equipment requiring such at the work site to permit thorough

inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required prior to the start of work.

Submit volumetric mixer calibration and efficiency test results. Results must be current within 6 months of concrete placement.

Provide Material Safety Data Sheets (MSDS) and Personal Protection Equipment (PPE) per 29 CFR 1910.

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Cement

Deliver cement in bulk or in suitable bags used for packaging cements and store in a manner to prevent absorption of moisture.

1.4.2 Aggregate

Deliver, handle, and store aggregate in a manner to avoid breakage, segregation, or contamination by foreign materials.

1.4.3 Other Materials

Deliver chemical admixtures and proprietary cementitious products to the site in such manner as to avoid damage or loss. Provide storage areas in a windowless and weatherproof, but ventilated, insulated noncombustible building, with provision nearby for conditioning the material to 70 to 85 degrees F for a period of 48 hours prior to use. Keep the ambient temperature in the storage area no higher than 100 degrees F.

1.5 Project/Site Conditions

Do not place concrete when weather conditions detrimentally affect the quality of the finished product. Do not place concrete when the air temperature is below 40 degrees F in the shade. When air temperature is likely to exceed 90 degrees F, provide concrete having a temperature not exceeding 90 degrees F when deposited. Keep the surface of placed concrete damp with a water fog until the approved curing medium is applied.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Coarse Aggregate

2.1.1.1 Composition

Provide coarse aggregate consisting of gravel, crushed gravel, crushed stone, or a combination thereof.

2.1.1.2 Quality

Provide aggregate, as delivered to the mixers, consisting of clean, hard, unweathered, and uncoated particles. Remove dust and other coatings from the coarse aggregate by adequate washing. Meet the requirements of ASTM C33/C33M, Class 4S for deleterious substances. Abrasion loss, when tested in accordance with ASTM C131, must not exceed 40 percent; the maximum allowable percentage for clay lumps and friable particles is 1.5

percent. Provide documentation of aggregate conforming to ASTM C136.

2.1.1.3 Particle Shape

Provide spherical or cubical shaped coarse aggregate particles.

2.1.1.4 Gradation

The maximum nominal size of the coarse aggregate is 3/8 inch. Provide well graded coarse aggregate, within the limits specified, and tested in accordance with ASTM C136, and conforming to the following grading requirements as delivered to the batching hoppers:

Sieve designation U.S. Standard square mesh	Percentage by weight passing individual sieves No. 4 to 1/2 inch
3/8 inch	40-100
No. 4	0-15
No. 8	0-5

2.1.1.5 Alkali Silica Reactivity

Evaluate and test coarse aggregate, to be used in all concrete, for alkali-silica reactivity in accordance with ASTM C1260. Measured expansion must not exceed 0.08 percent at 28 days when tested. Test data indicating an expansion greater than 0.08 percent will be rejected.

2.1.2 Fine Aggregate

2.1.2.1 Composition

Provide fine aggregate consisting of either natural sand, manufactured sand, or a combination of natural and manufactured sand, and composed of clean, hard, durable particles; conforming to ASTM C33/C33M, Table 1 for deleterious substances.

2.1.2.2 Particle Shape and Quality

Ensure particles of the fine aggregate are generally spherical or cubical in shape.

2.1.2.3 Grading

Conform grading of the fine aggregate as delivered to the mixer to the following requirements when tested in accordance with ASTM C136.

Sieve designation U.S. Standard square mesh	Percentage by weight, passing
3/8 inch	100
No. 4	95-100
No. 8	80-90
No. 16	60-80
No. 30	30-60
No. 50	12-30

Sieve designation U.S. Standard square mesh	Percentage by weight, passing
No. 100	2-10

In addition, provide fine aggregate, as delivered to the mixer, with a fineness modulus of not less than 2.40 nor more than 2.90, when calculated in accordance with ASTM C136.

2.1.2.4 Alkali Silica Reactivity

Evaluate and test fine aggregate to be used in all concrete for alkali-silica reactivity using the procedures described for coarse aggregate.

2.1.3 Admixtures

2.1.3.1 Air-Entraining Admixtures

Provide air-entraining admixtures conforming to ASTM C260/C260M.

2.1.3.2 Chemical Admixtures

ASTM C494/C494M. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

2.1.4 Cement

Provide portland cement conforming to ASTM C150/C150M, Type III. Provide low alkali cement if the proposed fine or coarse aggregate are found to have greater than 0.04 percent expansion when tested in accordance with paragraphs: Alkali Silica Reactivity.

2.1.4.1 Portland Cement Mix Design

Design the concrete mixture to produce a minimum compressive strength of 5,000 psi at 28 days of age, determined in conformance with ASTM C39/C39M and ASTM C192/C192M, using standard 6 by 12 inch cylinder specimens; and providing an air content by volume of 6 percent, plus or minus 1.5 percent, based on measurements made on concrete immediately after discharge from the mixer in conformance with ASTM C231/C231M.

The allowable range of slump is 0 + 1/2 inch (UFC 3-270-03) when tested in accordance with ASTM C143/C143M. To minimize drying shrinkage, the maximum water-cement ratio by weight is 0.45.

2.1.5 Curing Materials

2.1.5.1 Burlap

Provide burlap conforming to AASHTO M 182.

2.1.5.2 Pigmented Liquid Membrane-Forming Compound

Provide pigmented liquid membrane-forming compound conforming to COE CRD-C 300.

2.1.5.3 Waterproof Sheet Materials

Provide waterproof sheet materials conforming to ASTM C171, Type optional, color white.

2.1.6 Joint Sealant

Provide joint sealant as as specified in Section 32 01 19.61 RESEALING OF JOINTS IN RIGID PAVING.

2.1.7 Joint Filler

Provide joint filler material conforming to ASTM D1751 or ASTM D1752, Type II.

2.1.8 Water

Use only clean, fresh water, free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances. Water approved by Public Health authorities for domestic consumption may be accepted for use without being tested. Test water that is of questionable quality, in the opinion of the Contracting Officer, in accordance with ASTM C1602/C1602M and acceptance criteria of Table 1 of ASTM C94/C94M.

2.2 Neat Cement Grout

2.2.1 Sand-Cement Grout Bonding Course

Provide grout bonding course consisting of equal parts of Type III portland cement and fine aggregate by dry weight, thoroughly mixed with water to yield a stiff slurry. Fine aggregate must meet the requirements specified herein, except 100 percent must pass through a No. 8 sieve.

PART 3 EXECUTION

3.1 PREPARATION OF EXISTING PAVEMENT

3.1.1 Preparation of Existing Surfaces

In the area to be patched, remove existing concrete to a minimum depth of 2 inches below the pavement surface adjacent to spalls and to such additional depth where necessary to expose a surface of sound, unweathered concrete that is uncontaminated by sealants, oils, greases, or deicing salts or solutions. Make a vertical saw cut at least 2 inches deep and 2 inches outside of the area needing repair. Accomplish concrete removal in spalled areas with light, hand-held, high-frequency chipping hammers weighing not more than 30 pounds or other approved hand tools. Do not use jack hammers weighing more than 30 pounds and do not use pavement breaker devices mounted on or pulled by mobile equipment.

Clean the cavity surface by sandblasting, blowing with compressed air, sweeping, and vacuums. Use sandblasting to remove all traces of sealer, oils, grease, rust, and other contaminants.

3.1.2 Preparation of Joints Adjacent to Spalls

Remove existing joint sealing and joint filler materials. Saw as indicated and install insert, cut to appropriate dimensions, to prevent contact between new patch material and existing concrete at existing joints. At

the option of the Contractor, a bead of approved caulking material may be installed to preclude new patching material from getting around insert. Clean up any caulking material accidentally deposited on the prepared spall surface.

3.1.3 Disposal of Debris

Sweep from pavement surface to remove excess joint material, dirt, water, sand, and other debris by vacuum sweepers or hand brooms. Debris becomes property of Contractor and is to be removed from Government property.

3.1.4 Bonding Coat

Prior to placing concrete, wash the previously prepared surfaces with a high pressure water jet followed by an air jet to remove free water.

3.1.4.1 Neat Cement Grout

Coat the clean and dry surface, including sawed faces, with an approximate 1/16 inch thick coat of neat cement grout. Place the grout just prior to concrete placement and scrub with stiff bristle brushes to fill all voids and crevices in the spall cavity surface. Apply additional brush coats as needed to obtain the required thickness. The concrete patch material must be placed before the grout dries or sets. Remove dried or hardened grout by sandblasting and re-coat the cavity with fresh grout before placing concrete patch material.

3.2 BATCHING, MIXING AND PROPORTIONING

Provide facilities for the accurate measurement and control of each of the materials entering the concrete, mortar, or grout. Provide free access for the Contracting Officer to the batching and mixing plant at all times. Provide mixing equipment capable of combining the aggregate, cement, admixture, and water into a uniform mixture and discharging this mixture without segregation.

The use of volumetric batching and continuous mixing is acceptable, provided all operations are in accordance with ASTM C685/C685M.

3.2.1 Equipment

Assemble dependable and operable equipment, allowing time for thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required prior to final approval and the commencement of work. Maintain the equipment in good working condition.

3.2.2 Conveying

Convey concrete from mixer to repair area as rapidly as practicable by methods which prevent segregation or loss of ingredients.

3.2.3 Facilities for Sampling

Provide facilities for readily obtaining representative samples of aggregate and concrete for test purposes. Furnish necessary platforms, tools, and equipment for obtaining samples.

3.2.4 Mix Proportions

Use proportions of materials entering into the concrete mixture in accordance with the approved mix design. Revise the mix design whenever necessary to maintain the workability, strength, and standard of quality required, and to meet the varying conditions encountered during the construction; however, no changes shall be made without prior approval.

3.2.5 Measurement

Provide equipment necessary to measure and control the amount of each material in each batch of concrete. Weigh bulk cement. Cement in unopened bags as packed by the manufacturer may be used without weighing. One bag of portland cement is considered as weighing 94 pounds. Measure mixing water and air-entraining admixtures by volume or by weight. Consider one gallon of water as weighing 8.33 pounds.

3.2.6 Workability

Maintain the slump of the concrete at the lowest practicable value, not exceeding the specified value.

3.3 PLACING

3.3.1 Portland Cement Concrete

Place concrete within 30 minutes after the introduction of the mixing water to the cement and aggregate or the introduction of the cement to the aggregate, and before the concrete has obtained its initial set, and before the sand-cement grout bonding course has dried or obtained its initial set. The temperature of the concrete, as deposited in the repair area, must be not less than 50 degrees F nor more than 90 degrees F. Deposit concrete as to require a minimum of re-handling and in such a manner so as to least disturb the sand-cement grout. Place concrete as indicated to maintain existing joints and working cracks; do not allow new repair material to infiltrate or span existing joints and cracks indicated to remain. Place concrete continuously in each spall area. Do not allow workmen to walk on the bonding course surface or in the concrete during placing and finishing operations.

Consolidate the concrete by small spud vibrators not greater than one inch in diameter, except that repair areas less than 4 inches deep or one square foot in area may be consolidated by hand tamping or other approved means. To avoid pulling material away from patch edge and to maximize bond strength, work the finishing screed from the center of the patch out to the patch boundary. Fill all saw kerfs extending beyond the repair area with grout. Start finishing operations immediately after placement of the concrete. Match finished surface grade of patched areas to the existing surface grade of the adjacent undisturbed pavement. Keep screeding, floating, or toweling of patch material onto adjacent pavements to a minimum; remove loose or poorly bonded patch material from adjacent surfaces. Before the concrete becomes non-plastic, finish the surface with a broom or burlap drag to approximately match the surface finish of existing adjacent concrete pavement.

3.3.2 Joints

Construct new joints as detailed on the drawings and align with existing joints. After curing of the concrete, seal new joints as indicated.

3.4 FIELD QUALITY CONTROL

3.4.1 General Requirements

Furnish concrete samples taken in the field and tested to determine the slump, air content, and strength of the concrete. Make test cylinders for determining conformance with the strength requirements of these specifications and, when required, for determining the time at which pavements may be placed in service. Determine air content in conformance with ASTM C231/C231M. Mold and cure test cylinders in conformance with ASTM C31/C31M and as specified below. Furnish all materials, labor, and facilities required for molding, curing, and protecting test cylinders at the site and under the supervision of the Contracting Officer. Include furnishing and operating water tanks in curing facilities for test beams, equipped with temperature-control devices that will automatically maintain the temperature of the water at 73 degrees F plus or minus 5 degrees F. Also furnish and maintain at the site, boxes or other facilities suitable for storing the specimens while in the mold at a temperature of 73 degrees F plus or minus 10 degrees F. Tests of the fresh concrete and of the hardened concrete cylinders are to be made by and at the expense of the Contractor. Test Proprietary Cementitious Products in accordance with the manufacturer's written instructions.

3.4.2 Specimens for Strength Tests

Sample concrete in the field and test to determine the slump, air content, and strength of the concrete. Make cylinders for each shift of placed concrete. Mold each group of test cylinders from the same batch of concrete, consisting of a sufficient number of specimens to provide two compressive-strength tests at each test age. Make one group of specimens during the first half of each shift, and the other during the last portion of the shift. However, at the start of paving operations and each time the aggregate source, aggregate characteristics, or mix design is changed, make one additional set of test cylinders.

Determine the air content and slump in conformance with ASTM C173/C173M and ASTM C143/C143M, respectively. Mold and cure test cylinders in conformance with ASTM C31/C31M. Furnish and maintain at the site, boxes or other facilities suitable for storing the specimens while in the mold at a temperature of 73 degrees F plus or minus 10 degrees F. Test cylinders in accordance with ASTM C39/C39M.

3.4.2.1 Test Results

Remove concrete not meeting strength, consistency, and air content requirements and provide new acceptable concrete. The removal and replacement method or methods are subject to approval of the Contracting Officer.

3.4.2.2 Acceptance

Reject any spall repair material that cracks, or delaminates, or loses bond partly or completely, or causes spalling of adjacent portland cement concrete, or is not separated properly from adjacent slabs at joints, or fails to cure uniformly and completely, or is otherwise defective. Remove all unacceptable repairs, including new damaged areas adjacent to new spall patches, and provide new repairs meeting the specifications.

3.5 FINISHING

Start finishing operations immediately after placement of the concrete. Finished surfaces of patched areas are to approximate surface texture of the adjacent undisturbed pavements.

3.6 CURING

Cure the concrete by protection against loss of moisture and rapid temperature changes for a period of not less than 7 days from the beginning of the curing operation for normal concrete. Minimum 3-day wet/moist curing period for high early-strength concrete, unless shorter period is allowed in Manufacturer's Instructions for proprietary blends. Protect unhardened concrete from rain and flowing water. Provide all equipment needed for adequate curing and protection of the concrete on hand and ready to install before actual concrete placement begins. Cure proprietary cementitious products in accordance with manufacturer's recommendations. Failure to comply with curing requirements will be cause for immediate suspension of concreting operations.

3.6.1 Moist Curing

Moist-cure all portland cement concrete patches for the first 24-hours after finishing. Immediately after the finishing operations are complete and the concrete is set sufficiently to prevent marring the surface, cover the entire surface of the newly laid concrete with approved wetted burlap, and keep wet for a period of not less than 24 hours. Keep the surface of the newly laid concrete moist until the burlap coverings are in place. Ensure that moist curing is continuous 24 hours per day and that the entire surface is wet, by having an approved work system. Continue curing the concrete for the duration of the required curing period by this method or one of the methods specified below.

3.6.2 Waterproof-Paper Blankets or Impermeable Sheets

Immediately after removing the covering used for initial curing, moisten the exposed concrete surfaces with a fine spray of water and cover with waterproof-paper blankets, polyethylene-coated-burlap blankets, or impermeable sheets. Saturate polyethylene-coated burlap with water before placing. Place sheets with the light-colored side up. Overlap sheets not less than 12 inches with edges taped or secured to form a completely closed joint. Weight down coverings to prevent displacement or billowing from winds. Immediately repair tears or holes appearing during the curing by patching.

3.6.3 Membrane-Forming Curing Compound

Apply membrane -forming curing compound immediately to exposed concrete surfaces after removing burlap coverings. Apply the curing compound with an overlapping coverage that will give a two-coat application at a coverage of not more than 200 square feet per gallon for both coats. When application is made by hand-operated sprayers, apply the second coat in a direction approximately at right angles to the first coat.

Cure concrete properly at joints, but do not allow absorbent curing compound to enter joints that are to be sealed with joint-sealing compounds. Provide a uniform, continuous, cohesive compound film that will not check, crack, or peel, and that will be free from pinholes and other imperfections. Respray concrete surfaces that are subjected to heavy

rainfall within 3 hours after the curing compound has been applied at the coverage specified above and at no additional cost to the Government. Respray areas covered with absorbent curing material that are damaged by pedestrian and vehicular traffic or by subsequent construction operations within the specified curing period at no additional cost to the Government.

3.7 FINISH TOLERANCE

Provide finished surfaces of patched areas meeting the grade of the adjoining pavements without deviations more than 1/8 inch from a true plan surface within the patched area.

3.8 PAVEMENT PROTECTION

Protect the patched areas against damage prior to final acceptance of the work by the Government. Exclude traffic from the patched areas by erecting and maintaining barricades and signs until the completion of the curing period of the concrete.

3.9 JOINTS

Provide joints conforming in detail and in alignment with the existing joints. After curing of the concrete, prepare and seal the joints in accordance with Section 32 01 19.61 RESEALING OF JOINTS IN RIGID PAVEMENTS.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 11 23

AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE

08/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
 - 1.2.1 Aggregate Base Course
 - 1.2.2 Degree of Compaction
- 1.3 SYSTEM DESCRIPTION
- 1.4 SUBMITTALS
- 1.5 QUALITY ASSURANCE
 - 1.5.1 Sampling
 - 1.5.2 Tests
 - 1.5.2.1 Sieve Analysis
 - 1.5.2.2 Liquid Limit and Plasticity Index
 - 1.5.2.3 Moisture-Density Determinations
 - 1.5.2.4 Field Density Tests
 - 1.5.2.5 Wear Test
 - 1.5.2.6 Soundness
 - 1.5.3 Testing Frequency
 - 1.5.3.1 Initial Tests
 - 1.5.3.2 In Place Tests
 - 1.5.4 Approval of Material
- 1.6 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 AGGREGATES
 - 2.1.1 Coarse Aggregate
 - 2.1.1.1 Aggregate Base Course
 - 2.1.2 Gradation Requirements
- 2.2 LIQUID LIMIT AND PLASTICITY INDEX

PART 3 EXECUTION

- 3.1 GENERAL REQUIREMENTS
- 3.2 OPERATION OF AGGREGATE SOURCES
- 3.3 STOCKPILING MATERIAL
- 3.4 PREPARATION OF UNDERLYING COURSE
- 3.5 INSTALLATION
 - 3.5.1 Mixing the Materials
 - 3.5.2 Placing
 - 3.5.3 Grade Control
 - 3.5.4 Edges of Base Course
 - 3.5.5 Compaction
 - 3.5.6 Thickness
 - 3.5.7 Proof Rolling
 - 3.5.8 Finishing

- 3.5.9 Smoothness
- 3.6 TRAFFIC
- 3.7 MAINTENANCE
- 3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

-- End of Section Table of Contents --

SECTION 32 11 23

AGGREGATE AND/OR GRADED-CRUSHED AGGREGATE BASE COURSE
08/08

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO T 180 (2010) 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

AASHTO T 224 (2010) Standard Method of Test for Correction for Coarse Particles in the Soil Compaction Test

ASTM INTERNATIONAL (ASTM)

ASTM C117 (2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C127 (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

ASTM C128 (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

ASTM C131 (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C29/C29M (2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

ASTM C88 (2013) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM D1556 (2007) Density and Unit Weight of Soil in

	Place by the Sand-Cone Method
ASTM D1557	(2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2487	(2011) Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D422	(1963; R 2007) Particle-Size Analysis of Soils
ASTM D4318	(2010) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D5821	(2001; R 2006) Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM D75/D75M	(2009) Standard Practice for Sampling Aggregates
ASTM E11	(2009; E 2010) Wire Cloth and Sieves for Testing Purposes

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

NDDOT SS	(2008) Standard Specifications for Road and Bridge Construction
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1.2 DEFINITIONS

For the purposes of this specification, the following definitions apply.

1.2.1 Aggregate Base Course

Aggregate base course (ABC) is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Degree of Compaction

Degree of compaction required, except as noted in the second sentence, is expressed as a percentage of the maximum laboratory dry density obtained by the test procedure presented in ASTM D1557 abbreviated as a percent of laboratory maximum dry density. Since ASTM D1557 applies only to soils that have 30 percent or less by weight of their particles retained on the 3/4 inch sieve, the degree of compaction for material having more than 30 percent by weight of their particles retained on the 3/4 inch sieve are expressed as a percentage of the laboratory maximum dry density in accordance with AASHTO T 180 Method D and corrected with AASHTO T 224.

1.3 SYSTEM DESCRIPTION

All plant, equipment, and tools used in the performance of the work will be subject to approval before the work is started and shall be maintained in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Provide adequate equipment having the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sieve Analysis, Liquid Limit, Plasticity Index, Soundness, L.A.
Abrasion (wear)
Plant, Equipment, and Tools
Waybills and Delivery Tickets

SD-06 Test Reports

Sampling and Testing
Field Density Tests

1.5 QUALITY ASSURANCE

Sampling and testing are the responsibility of the Contractor and performed by a testing laboratory approved in accordance with Section 01 45 00.10 20 QUALITY CONTROL FOR MINOR CONSTRUCTION PROJECTS. Work requiring testing will not be permitted until the testing laboratory has been inspected and approved. Test the materials to establish compliance with the specified requirements; perform testing at the specified frequency. The Contracting Officer may specify the time and location of the tests. Furnish copies of test results to the Contracting Officer within 24 hours of completion of the tests.

1.5.1 Sampling

Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Contracting Officer.

1.5.2 Tests

Perform the following tests in conformance with the applicable standards listed.

1.5.2.1 Sieve Analysis

Make sieve analysis in conformance with ASTM C117 and ASTM C136. Sieves shall conform to ASTM E11. Particle-size analysis of the soils shall also be completed in conformance with ASTM D422.

1.5.2.2 Liquid Limit and Plasticity Index

Determine liquid limit and plasticity index in accordance with ASTM D4318.

1.5.2.3 Moisture-Density Determinations

Determine the laboratory maximum dry density and optimum moisture content in accordance with ASTM D1557.

1.5.2.4 Field Density Tests

Measure field density in accordance with ASTM D1556 and ASTM D6938. For the method presented in ASTM D6938 check the calibration curves and adjust them, if necessary, using only the sand cone method as described in paragraph Calibration, of the ASTM publication. Tests performed in accordance with ASTM D6938 result in a wet unit weight of soil, and ASTM D6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall also be checked along with density calibration checks as described in ASTM D6938. The calibration checks of both the density and moisture gauges shall be made by the prepared containers of material method, as described in paragraph Calibration of ASTM D6938, on each different type of material being tested at the beginning of a job and at intervals as directed.

- a. Submit certified copies of test results for approval not less than 30 days before material is required for the work.
- b. Submit calibration curves and related test results prior to using the device or equipment being calibrated.
- c. Submit copies of field test results within 24 hours after the tests are performed.

1.5.2.5 Wear Test

Perform wear tests on ABC course material in conformance with ASTM C131.

1.5.2.6 Soundness

Perform soundness tests on ABC in accordance with ASTM C88.

1.5.3 Testing Frequency

1.5.3.1 Initial Tests

Perform one of each of the following tests, on the proposed material prior to commencing construction, to demonstrate that the proposed material meets all specified requirements when furnished. If materials from more than one source are going to be utilized, this testing shall be completed for each source.

- a. Sieve Analysis including the No. 635 sieve.
- b. Liquid limit and plasticity index.
- c. Moisture-density relationship.
- d. Wear.

- e. Soundness.

1.5.3.2 In Place Tests

Perform each of the following tests on samples taken from the placed and compacted ABC. Samples shall be taken and tested at the rates indicated.

- a. Perform density tests on every lift of material placed and at a frequency of one set of tests for every 150 square yards, or portion thereof, of completed area.
- b. Perform sieve analysis including the No. 635 sieve on every lift of material placed and at a frequency of one sieve analysis for every 2000 square yards, or portion thereof, of material placed.
- c. Perform liquid limit and plasticity index tests at the same frequency as the sieve analysis.
- d. Measure the total thickness of the base course at intervals, in such a manner as to ensure one measurement for each 500 square yards of base course. Measurements shall be made in 3 inch diameter test holes penetrating the base course.

1.5.4 Approval of Material

Select the source of the material 30 days prior to the time the material will be required in the work. Tentative approval of material will be based on initial test results. Final approval of the materials will be based on sieve analysis, liquid limit, plasticity index, soundness, L.A. Abrasion (wear) tests performed on samples taken from the completed and fully compacted course(s).

1.6 ENVIRONMENTAL REQUIREMENTS

Perform construction when the atmospheric temperature is above 35 degrees F. When the temperature falls below 35 degrees F, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide ABC in conformance with NDDOT Standard Specifications Section 816.

2.1.1 Coarse Aggregate

Provide coarse aggregates with angular particles of uniform density. When the coarse aggregate is supplied from more than one source, aggregate from each source shall meet the specified requirements and shall be stockpiled separately.

- a. Crushed Gravel: Crushed gravel shall be manufactured by crushing gravels, and shall meet all the requirements of NDDOT Standard Specifications Section 816.

2.1.1.1 Aggregate Base Course

Shall be NDDOT Standard Specifications ABC Class 5.

2.1.2 Gradation Requirements

Gradation shall be in conformance with NDDOT Standard Specifications Section 816.

2.2 LIQUID LIMIT AND PLASTICITY INDEX

Shall be in conformance with NDDOT Standard Specifications Section 816. Apply liquid limit and plasticity index requirements to the completed course and to any component that is blended to meet the required gradation. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the ABC is constructed in more than one layer, clean the previously constructed layer of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Provide adequate drainage during the entire period of construction to prevent water from collecting or standing on the working area. Provide line and grade stakes as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

Clearing, stripping, and excavating are the responsibility of the Contractor. Operate the aggregate sources to produce the quantity and quality of materials meeting the specified requirements in the specified time limit. Aggregate sources on private lands shall be conditioned in agreement with local laws or authorities.

3.3 STOCKPILING MATERIAL

If prior approval is received from the Contracting Officer for on-site stockpiling, clear and level storage sites prior to stockpiling of material. Stockpile all materials, including approved material available from excavation and grading, in the manner and at the locations designated. Aggregates shall be stockpiled on the cleared and leveled areas designated by the Contracting Officer to prevent segregation. Materials obtained from different sources shall be stockpiled separately.

3.4 PREPARATION OF UNDERLYING COURSE

Prior to constructing the base course(s), the underlying course or subgrade shall be cleaned of all foreign substances. At the time of construction of the base course(s), the underlying course shall contain no frozen material. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. The underlying course shall conform to Section 31 00 00 EARTHWORK. Ruts or soft yielding spots in the underlying courses, areas having inadequate compaction, and deviations of the surface from the requirements set forth herein shall be corrected by

loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses containing sands or gravels, as defined in ASTM D2487, the surface shall be stabilized prior to placement of the base course(s). Stabilization shall be accomplished by mixing ABC into the underlying course and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements of the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the base course is placed.

3.5 INSTALLATION

3.5.1 Mixing the Materials

Mix the coarse and fine aggregates in a stationary plant, or in a traveling plant or bucket loader on an approved paved working area. Make adjustments in mixing procedures or in equipment, as directed, to obtain true grades, to minimize segregation or degradation, to obtain the required water content, and to insure a satisfactory base course meeting all requirements of this specification.

3.5.2 Placing

Place the mixed material on the prepared subgrade or subbase in layers of uniform thickness with an approved spreader. When a compacted layer 6 inches or less in thickness is required, place the material in a single layer. When a compacted layer in excess of 6 inches is required, place the material in layers of equal thickness. No layer shall be thicker than 6 inches or thinner than 3 inches when compacted. The layers shall be so placed that when compacted they will be true to the grades or levels required with the least possible surface disturbance. Where the base course is placed in more than one layer, the previously constructed layers shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, or hand brooms, as directed. Such adjustments in placing procedures or equipment shall be made as may be directed to obtain true grades, to minimize segregation and degradation, to adjust the water content, and to insure an acceptable base course.

3.5.3 Grade Control

The finished and completed base course shall conform to the lines, grades, and cross sections shown. Underlying material(s) shall be excavated and prepared at sufficient depth for the required base course thickness so that the finished base course and the subsequent surface course will meet the designated grades.

3.5.4 Edges of Base Course

The base course(s) shall be placed so that the completed section will be a minimum of 1 foot wider, on all sides, than the next layer that will be placed above it. Additionally, place approved fill material along the outer edges of the base course in sufficient quantities to compact to the thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 2 foot width of this material to be rolled and compacted simultaneously with rolling and compacting of each layer of base course. If this base course material is to be placed adjacent to another pavement section, then the

layers for both of these sections shall be placed and compacted along this edge at the same time.

3.5.5 Compaction

Compact each layer of the base course, as specified, with approved compaction equipment. Maintain water content during the compaction procedure to within plus or minus 2 percent of the optimum water content determined from laboratory tests as specified in this Section. Begin rolling at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. In all places not accessible to the rollers, the mixture shall be compacted with hand-operated power tampers. Continue compaction until each layer has a degree of compaction that is at least 100 percent of laboratory maximum density through the full depth of the layer. Make such adjustments in compacting or finishing procedures as may be directed to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to ensure a satisfactory base course. Any materials that are found to be unsatisfactory shall be removed and replaced with satisfactory material or reworked, as directed, to meet the requirements of this specification.

3.5.6 Thickness

Construct the compacted thickness of the base course as indicated. No individual layer shall be thicker than 6 inches nor be thinner than 3 inches in compacted thickness. The total compacted thickness of the base course(s) shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, correct such areas by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated. The total thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 1000 square yards of base course. Measurements shall be made in 3 inch diameter test holes penetrating the base course.

3.5.7 Proof Rolling

Proof rolling of the areas indicated shall be in addition to the compaction specified and shall consist of the application of coverages with a heavy pneumatic-tired roller having four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum of 125 psi. In areas designated, apply proof rolling to the top of the underlying material on which the base course is laid and to each layer of base course. Maintain water content of the underlying material at optimum or at the percentage directed from start of compaction to completion of proof rolling of that layer. Water content of each layer of the base course shall be maintained at the optimum percentage directed from start of compaction to completion of proof rolling. Any base course materials or any underlying materials that produce unsatisfactory results by proof rolling shall be removed and replaced with satisfactory materials, recompacted and proof rolled to meet these specifications.

3.5.8 Finishing

The surface of the top layer of base course shall be finished after final compaction and proof rolling by cutting any overbuild to grade and rolling with a steel-wheeled roller. Thin layers of material shall not be added to the top layer of base course to meet grade. If the elevation of the top layer of base course is 1/2 inch or more below grade, then the top layer should be scarified to a depth of at least 3 inches and new material shall be blended in and compacted to bring to grade. Adjustments to rolling and finishing procedures shall be made as directed to minimize segregation and degradation, obtain grades, maintain moisture content, and insure an acceptable base course. Should the surface become rough, corrugated, uneven in texture, or traffic marked prior to completion, the unsatisfactory portion shall be scarified, reworked and recompacted or it shall be replaced as directed.

3.5.9 Smoothness

The surface of the top layer shall show no deviations in excess of 3/8 inch when tested with a 12 foot straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 100 foot intervals. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

3.6 TRAFFIC

Do not allow traffic on the completed base course.

3.7 MAINTENANCE

Maintain the base course in a satisfactory condition until the full pavement section is completed and accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any base course that is not paved over prior to the onset of winter, shall be retested to verify that it still complies with the requirements of this specification. Any area of base course that is damaged shall be reworked or replaced as necessary to comply with this specification.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Any unsuitable materials that must be removed shall be disposed of outside the limits of Government-controlled land. No additional payments will be made for materials that must be replaced.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 12 10

BITUMINOUS TACK COATS

08/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SYSTEM DESCRIPTION
 - 1.2.1 General Requirements
 - 1.2.2 Bituminous Distributor
 - 1.2.3 Heating Equipment for Storage Tanks
 - 1.2.4 Power Brooms and Power Blowers
- 1.3 SUBMITTALS
- 1.4 DELIVERY, STORAGE, AND HANDLING
- 1.5 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 PRIME COAT
- 2.2 TACK COAT
 - 2.2.1 Emulsified Asphalt

PART 3 EXECUTION

- 3.1 PREPARATION OF SURFACE
- 3.2 APPLICATION RATE
 - 3.2.1 Tack Coat
- 3.3 APPLICATION TEMPERATURE
 - 3.3.1 Viscosity Relationship
 - 3.3.2 Temperature Ranges
- 3.4 APPLICATION
 - 3.4.1 General
 - 3.4.2 Tack Coat
- 3.5 CURING PERIOD
- 3.6 FIELD QUALITY CONTROL
- 3.7 SAMPLING AND TESTING
 - 3.7.1 Calibration Test
 - 3.7.2 Trial Applications
 - 3.7.2.1 Tack Coat Trial Application Rate
 - 3.7.3 Sampling and Testing During Construction
- 3.8 TRAFFIC CONTROLS

-- End of Section Table of Contents --

SECTION 32 12 10

BITUMINOUS TACK COATS
08/08

PART 1 GENERAL

1.1 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 M 140	(2013) Standard Specification for Emulsified Asphalt
AASHTO M 208	(2009) Standard Specification for Cationic Emulsified Asphalt
AASHTO M 226	(1980; R 2008) Standard Specification for Viscosity-Graded Asphalt Cement
AASHTO T 102	(2009) Standard Method of Test for Spot Test of Asphaltic Materials
AASHTO T 40	(2002; R 2006) Sampling Bituminous Materials

ASTM INTERNATIONAL (ASTM)

ASTM D1250	(2008) Standard Guide for Use of the Petroleum Measurement Tables
ASTM D140/D140M	(2009) Standard Practice for Sampling Bituminous Materials
ASTM D2026/D2026M	(1997; E 2010; R 2010) Cutback Asphalt (Slow-Curing Type)
ASTM D2027/D2027M	(2010) Cutback Asphalt (Medium-Curing Type)
ASTM D2028/D2028M	(2010) Cutback Asphalt (Rapid-Curing Type)
ASTM D2397	(2005) Standard Specification for Cationic Emulsified Asphalt
ASTM D2995	(1999; R 2009) Determining Application Rate of Bituminous Distributors
ASTM D3381/D3381M	(2013) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D946/D946M	(2009a) Penetration-Graded Asphalt Cement

for Use in Pavement Construction

ASTM D977 (2013) Emulsified Asphalt

U.S. GREEN BUILDING COUNCIL (USGBC)

LEED NC (2009) Leadership in Energy and Environmental Design(tm) New Construction Rating System

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

NDDOT SS (2008) Standard Specifications for Road and Bridge Construction

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Plant, equipment, machines and tools used in the work are subject to approval and shall be maintained in a satisfactory working condition at all times. Calibrated equipment such as asphalt distributors, scales, batching equipment, spreaders and similar equipment, should have been recalibrated by a calibration laboratory within 12 months prior to commencing work and every 3 months thereafter, by such laboratory from the date of recalibration, during the term of the contract.

1.2.2 Bituminous Distributor

Refer to NDDOT Standard Specifications Section 151.

1.2.3 Heating Equipment for Storage Tanks

Refer to NDDOT Standard Specifications Section 152.

1.2.4 Power Brooms and Power Blowers

Use power brooms and power blowers suitable for cleaning the surfaces to which the bituminous coat is to be applied.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Waybills and Delivery Tickets

Local/Regional Materials

SD-06 Test Reports

Sampling and Testing

1.4 DELIVERY, STORAGE, AND HANDLING

Inspect the materials delivered to the site for contamination and damage. Unload and store the materials with a minimum of handling.

1.5 ENVIRONMENTAL REQUIREMENTS

Apply bituminous coat only when the surface to receive the bituminous coat is dry and meets the requirements of the NDDOT Standard Specifications Section 408.

PART 2 PRODUCTS

2.1 PRIME COAT

Prime coat is not required.

2.2 TACK COAT

Provide asphalt conforming to ASTM D2028/D2028M.

2.2.1 Emulsified Asphalt

Provide cationic or anionic emulsified asphalt CSS-1h or SS-1h as per NDDOT Standard Specifications Section 818.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, remove all loose material, dirt, clay, or other objectionable material from the surface to be treated by means of a power broom or blower supplemented with hand brooms. The surface shall be dry and clean at the time of treatment.

3.2 APPLICATION RATE

3.2.1 Tack Coat

Application rate shall be in accordance with NDDOT Standard Specifications Section 401.

3.3 APPLICATION TEMPERATURE

3.3.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity between 10 and 60 seconds, Saybolt Furol. Furnish the temperature viscosity relation to the Contracting Officer.

3.3.2 Temperature Ranges

The viscosity requirements determine the application temperature to be used. The following is a normal range of application temperatures:

Emulsions	

SS-1h	70-160 degrees F
CSS-1h	70-160 degrees F

These temperature ranges exceed the flash point of the material and care

should be taken in their heating.

3.4 APPLICATION

3.4.1 General

Following preparation and subsequent inspection of the surface, apply the bituminous tack coat with the Bituminous Distributor at the specified rate with uniform distribution over the surface to be treated. Properly treat all areas and spots missed by the distributor with the hand spray. Until the succeeding layer of pavement is placed, maintain the surface by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, spread clean dry sand to effectively blot up any excess bituminous material. No smoking, fires, or flames other than those from the heaters that are a part of the equipment are permitted within 25 feet of heating, distributing, and transferring operations of bituminous material other than bituminous emulsions. Prevent all traffic, except for paving equipment used in constructing the surfacing, from using the underlying material, whether primed or not, until the surfacing is completed. The bituminous coat shall conform to all requirements as described herein.

3.4.2 Tack Coat

Apply tack coat at the locations shown on the drawings. Apply the tack coat when the surface to be treated is dry. Immediately following the preparation of the surface for treatment, apply the bituminous material by means of the bituminous distributor, within the limits of temperature specified herein and at a rate as specified above in paragraph APPLICATION RATE. Apply the bituminous material so that uniform distribution is obtained over the entire surface to be treated. Treat lightly coated areas and spots missed by the distributor with the bituminous material. Following the application of bituminous material, allow the surface to cure without being disturbed for period of time necessary to permit setting of the tack coat. Apply the bituminous tack coat only as far in advance of the placing of the overlying layer as required for that day's operation. Maintain and protect the treated surface from damage until the succeeding course of pavement is placed.

3.5 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, allow the bituminous coat to cure and to obtain evaporation of any volatiles or moisture. Maintain the coated surface until the succeeding layer of pavement is placed, by protecting the surface against damage and by repairing and recoating deficient areas.

3.6 FIELD QUALITY CONTROL

Samples of the bituminous material used shall be obtained by the Contractor as directed, under the supervision of the Contracting Officer. The sample may be retained and tested by the Government at no cost to the Contractor.

3.7 SAMPLING AND TESTING

3.7.1 Calibration Test

Furnish all equipment, materials, and labor necessary to calibrate the bituminous distributor. Calibration shall be made with the approved job

material and prior to applying the bituminous coat material to the prepared surface. Calibrate the bituminous distributor in accordance with ASTM D2995.

3.7.2 Trial Applications

Before providing the complete bituminous coat, apply three lengths of at least 100 feet for the full width of the distributor bar to evaluate the amount of bituminous material that can be satisfactorily applied.

3.7.2.1 Tack Coat Trial Application Rate

Unless otherwise authorized, apply the trial application rate of bituminous tack coat materials in the amount of 0.05 gallons per square yard. Other trial applications shall be made using various amounts of material as may be deemed necessary.

3.7.3 Sampling and Testing During Construction

Perform quality control sampling and testing as required in paragraph FIELD QUALITY CONTROL.

3.8 TRAFFIC CONTROLS

Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so that traffic will not travel over freshly treated surfaces.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 12 16

HOT-MIX ASPHALT (HMA) FOR ROADS

08/09

PART 1 GENERAL

- 1.1 UNIT PRICES
 - 1.1.1 Basis of Payment
 - 1.1.2 Percent Payment
 - 1.1.3 Laboratory Air Voids and Theoretical Maximum Density
 - 1.1.4 Mean Absolute Deviation
 - 1.1.5 In-place Density
 - 1.1.6 Mat and Joint Densities
 - 1.1.7 Pay Factor Based on In-place Density
 - 1.1.8 Pay Factor for Grade
 - 1.1.9 Payment Adjustment for Smoothness
- 1.2 REFERENCES
- 1.3 SYSTEM DESCRIPTION
 - 1.3.1 Asphalt Mixing Plant
 - 1.3.2 Hauling Equipment
 - 1.3.3 Asphalt Pavers
 - 1.3.3.1 Receiving Hopper
 - 1.3.3.2 Automatic Grade Controls
 - 1.3.4 Rollers
- 1.4 SUBMITTALS
- 1.5 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 AGGREGATES
 - 2.1.1 Coarse Aggregate
 - 2.1.2 Fine Aggregate
 - 2.1.3 Mineral Filler
 - 2.1.4 Aggregate Gradation
- 2.2 ASPHALT CEMENT BINDER
- 2.3 MIX DESIGN
 - 2.3.1 JMF Requirements
 - 2.3.2 Adjustments to Field JMF

PART 3 EXECUTION

- 3.1 PREPARATION OF ASPHALT BINDER MATERIAL
- 3.2 PREPARATION OF MINERAL AGGREGATE
- 3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE
- 3.4 PREPARATION OF THE UNDERLYING SURFACE
- 3.5 TEST SECTION
 - 3.5.1 Sampling and Testing for Test Section
 - 3.5.2 Additional Test Sections
- 3.6 TESTING LABORATORY
- 3.7 TRANSPORTING AND PLACING

- 3.7.1 Transporting
- 3.7.2 Placing
- 3.8 COMPACTION OF MIXTURE
- 3.9 JOINTS
 - 3.9.1 Transverse Joints
 - 3.9.2 Longitudinal Joints
- 3.10 CONTRACTOR QUALITY CONTROL
 - 3.10.1 General Quality Control Requirements
 - 3.10.2 Testing Laboratory
 - 3.10.3 Quality Control Testing
 - 3.10.3.1 Asphalt Content
 - 3.10.3.2 Gradation
 - 3.10.3.3 Temperatures
 - 3.10.3.4 Aggregate Moisture
 - 3.10.3.5 Moisture Content of Mixture
 - 3.10.3.6 Laboratory Air Voids, Marshall Stability and Flow
 - 3.10.3.7 In-Place Density
 - 3.10.3.8 Grade and Smoothness
 - 3.10.3.9 Additional Testing
 - 3.10.3.10 QC Monitoring
 - 3.10.4 Sampling
 - 3.10.5 Control Charts
- 3.11 MATERIAL ACCEPTANCE
 - 3.11.1 Sublot Sampling
 - 3.11.2 Additional Sampling and Testing
 - 3.11.3 Grade
 - 3.11.4 Surface Smoothness
 - 3.11.4.1 Smoothness Requirements
 - 3.11.4.2 Testing Method

-- End of Section Table of Contents --

SECTION 32 12 16

HOT-MIX ASPHALT (HMA) FOR ROADS
08/09

PART 1 GENERAL

1.1 UNIT PRICES

1.1.1 Basis of Payment

The measured quantity of hot-mix asphalt will be paid for and included in the lump-sum contract price. Payment will constitute full compensation for furnishing all materials, equipment, plant, and tools; and for all labor and other incidentals necessary to complete work required by this section of the specification. If less than 100 percent payment is due based on the pay factors stipulated in paragraphs MATERIAL ACCEPTANCE and PERCENT PAYMENT, use a unit price of 80 per short ton for purposes of calculating the payment reduction.

1.1.2 Percent Payment

Submit pay calculations. When a lot of material fails to meet the specification requirements for 100 percent pay, as outlined in the following paragraphs, that lot shall be removed and replaced, or accepted at a reduced price which will be computed by multiplying the unit price by the lot's pay factor. The lot pay factor is determined by taking the lowest computed pay factor based on either laboratory air voids, in-place density, grade or smoothness (each discussed below). At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor equals or exceeds 95.0 percent, and no individual lot has a pay factor less than 75.1 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor. For any lots which are less than 2000 short tons, a weighted lot pay factor will be used to calculate the average lot pay factor.

1.1.3 Laboratory Air Voids and Theoretical Maximum Density

Laboratory air voids will be calculated by determining the Marshall or Superpave density of each lab compacted specimen using the laboratory-prepared, thoroughly dry method of ASTM D2726/D2726M and determining the theoretical maximum density of every other subplot sample using ASTM D2041/D2041M. Laboratory air void calculations for each subplot will use the latest theoretical maximum density values obtained, either for that subplot or the previous subplot. The mean absolute deviation of the four laboratory air void contents (one from each subplot) from the JMF air void content will be evaluated and a pay factor determined from Table 1. All laboratory air void tests will be completed and reported within 24 hours after completion of construction of each lot.

1.1.4 Mean Absolute Deviation

An example of the computation of mean absolute deviation for laboratory air voids is as follows: Assume that the laboratory air voids are determined

from 4 random samples of a lot (where 3 specimens were compacted from each sample). The average laboratory air voids for each subplot sample are determined to be 3.5, 3.0, 4.0, and 3.7. Assume that the target air voids from the JMF is 4.0. The mean absolute deviation is then:

$$\begin{aligned} \text{Mean Absolute Deviation} &= (|3.5 - 4.0| + |3.0 - 4.0| + |4.0 - 4.0| + |3.7 - 4.0|)/4 \\ &= (0.5 + 1.0 + 0.0 + 0.3)/4 = (1.8)/4 = 0.45 \end{aligned}$$

The mean absolute deviation for laboratory air voids is determined to be 0.45. It can be seen from Table 1 that the lot's pay factor based on laboratory air voids, is 100 percent.

Mean Absolute Deviation of Lab Air Voids from JMF	Pay Factor, percent
0.60 or less	100
0.61 - 0.80	98
0.81 - 1.00	95
1.01 - 1.20	90
Above 1.20	reject (0)

1.1.5 In-place Density

For determining in-place density, one random core (4 inches or 6 inches in diameter) will be taken by the Government from the mat (interior of the lane) of each subplot, and one random core will be taken from the joint (immediately over joint) of each subplot. Each random core will be full thickness of the layer being placed. When the random core is less than 1 inch thick, it will not be included in the analysis. In this case, another random core will be taken. After air drying to a constant weight, cores obtained from the mat and from the joints will be used for in-place density determination.

1.1.6 Mat and Joint Densities

The average in-place mat and joint densities are expressed as a percentage of the average TMD for the lot. The TMD for each lot will be determined as the average TMD of the two random samples per lot. The average in-place mat density and joint density for a lot are determined and compared with Table 2 to calculate a single pay factor per lot based on in-place density, as described below. First, a pay factor for both mat density and joint density are determined from Table 2. The area associated with the joint is then determined and will be considered to be 5 feet wide times the length of completed longitudinal construction joint in the lot. This area will not exceed the total lot size. The length of joint to be considered will be that length where a new lane has been placed against an adjacent lane of hot-mix asphalt pavement, either an adjacent freshly paved lane or one paved at any time previously. The area associated with the joint is expressed as a percentage of the total lot area. A weighted pay factor for the joint is determined based on this percentage (see example below). The pay factor for mat density and the weighted pay factor for joint density is compared and the lowest selected. This selected pay factor is the pay factor based on density for the lot. When the TMD on both sides of a longitudinal joint is different, the average of these two TMD will be used as the TMD needed to calculate the percent joint density. All density results for a lot will be completed and reported within 24 hours after the construction of that lot.

Table 2. Pay Factor Based on In-place Density

Average Mat Density (4 Cores) (% of TMD)	Pay Factor, %	Average Joint Density (4 Cores) (% of TMD)
94.0 - 96.0	100.0	92.5 or above
93.9	100.0	92.4
93.8 or 96.1	99.9	92.3
93.7	99.8	92.2
93.6 or 96.2	99.6	92.1
93.5	99.4	92.0
93.4 or 96.3	99.1	91.9
93.3	98.7	91.8
93.2 or 96.4	98.3	91.7
93.1	97.8	91.6
93.0 or 96.5	97.3	91.5
92.9	96.3	91.4
92.8 or 96.6	94.1	91.3
92.7	92.2	91.2
92.6 or 96.7	90.3	91.1
92.5	87.9	91.0
92.4 or 96.8	85.7	90.9
92.3	83.3	90.8
92.2 or 96.9	80.6	90.7
92.1	78.0	90.6
92.0 or 97.0	75.0	90.5
below 92.0 or above 97.0	0.0 (reject)	below 90.5

1.1.7 Pay Factor Based on In-place Density

An example of the computation of a pay factor (in I-P units only) based on in-place density, is as follows: Assume the following test results for field density made on the lot: (1) Average mat density = 93.2 percent of TMD. (2) Average joint density = 91.5 percent of TMD. (3) Total area of lot = 30,000 square feet. (4) Length of completed longitudinal construction joint = 2000 feet.

a. Step 1: Determine pay factor based on mat density and on joint density, using Table 2:

(1) Mat density of 93.2percent = 98.3 pay factor.

(2) Joint density of 91.5 percent = 97.3 pay factor.

b. Step 2: Determine ratio of joint area (length of longitudinal joint x 5 ft) to mat area (total paved area in the lot): Multiply the length of completed longitudinal construction joint by the specified 5 ft. width and divide by the mat area (total paved area in the lot).

(1) (2000 ft. x 5 ft.)/30000 sq.ft. = 0.3333 ratio of joint area to mat area (ratio).

c. Step 3: Weighted pay factor (wpf) for joint is determined as indicated below:

$$\text{wpf} = \text{joint pay factor} + (100 - \text{joint pay factor}) (1 - \text{ratio})$$

$$\text{wpf} = 97.3 + (100-97.3) (1-.3333) = 99.1 \text{ percent}$$

- d. Step 4: Compare weighted pay factor for joint density to pay factor for mat density and select the smaller:
 - (1) Pay factor for mat density: 98.3 percent. Weighted pay factor for joint density: 99.1 percent
 - (2) Select the smaller of the two values as pay factor based on density: 98.3 percent

1.1.8 Pay Factor for Grade

When more than 5 percent of all measurements made within a lot are outside the 0.05 foot tolerance, the pay factor based on grade for that lot will be 95 percent. In areas where the grade exceeds the tolerance by more than 50 percent, remove the surface lift full depth and replace the lift with hot-mix asphalt to meet specification requirements, at no additional cost to the Government.

1.1.9 Payment Adjustment for Smoothness

- a. Straightedge Testing. Record location and deviation from straightedge for all measurements. When between 5.0 and 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph Smoothness Requirements above, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness, will be 95 percent. When more than 10.0 percent of all measurements exceed the tolerance, the computed pay factor will be 90 percent. When between 15.0 and 20.0 percent of all measurements exceed the tolerance, the computed pay factor will be 75 percent. When 20.0 percent or more of the measurements exceed the tolerance, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 50 percent, shall be corrected by diamond grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.
- b. Profilograph Testing. Record location and data from all profilograph measurements. When the Profile Index of a 0.1 mile segment of a lot exceeds the tolerance specified in paragraph Smoothness Requirements above by 1.0 inch/mile, but less than 2.0 inches/mile, after any reduction of high spots or removal and replacement, the computed pay factor for that lot based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 2.0 inches/mile, but less than 3.0 inches/mile, the computed pay factor will be 90 percent. When the Profile Index exceeds the tolerance by 3.0 inches/mile, but less than 4.0 inches/mile, the computed pay factor will be 75 percent. When the Profile Index exceeds the tolerance by 4.0 inches/mile or more, the lot shall be removed and replaced at no additional cost to the Government. Regardless of the above, any small individual area with surface deviation which exceeds the tolerance given above by more than 5.0 inches/mile or more, shall be corrected by grinding to meet the specification requirements above or shall be removed and replaced at no additional cost to the Government.
- c. Bumps ("Must Grind" Areas). Any bumps ("must grind" areas) shown on the profilograph trace which exceed 0.3 inch in height shall be reduced by diamond grinding until they do not exceed 0.3 inch when retested.

Such grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. The following will not be permitted: (1) skin patching for correcting low areas, (2) planing or milling for correcting high areas. At the Contractor's option, pavement areas, including ground areas, may be rechecked with the profilograph in order to record a lower Profile Index.

1.2 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 M 156 (2013) Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures

AASHTO M 320 (2010) Standard Specification for Performance-Graded Asphalt Binder

ASPHALT INSTITUTE (AI)

AI MS-2 (1997 6th Ed) Mix Design Methods

AI MS-22 (2001; 2nd Ed) Construction of Hot-Mix Asphalt Pavements

AI SP-2 (2001; 3rd Ed) Superpave Mix Design

ASTM INTERNATIONAL (ASTM)

ASTM C117 (2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing

ASTM C1252 (2006) Standard Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)

ASTM C127 (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

ASTM C128 (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

ASTM C131 (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C142/C142M	(2010) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C29/C29M	(2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C88	(2013) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM D140/D140M	(2009) Standard Practice for Sampling Bituminous Materials
ASTM D1461	(2011) Moisture or Volatile Distillates in Bituminous Paving Mixtures
ASTM D2041/D2041M	(2011) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D2172/D2172M	(2011) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
ASTM D2419	(2009) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D242/D242M	(2009) Mineral Filler for Bituminous Paving Mixtures
ASTM D2489/D2489M	(2008) Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures
ASTM D2726/D2726M	(2013) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D2950/D2950M	(2011) Density of Bituminous Concrete in Place by Nuclear Methods
ASTM D3381/D3381M	(2013) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D3665	(2012) Random Sampling of Construction Materials
ASTM D3666	(2011) Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D4125/D4125M	(2010) Asphalt Content of Bituminous Mixtures by the Nuclear Method
ASTM D4791	(2010) Flat Particles, Elongated

	Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D4867/D4867M	(2009) Effect of Moisture on Asphalt Concrete Paving Mixtures
ASTM D5444	(2008) Mechanical Size Analysis of Extracted Aggregate
ASTM D6307	(2010) Asphalt Content of Hot Mix Asphalt by Ignition Method
ASTM D6925	(2009) Standard Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
ASTM D6926	(2010) Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus
ASTM D6927	(2006) Standard Test Method for Marshall Stability and Flow of Bituminous Mixtures
ASTM D946/D946M	(2009a) Penetration-Graded Asphalt Cement for Use in Pavement Construction

STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION (CALTRANS)

Ref Id	Ref Title
CTM 526	(2002) Operation of California Profilograph and Evaluation of Profiles

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 171	(1995) Standard Test Method for Determining Percentage of Crushed Particles in Aggregate
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NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

NDDOT SS	2008) Standard Specifications for Road and Bridge Construction
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1.3 SYSTEM DESCRIPTION

Perform the work consisting of pavement courses composed of mineral aggregate and asphalt material heated and mixed in a central mixing plant and placed on a prepared course. HMA designed and constructed in accordance with this section shall conform to the lines, grades, thicknesses, and typical cross sections shown on the drawings. Construct each course to the depth, section, or elevation required by the drawings and roll, finish, and approve it before the placement of the next course.

1.3.1 Asphalt Mixing Plant

Plants used for the preparation of hot-mix asphalt shall conform to the requirements of AASHTO M 156 with the following changes:

- a. Truck Scales. Weigh the asphalt mixture on approved, certified scales at the Contractor's expense. Inspect and seal scales at least annually by an approved calibration laboratory.
- b. Testing Facilities. Provide laboratory facilities at the plant for the use of the Government's acceptance testing and the Contractor's quality control testing.
- c. Inspection of Plant. Provide the Contracting Officer with 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; checking the temperatures maintained in the preparation of the mixtures and for taking samples. Provide assistance as requested, for the Government to procure any desired samples.
- d. Storage Bins. Use of storage bins for temporary storage of hot-mix asphalt will be permitted as follows:
 - (1) The asphalt mixture may be stored in non-insulated storage bins for a period of time not exceeding 3 hours.
 - (2) The asphalt mixture may be stored in insulated storage bins for a period of time not exceeding 8 hours. The mix drawn from bins shall meet the same requirements as mix loaded directly into trucks.

1.3.2 Hauling Equipment

Provide trucks for hauling hot-mix asphalt having tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other approved material. Petroleum based products shall not be used as a release agent. 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 (tarps) shall be securely fastened.

1.3.3 Asphalt Pavers

Provide asphalt pavers which are self-propelled, with an activated screed, heated as necessary, and capable of spreading and finishing courses of hot-mix asphalt which 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.

1.3.3.1 Receiving Hopper

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

1.3.3.2 Automatic Grade Controls

Equip the paver with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. A transverse slope controller shall not be used to control grade. Provide controls capable of working in conjunction with any of the following attachments:

- a. Ski-type device of not less than 30 feet in length.
- b. Taut stringline set to grade.
- c. Short ski or shoe for joint matching.
- d. Laser control.

1.3.4 Rollers

Rollers shall be in good condition and shall be operated at slow speeds to avoid displacement of the asphalt mixture. The number, type, and weight of rollers shall be sufficient to compact the mixture to the required density while it is still in a workable condition. Do not use equipment which causes excessive crushing of the aggregate.

1.4 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

NDDOT Standard Specifications Book
Mix Design Contractor Quality Control
Material Acceptance
Percent Payment

SD-06 Test Reports

Aggregates
QC Monitoring

SD-07 Certificates

Asphalt Cement Binder
Testing Laboratory

1.5 ENVIRONMENTAL REQUIREMENTS

When it does not comply with NDDOT Standard Specifications, Section 408.04.D, the temperature requirements may be waived by the Contracting Officer, if requested; however, all other requirements, including compaction, shall be met.

PART 2 PRODUCTS

2.1 AGGREGATES

Provide aggregates consisting of crushed stone, crushed gravel, crushed slag, screenings, natural sand and mineral filler, as required. Submit sufficient materials to produce 200 lb of blended mixture for mix design verification. The portion of material retained on the No. 4 sieve is coarse aggregate. The portion of material passing the No. 4 sieve and retained on the No. 200 sieve is fine aggregate. The portion passing the No. 200 sieve is defined as mineral filler. Submit all aggregate test results and samples to the Contracting Officer at least 14 days prior to start of construction.

2.1.1 Coarse Aggregate

Provide coarse aggregate consisting of sound, tough, durable particles, free from films of material that would prevent thorough coating and bonding with the asphalt material and free from organic matter and other deleterious substances. All individual coarse aggregate sources shall meet the requirements of NDDOT Standard Specifications, Section 410.02.B and the following requirements:

- a. The percentage of loss shall not be greater than 18 percent after five cycles when tested in accordance with ASTM C88 using magnesium sulfate or 12 percent when using sodium sulfate.
- b. At least 75 percent by weight of coarse aggregate shall have at least two or more fractured faces when tested in accordance with COE CRD-C 171. Fractured faces shall be produced by crushing.
- c. The particle shape shall be essentially cubical and the aggregate shall not contain more than 10 percent, by weight, of flat and elongated particles (3:1 ratio of maximum to minimum) when tested in accordance with ASTM D4791.
- d. Slag shall be air-cooled, blast furnace slag, with a compacted weight of not less than 75 lb/cu ft when tested in accordance with ASTM C29/C29M.
- e. Clay lumps and friable particles shall not exceed 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M.

2.1.2 Fine Aggregate

Fine aggregate shall consist of clean, sound, tough, durable particles free from coatings of clay, silt, or any objectionable material and containing no clay balls. All fine aggregate shall meet the requirements of NDDOT Standard Specifications, Section 410.02.B and the following requirements:

- a. All individual fine aggregate sources shall have a sand equivalent value not less than 45 when tested in accordance with ASTM D2419.
- b. The fine aggregate portion of the blended aggregate shall have an uncompacted void content not less than 45.0 percent when tested in accordance with ASTM C1252 Method A.
- c. The quantity of natural sand (noncrushed material) added to the aggregate blend shall not exceed 25 percent by weight of total

aggregate.

- d. Clay lumps and friable particles shall not exceed 0.3 percent, by weight, when tested in accordance with ASTM C142/C142M

2.1.3 Mineral Filler

Mineral filler shall be nonplastic material meeting the requirements of ASTM D242/D242M.

2.1.4 Aggregate Gradation

Aggregate blend and gradation shall meet the initial requirements of NDDOT Standard Specifications, Section 410.02, Table 1.

2.2 ASPHALT CEMENT BINDER

Submit a 5 gallon sample for mix design verification. Asphalt cement binder shall conform to AASHTO M 320 Performance Grade (PG) 58-28. Test data indicating grade certification shall be provided by the supplier at the time of delivery of each load to the mix plant. Submit copies of these certifications to the Contracting Officer. The supplier is defined as the last source of any modification to the binder. The Contracting Officer may sample and test the binder at the mix plant at any time before or during mix production. Obtain samples for this verification testing in accordance with ASTM D140/D140M and in the presence of the Contracting Officer. Furnish these samples to the Contracting Officer for the verification testing, which shall be at no cost to the Contractor. Submit samples of the asphalt cement specified for approval not less than 14 days before start of the test section. Submit copies of certified test data, amount, type and description of any modifiers blended into the asphalt cement binder.

2.3 MIX DESIGN

- a. Develop the mix design. The asphalt mix shall be composed of a mixture of well-graded aggregate, mineral filler if required, and asphalt material. 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). Submit proposed JMF; do not produce hot-mix asphalt for payment until a JMF has been approved. The hot-mix asphalt shall be designed in accordance with Superpave (SP-2) procedures and the criteria shown in Table 5 of this section and Table 4 of Section 410.04 of the NDDOT Standard Specifications. If the Tensile Strength Ratio (TSR) of the composite mixture, as determined by ASTM D4867/D4867M is less than 75, the aggregates shall be rejected or the asphalt mixture treated with an approved anti-stripping agent. The amount of anti-stripping agent added shall be sufficient to produce a TSR of not less than 75. Provide an antistrip agent, if required, at no additional cost. Sufficient materials to produce 200 pound of blended mixture shall be provided to the Contracting Officer for verification of mix design at least 14 days prior to construction of test section.
- b. The volumetric mix design shall be NDDOT FAA Superpave 43. Design the Superpave volumetric mix in accordance with Section 410 of the NDDOT Standard Specifications. The nominal maximum aggregate size (NMAS) shall be 1/2 inch. The number of compaction gyrations, N_{des} , shall be based on a design traffic of 615,000 equivalent single axle loads

(EASLs) for the section on ALCMHASS to Deterence Drive and 275,000 equivalent single axle loads (EASDs) for all other locations.

c. Design Superpave mixes with the number of gyrations specified in Table 5.

2.3.1 JMF Requirements

Submit in writing the job mix formula for approval at least 14 days prior to the start of the test section including as a minimum:

- a. Percent passing each sieve size.
- b. Percent of asphalt cement.
- c. Percent of each aggregate and mineral filler to be used.
- d. Asphalt viscosity grade, penetration grade, or performance grade.
- f. Number of gyrations of Superpave gyratory compactor.
- g. Laboratory mixing temperature.
- h. Lab compaction temperature.
- i. Temperature-viscosity relationship of the asphalt cement.
- j. Plot of the combined gradation on the 0.45 power gradation chart, stating the nominal maximum size.
- k. Specific gravity and absorption of each aggregate.
- l. Percent natural sand.
- m. Percent particles with 2 or more fractured faces (in coarse aggregate).
- n. Fine aggregate angularity.
- o. Percent flat or elongated particles (in coarse aggregate).
- p. Tensile Strength Ratio(TSR).
- q. Antistrip agent (if required) and amount.
- r. List of all modifiers and amount.

2.3.2 Adjustments to Field JMF

Keep the Laboratory JMF for each mixture in effect until a new formula is approved in writing by the Contracting Officer. Should a change in sources of any materials be made, perform a new laboratory JMF design and have a new JMF approved before the new material is used. The Contractor will be allowed to adjust the Laboratory JMF within the limits specified below to optimize mix volumetric properties with the approval of the Contracting Officer. Adjustments to the Laboratory JMF shall be applied to the field (plant) established JMF and limited to those values as shown. Adjustments shall be targeted to produce or nearly produce 4 percent voids total mix (VTM).

TABLE 6. Field (Plant) Established JMF Tolerances
Sieves Adjustments (plus or minus), percent

1/2 inch	3
No. 4	3
No. 8	3
No. 200	1
Binder Content	0.40

If adjustments are needed that exceed these limits, develop a new mix design. Tolerances given above may permit the aggregate grading to be outside the limits shown in Table 4; while not desirable, this is acceptable, except for the No. 200 sieve, which shall remain within the aggregate grading of Table 4.

PART 3 EXECUTION

3.1 PREPARATION OF ASPHALT BINDER MATERIAL

Heat the asphalt cement material avoiding local overheating and providing a continuous supply of the asphalt material to the mixer at a uniform temperature. Performance-Graded (PG) asphalts shall be within the temperature range of 260-310 degrees F when added to the aggregate.

3.2 PREPARATION OF MINERAL AGGREGATE

Heat and dry the aggregate for the mixture prior to mixing. No damage shall occur to the aggregates due to the maximum temperature and rate of heating used. The temperature of the aggregate and mineral filler shall not exceed 350 degrees F when the asphalt cement is added. 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.

3.3 PREPARATION OF HOT-MIX ASPHALT MIXTURE

The aggregates and the asphalt cement shall be weighed or metered and introduced into the mixer in the amount specified by the JMF. Mix the combined materials 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 no less than 25 seconds for batch plants. Establish the wet mixing time for all plants based on the procedure for determining the percentage of coated particles described in ASTM D2489/D2489M, for each individual plant and for each type of aggregate used. The wet mixing time will be set to at least achieve 95 percent of coated particles. The moisture content of all hot-mix asphalt upon discharge from the plant shall not exceed 0.5 percent by total weight of mixture as measured by ASTM D1461.

3.4 PREPARATION OF THE UNDERLYING SURFACE

Immediately before placing the hot mix asphalt, clean the underlying course of dust and debris. Apply a tack coat in accordance with the contract specifications to all existing or new asphalt or concrete layers.

3.5 TEST SECTION

Prior to full production, place a test section for each JMF used. Construct a test section 250 - 500 feet long and two paver passes wide

placed for two lanes, with a longitudinal cold joint. The test section shall be of the same thickness as the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment and personnel used in construction of the test section shall be the same equipment to be used on the remainder of the course represented by the test section. Place the test section as part of the project pavement, as approved by the Contracting Officer.

3.5.1 Sampling and Testing for Test Section

Take one random sample at the plant, triplicate specimens compacted, and tested for stability, flow, and laboratory air voids. Test a portion of the same sample for theoretical maximum density (TMD), aggregate gradation and asphalt content. Take four randomly selected cores from the finished pavement mat, and four from the longitudinal joint, and test for density. Random sampling shall be in accordance with procedures contained in ASTM D3665. The test results shall be within the tolerances shown in Table 7 for work to continue. If all test results meet the specified requirements, the test section shall remain as part of the project pavement. If test results exceed the tolerances shown, the test section shall be removed and replaced at no cost to the Government and another test section shall be constructed. The test section shall be paid for with the first lot of paving.

Table 7. Test Section Requirements for Material and Mixture Properties

<u>Property</u>	<u>Specification Limit</u>
Aggregate Gradation-Percent Passing (Individual Test Result)	
No. 4 and larger	JMF plus or minus 8
No. 8, No. 16, No. 30, and No. 50	JMF plus or minus 6
No. 100 and No. 200	JMF plus or minus 2.0
Asphalt Content, Percent (Individual Test Result)	JMF plus or minus 0.5
Laboratory Air Voids, Percent (Average of 3 specimens)	JMF plus or minus 1.0
VMA, Percent (Average of 3 specimens)	14 minimum
Flow, 0.01 inches (Average of 3 specimens)	8 - 18 for 50 blows
Mat Density, Percent of TMD (Average of 4 Random Cores)	92.0 - 96.0
Joint Density, Percent of TMD (Average of 4 Random Cores)	90.5 - 92.5

3.5.2 Additional Test Sections

If the initial test section should prove to be unacceptable, make the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures and place a second test section. Additional test

sections, as required, shall be constructed and evaluated for conformance to the specifications. Full production shall not begin until an acceptable section has been constructed and accepted.

3.6 TESTING LABORATORY

Submit certification of compliance and Plant Scale Calibration Certification. Use a laboratory to develop the JMF that meets the requirements of ASTM D3666. The Government will inspect the laboratory equipment and test procedures prior to the start of hot mix operations for conformance to ASTM D3666. The laboratory shall maintain the Corps certification for the duration of the project. A statement signed by the manager of the laboratory stating that it meets these requirements or clearly listing all deficiencies shall be submitted to the Contracting Officer prior to the start of construction. The statement shall contain as a minimum:

- a. Qualifications of personnel; laboratory manager, supervising technician, and testing technicians.
- b. A listing of equipment to be used in developing the job mix.
- c. Acopy of the laboratory's quality control system.
- d. Evidence of participation in the AASHTO Materials Reference Laboratory (AMRL) program.

3.7 TRANSPORTING AND PLACING

3.7.1 Transporting

Transport the hot-mix asphalt from the mixing plant to the site in clean, tight vehicles. Schedule deliveries so that placing and compacting of mixture is uniform with minimum stopping and starting of the paver. Provide adequate artificial lighting for night placements. Hauling over freshly placed material will not be permitted until the material has been compacted as specified, and allowed to cool to 140 degrees F. To deliver mix to the paver, use a material transfer vehicle operated to produce continuous forward motion of the paver.

3.7.2 Placing

Place and compact the mix at a temperature suitable for obtaining density, surface smoothness, and other specified requirements. Upon arrival, place the mixture to the full width by an asphalt paver; it shall be struck off in a uniform layer of such depth that, when the work is completed, it will have the required thickness and conform to the grade and contour indicated. Regulate the speed of the paver to eliminate pulling and tearing of the asphalt mat. Unless otherwise permitted, placement of the mixture shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. Place the mixture in consecutive adjacent strips having a minimum width of 10 feet. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot; however, the joint in the surface course shall be at the centerline of the pavement. 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 isolated areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical,

the mixture may be spread and luted by hand tools.

3.8 COMPACTION OF MIXTURE

After placing, the mixture shall be thoroughly and uniformly compacted by rolling. Compact the surface as soon as possible without causing displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once. Furnish sufficient rollers to handle the output of the plant. Continue rolling until the surface is of uniform texture, true to grade and cross section, and the required field density is obtained. To prevent adhesion of the mixture to the roller, keep the wheels properly moistened but excessive water will not be permitted. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers. Any mixture that becomes loose and broken, mixed with dirt, contains check-cracking, or is in any way defective shall be removed full depth, 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 will not be allowed.

3.9 JOINTS

The formation of joints shall be performed ensuring a continuous bond between the courses and to 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.

3.9.1 Transverse Joints

Do not pass the roller over the unprotected end of the freshly laid mixture, 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 material at the joint. Remove the cutback material from the project. In both methods, all contact surfaces shall be given a light tack coat of asphalt material before placing any fresh mixture against the joint.

3.9.2 Longitudinal Joints

Longitudinal joints which are irregular, damaged, uncompacted, cold (less than 175 degrees F at the time of placing adjacent lanes), or otherwise defective, shall be cut back a maximum of 3 inches from the top of the course with a cutting wheel to expose a clean, sound vertical surface for the full depth of the course. All cutback material shall be removed from the project. All contact surfaces shall be given a light tack coat of asphalt material prior to placing any fresh mixture against the joint. The Contractor will be allowed to use an alternate method if it can be demonstrated that density, smoothness, and texture can be met.

3.10 CONTRACTOR QUALITY CONTROL

3.10.1 General Quality Control Requirements

Develop and submit an approved Quality Control Plan. Submit aggregate and

QC test results. Do not produce hot-mix asphalt for payment until the quality control plan has been approved addressing all elements which affect the quality of the pavement including, but not limited to:

- a. Mix Design
- b. Aggregate Grading
- c. Quality of Materials
- d. Stockpile Management
- e. Proportioning
- f. Mixing and Transportation
- g. Mixture Volumetrics
- h. Moisture Content of Mixtures
- i. Placing and Finishing
- j. Joints
- k. Compaction
- l. Surface Smoothness

3.10.2 Testing Laboratory

Provide a fully equipped asphalt laboratory located at the plant or job site and meeting the pertinent requirements in ASTM D3666. Laboratory facilities shall be kept clean and all equipment maintained in proper working condition. The Contracting Officer shall be permitted unrestricted access to inspect the Contractor's laboratory facility, to witness quality control activities, and to perform any check testing desired. The Contracting Officer will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to adversely affect test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are corrected.

3.10.3 Quality Control Testing

Perform all quality control tests applicable to these specifications and as set forth in the Quality Control Program. The testing program shall include, but shall not be limited to, tests for the control of asphalt content, aggregate gradation, temperatures, aggregate moisture, moisture in the asphalt mixture, laboratory air voids, in-place density, grade and smoothness. Develop a Quality Control Testing Plan as part of the Quality Control Program.

3.10.3.1 Asphalt Content

A minimum of two tests to determine asphalt content will be performed per lot (a lot is defined in paragraph MATERIAL ACCEPTANCE and PERCENT PAYMENT) by one of the following methods: the extraction method in accordance with ASTM D2172/D2172M, Method A or B, the ignition method in accordance with

ASTM D6307, or the nuclear method in accordance with ASTM D4125/D4125M. Calibrate the ignition oven or the nuclear gauge for the specific mix being used. For the extraction method, determine the weight of ash, as described in ASTM D2172/D2172M, as part of the first extraction test performed at the beginning of plant production; and as part of every tenth extraction test performed thereafter, for the duration of plant production. The last weight of ash value obtained shall be used in the calculation of the asphalt content for the mixture.

3.10.3.2 Gradation

Determine aggregate gradations a minimum of twice per lot from mechanical analysis of recovered aggregate in accordance with ASTM D5444. When asphalt content is determined by the ignition oven or nuclear method, aggregate gradation shall be determined from hot bin samples on batch plants, or from the cold feed on drum mix plants. For batch plants, test aggregates in accordance with ASTM C136 using actual batch weights to determine the combined aggregate gradation of the mixture.

3.10.3.3 Temperatures

Check temperatures at least four times per lot, at necessary locations, to determine the temperature at the dryer, the asphalt cement in the storage tank, the asphalt mixture at the plant, and the asphalt mixture at the job site.

3.10.3.4 Aggregate Moisture

Determine the moisture content of aggregate used for production a minimum of once per lot in accordance with ASTM C566.

3.10.3.5 Moisture Content of Mixture

Determine the moisture content of the mixture at least once per lot in accordance with ASTM D1461 or an approved alternate procedure.

3.10.3.6 Laboratory Air Voids, Marshall Stability and Flow

Take mixture samples at least four times per lot compacted into specimens. When the Superpave gyratory compactor is used, mixes will be compacted to 50 gyrations in accordance with ASTM D6925. Hot-mix shall be compacted in accordance with the DOT requirements. After compaction, determine the laboratory air voids of each specimen.

3.10.3.7 In-Place Density

Conduct any necessary testing to ensure the specified density is achieved. A nuclear gauge may be used to monitor pavement density in accordance with ASTM D2950/D2950M.

3.10.3.8 Grade and Smoothness

Conduct the necessary checks to ensure the grade and smoothness requirements are met in accordance with paragraphs MATERIAL ACCEPTANCE and PERCENT PAYMENT.

3.10.3.9 Additional Testing

Any additional testing, which the Contractor deems necessary to control the

process, may be performed at the Contractor's option.

3.10.3.10 QC Monitoring

Submit all QC test results to the Contracting Officer on a daily basis as the tests are performed. The Contracting Officer reserves the right to monitor any of the Contractor's quality control testing and to perform duplicate testing as a check to the Contractor's quality control testing.

3.10.4 Sampling

When directed by the Contracting Officer, sample and test any material which appears inconsistent with similar material being produced, unless such material is voluntarily removed and replaced or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

3.10.5 Control Charts

For process control, establish and maintain linear control charts on both individual samples and the running average of last four samples for the parameters listed in Table 8, as a minimum. These control charts shall be posted as directed by the Contracting Officer and kept current at all times. The control charts shall identify the project number, the test parameter being plotted, the individual sample numbers, the Action and Suspension Limits listed in Table 8 applicable to the test parameter being plotted, and the Contractor's test results. Target values from the JMF shall also be shown on the control charts as indicators of central tendency for the cumulative percent passing, asphalt content, and laboratory air voids parameters. When the test results exceed either applicable Action Limit, take immediate steps to bring the process back in control. When the test results exceed either applicable Suspension Limit, halt production until the problem is solved. Use the control charts as part of the process control system for identifying trends so that potential problems can be corrected before they occur. Make decisions concerning mix modifications based on analysis of the results provided in the control charts. The Quality Control Plan shall indicate the appropriate action to be taken to bring the process into control when certain parameters exceed their Action Limits.

Table 8. Action and Suspension Limits for the Parameters to be Plotted on Individual and Running Average Control Charts

Parameter to be Plotted	<u>Individual Samples</u>		<u>Running Average of Last Four Samples</u>	
	Action Limit	Suspension Limit	Action Limit	Suspension Limit
No. 4 sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	6	8	4	5
No. 30 sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	4	6	3	4
No. 200 sieve, Cumulative % Passing, deviation from JMF target; plus or minus values	1.4	2.0	1.1	1.5
Asphalt content, % deviation from JMF target; plus or minus value	0.4	0.5	0.2	0.3
Laboratory Air Voids, % deviation from JMF target value	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Mat Density, % of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment			
In-place Joint Density, % of TMD	No specific action and suspension limits set since this parameter is used to determine percent payment			

3.11 MATERIAL ACCEPTANCE

Testing for acceptability of work will be performed by an independent laboratory hired by the Contractor. Forward test results and payment calculations daily to the Contracting Officer. Acceptance of the plant produced mix and in-place requirements will be on a lot to lot basis. A standard lot for all requirements will be equal to 8 hours of production. Where appropriate, adjustment in payment for individual lots of hot-mix asphalt will be made based on in-place density, laboratory air voids, grade and smoothness in accordance with the following paragraphs. Grade and surface smoothness determinations will be made on the lot as a whole. Exceptions or adjustments to this will be made in situations where the mix within one lot is placed as part of both the intermediate and surface courses, thus grade and smoothness measurements for the entire lot cannot be made. In order to evaluate laboratory air voids and in-place (field) density, each lot will be divided into four equal sublots.

3.11.1 Sublot Sampling

One random mixture sample for determining laboratory air voids, theoretical maximum density, and for any additional testing the Contracting Officer desires, will be taken from a loaded truck delivering mixture to each subplot, or other appropriate location for each subplot. All samples will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs. Laboratory air voids will be determined from three laboratory compacted specimens of each subplot sample in accordance with ASTM D6926. The specimens will be compacted within 2 hours of the time the mixture was loaded into trucks at the asphalt plant. Samples will not be reheated prior to compaction and insulated containers will be used as necessary to maintain the temperature.

3.11.2 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. The cost of any additional testing will be paid for by the Government. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot.

3.11.3 Grade

The final wearing surface of pavement shall conform to the elevations and cross sections shown and shall vary not more than 0.05 foot from the plan grade established and approved at site of work. Finished surfaces at juncture with other pavements shall coincide with finished surfaces of abutting pavements. Deviation from the plan elevation will not be permitted in areas of pavements where closer conformance with planned elevation is required for the proper functioning of drainage and other appurtenant structures involved. The grade will be determined by running lines of levels at intervals of 25 feet, or less, longitudinally and transversely, to determine the elevation of the completed pavement surface. Within 5 working days, after the completion of a particular lot incorporating the final wearing surface, test the final wearing surface of the pavement for conformance with the specified plan grade. Diamond grinding may be used to remove high spots to meet grade requirements. Skin patching for correcting low areas or planing or milling for correcting high areas will not be permitted.

3.11.4 Surface Smoothness

Use one of the following methods to test and evaluate surface smoothness of the pavement. Perform all testing in the presence of the Contracting Officer. Keep detailed notes of the results of the testing and furnish a copy to the Government immediately after each day's testing. Where drawings show required deviations from a plane surface (crowns, drainage inlets, etc.), the surface shall be finished to meet the approval of the Contracting Officer.

3.11.4.1 Smoothness Requirements

- a. Straightedge Testing: The finished surfaces of the pavements shall have no abrupt change of 1/4 inch or more, and all pavements shall be within the tolerances of 1/4 inch in both the longitudinal and transverse directions, when tested with an approved 12 feet straightedge.

- b. Profilograph Testing: The finished surfaces of the pavements shall have no abrupt change of 1/8 inch or more, and each 0.1 mile segment of each pavement lot shall have a Profile Index not greater than 9 inches/mile when tested with an approved California-type profilograph. If the extent of the pavement in either direction is less than 200 feet, that direction shall be tested by the straightedge method and shall meet requirements specified above.

3.11.4.2 Testing Method

After the final rolling, but not later than 24 hours after placement, test the surface of the pavement in each entire lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. Separate testing of individual sublots is not required. If any pavement areas are ground, these areas shall be retested immediately after grinding. Test each lot of the pavement in both a longitudinal and a transverse direction on parallel lines. Set the transverse lines 15 feet or less apart, as directed. The longitudinal lines shall be at the centerline of each paving lane for lanes less than 20 feet wide and at the third points for lanes 20 feet or wider. Also test other areas having obvious deviations. Longitudinal testing lines shall be continuous across all joints.

- a. Straightedge Testing. Hold the straightedge in contact with the surface and move it ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points.
- b. Profilograph Testing. Perform profilograph testing using approved equipment and procedures described in CTM 526. The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for each 0.1 mile segment of each pavement lot. Grade breaks on parking lots shall be accommodated by breaking the profile segment into shorter sections and repositioning the blanking band on each segment. The "blanking band" shall be 0.2 inches wide and the "bump template" shall span 1 inch with an offset of 0.3 inch. Compute the Profile Index for each pass of the profilograph in each 0.1 mile segment. The Profile Index for each segment shall be the average of the Profile Indices for each pass in each segment. The profilograph shall be operated by a DOT approved operator. Furnish a copy of the reduced tapes to the Government at the end of each day's testing.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 16 13

CONCRETE SIDEWALKS AND CURBS AND GUTTERS

04/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SYSTEM DESCRIPTION
 - 1.2.1 General Requirements
 - 1.2.2 Slip Form Equipment
- 1.3 SUBMITTALS
- 1.4 ENVIRONMENTAL REQUIREMENTS
 - 1.4.1 Placing During Cold Weather
 - 1.4.2 Placing During Warm Weather

PART 2 PRODUCTS

- 2.1 CONCRETE
 - 2.1.1 Air Content
 - 2.1.2 Slump
 - 2.1.3 Reinforcement Steel
- 2.2 CONCRETE CURING MATERIALS
 - 2.2.1 Impervious Sheet Materials
 - 2.2.2 Burlap
 - 2.2.3 White Pigmented Membrane-Forming Curing Compound
- 2.3 CONCRETE PROTECTION MATERIALS
- 2.4 JOINT FILLER STRIPS
 - 2.4.1 Contraction Joint Filler for Curb and Gutter
 - 2.4.2 Expansion Joint Filler, Premolded
- 2.5 JOINT SEALANTS
- 2.6 FORM WORK
 - 2.6.1 Sidewalk Forms
 - 2.6.2 Curb and Gutter Forms

PART 3 EXECUTION

- 3.1 SUBGRADE PREPARATION
 - 3.1.1 Sidewalk Subgrade
 - 3.1.2 Curb and Gutter Subgrade
 - 3.1.3 Maintenance of Subgrade
- 3.2 FORM SETTING
 - 3.2.1 Sidewalks
 - 3.2.2 Curbs and Gutters
- 3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING
 - 3.3.1 Formed Sidewalks
 - 3.3.2 Concrete Finishing
 - 3.3.3 Edge and Joint Finishing
 - 3.3.4 Surface and Thickness Tolerances
- 3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING
 - 3.4.1 Formed Curb and Gutter

- 3.4.2 Curb and Gutter Finishing
- 3.4.3 Concrete Finishing
- 3.4.4 Joint Finishing
- 3.4.5 Surface and Thickness Tolerances
- 3.5 SIDEWALK JOINTS
 - 3.5.1 Sidewalk Contraction Joints
 - 3.5.2 Sidewalk Expansion Joints
 - 3.5.3 Reinforcement Steel Placement
- 3.6 CURB AND GUTTER JOINTS
 - 3.6.1 Contraction Joints
 - 3.6.2 Expansion Joints
- 3.7 CURING AND PROTECTION
 - 3.7.1 General Requirements
 - 3.7.1.1 Impervious Sheeting Method
 - 3.7.1.2 Membrane Curing Method
 - 3.7.2 Backfilling
 - 3.7.3 Protection
 - 3.7.4 Protective Coating
 - 3.7.4.1 Application
 - 3.7.4.2 Precautions
- 3.8 FIELD QUALITY CONTROL
 - 3.8.1 General Requirements
 - 3.8.2 Concrete Testing
 - 3.8.2.1 Strength Testing
 - 3.8.2.2 Air Content
 - 3.8.2.3 Slump Test
 - 3.8.3 Thickness Evaluation
 - 3.8.4 Surface Evaluation
- 3.9 SURFACE DEFICIENCIES AND CORRECTIONS
 - 3.9.1 Thickness Deficiency
 - 3.9.2 High Areas
 - 3.9.3 Appearance

-- End of Section Table of Contents --

SECTION 32 16 13

CONCRETE SIDEWALKS AND CURBS AND GUTTERS

04/08

PART 1 GENERAL

1.1 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 M 182 (2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM A185/A185M (2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

ASTM A615/A615M (2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM C143/C143M (2012) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C171 (2007) Standard Specification for Sheet Materials for Curing Concrete

ASTM C172/C172M (2010) Standard Practice for Sampling Freshly Mixed Concrete

ASTM C173/C173M (2012) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C231/C231M (2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C309 (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C31/C31M (2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C920 (2011) Standard Specification for Elastomeric Joint Sealants

ASTM D1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D5893/D5893M	(2010) Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
NDDOT SS	(2008) Standard Specifications for Road and Bridge Construction

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Provide plant, equipment, machines, and tools used in the work subject to approval and maintained in a satisfactory working condition at all times. The equipment shall have the capability of producing the required product, meeting grade controls, thickness control and smoothness requirements as specified. Use of the equipment shall be discontinued if it produces unsatisfactory results. The Contracting Officer shall have access at all times to the plant and equipment to ensure proper operation and compliance with specifications.

1.2.2 Slip Form Equipment

Slip form paver or curb forming machine, will be approved based on trial use on the job and shall be self-propelled, automatically controlled, crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Concrete

SD-06 Test Reports

Field Quality Control

1.4 ENVIRONMENTAL REQUIREMENTS

1.4.1 Placing During Cold Weather

Do not place concrete when the air temperature reaches 40 degrees F and is falling, or is already below that point. Placement may begin when the air temperature reaches 35 degrees F and is rising, or is already above 40

degrees F. Make provisions to protect the concrete from freezing during the specified curing period. If necessary to place concrete when the temperature of the air, aggregates, or water is below 35 degrees F, placement and protection shall be approved in writing. Approval will be contingent upon full conformance with the following provisions. The underlying material shall be prepared and protected so that it is entirely free of frost when the concrete is deposited. Mixing water and aggregates shall be heated as necessary to result in the temperature of the in-place concrete being between 50 and 85 degrees F. Methods and equipment for heating shall be approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period.

1.4.2 Placing During Warm Weather

The temperature of the concrete as placed shall not exceed 85 degrees F except where an approved retarder is used. The mixing water and/or aggregates shall be cooled, if necessary, to maintain a satisfactory placing temperature. The placing temperature shall not exceed 95 degrees F at any time.

PART 2 PRODUCTS

2.1 CONCRETE

Provide concrete conforming to the applicable requirements of Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE except as otherwise specified. Concrete shall have a minimum compressive strength of 4000 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inches. Submit copies of certified delivery tickets for all concrete used in the construction.

2.1.1 Air Content

Mixtures shall have air content by volume of concrete of 5 to 7 percent, based on measurements made immediately after discharge from the mixer.

2.1.2 Slump

The concrete slump for slipform shall be 2 inches plus or minus 1 inch where determined in accordance with ASTM C143/C143M. The concrete slump for hard placed concrete shall be 3 inches.

2.1.3 Reinforcement Steel

Reinforcement bars shall conform to ASTM A615/A615M.

2.2 CONCRETE CURING MATERIALS

2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C171, type optional, except that polyethylene film, if used, shall be white opaque.

2.2.2 Burlap

Burlap shall conform to AASHTO M 182.

2.2.3 White Pigmented Membrane-Forming Curing Compound

White pigmented membrane-forming curing compound shall conform to ASTM C309, Type 2.

2.3 CONCRETE PROTECTION MATERIALS

Concrete protection materials shall be a linseed oil mixture of equal parts, by volume, of linseed oil and either mineral spirits, naphtha, or turpentine. At the option of the Contractor, commercially prepared linseed oil mixtures, formulated specifically for application to concrete to provide protection against the action of deicing chemicals may be used, except that emulsified mixtures are not acceptable.

2.4 JOINT FILLER STRIPS

2.4.1 Contraction Joint Filler for Curb and Gutter

Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

2.4.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D1751 or ASTM D1752, 1/2 inch thick, unless otherwise indicated.

2.5 JOINT SEALANTS

Joint sealant, cold-applied shall conform to ASTM C920 or ASTM D5893/D5893M.

2.6 FORM WORK

Design and construct form work to ensure that the finished concrete will conform accurately to the indicated dimensions, lines, and elevations, and within the tolerances specified. Forms shall be of wood or steel, straight, of sufficient strength to resist springing during depositing and consolidating concrete. Wood forms shall be surfaced plank, 2 inch nominal thickness, straight and free from warp, twist, loose knots, splits or other defects. Wood forms shall have a nominal length of 10 feet. Radius bends may be formed with 3/4 inch boards, laminated to the required thickness. Steel forms shall be channel-formed sections with a flat top surface and with welded braces at each end and at not less than two intermediate points. Ends of steel forms shall be interlocking and self-aligning. Steel forms shall include flexible forms for radius forming, corner forms, form spreaders, and fillers. Steel forms shall have a nominal length of 10 feet with a minimum of 3 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

2.6.1 Sidewalk Forms

Sidewalk forms shall be of a height equal to the full depth of the finished sidewalk.

2.6.2 Curb and Gutter Forms

Curb and gutter outside forms shall have a height equal to the full depth of the curb or gutter. The inside form of curb shall have batter as indicated and shall be securely fastened to and supported by the outside

form. Rigid forms shall be provided for curb returns, except that benders or thin plank forms may be used for curb or curb returns with a radius of 10 feet or more, where grade changes occur in the return, or where the central angle is such that a rigid form with a central angle of 90 degrees cannot be used. Back forms for curb returns may be made of 1-1/2 inch benders, for the full height of the curb, cleated together. In lieu of inside forms for curbs, a curb "mule" may be used for forming and finishing this surface, provided the results are approved.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

The subgrade shall be constructed to the specified grade and cross section prior to concrete placement. Subgrade shall be placed and compacted in conformance with Section 31 00 00 EARTHWORK.

3.1.1 Sidewalk Subgrade

The subgrade shall be tested for grade and cross section with a template extending the full width of the sidewalk and supported between side forms.

3.1.2 Curb and Gutter Subgrade

The subgrade shall be tested for grade and cross section by means of a template extending the full width of the curb and gutter. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement.

3.1.3 Maintenance of Subgrade

The subgrade shall be maintained in a smooth, compacted condition in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed. The subgrade shall be prepared and protected to produce a subgrade free from frost when the concrete is deposited.

3.2 FORM SETTING

Set forms to the indicated alignment, grade and dimensions. Hold forms rigidly in place by a minimum of 3 stakes per form placed at intervals not to exceed 4 feet. Corners, deep sections, and radius bends shall have additional stakes and braces, as required. Clamps, spreaders, and braces shall be used where required to ensure rigidity in the forms. Forms shall be removed without injuring the concrete. Bars or heavy tools shall not be used against the concrete in removing the forms. Any concrete found defective after form removal shall be promptly and satisfactorily repaired. Forms shall be cleaned and coated with form oil each time before concrete is placed. Wood forms may, instead, be thoroughly wetted with water before concrete is placed, except that with probable freezing temperatures, oiling is mandatory.

3.2.1 Sidewalks

Set forms for sidewalks with the upper edge true to line and grade with an allowable tolerance of 1/8 inch in any 10 foot long section. After forms are set, grade and alignment shall be checked with a 10 foot straightedge. Forms shall have a transverse slope of 1/4 inch per foot with the low side adjacent to the roadway. Side forms shall not be removed for 12 hours

after finishing has been completed.

3.2.2 Curbs and Gutters

The forms of the front of the curb shall be removed not less than 2 hours nor more than 6 hours after the concrete has been placed. Forms in back of curb shall remain in place until the face and top of the curb have been finished, as specified for concrete finishing. Gutter forms shall not be removed while the concrete is sufficiently plastic to slump in any direction.

3.3 SIDEWALK CONCRETE PLACEMENT AND FINISHING

3.3.1 Formed Sidewalks

Place concrete in the forms in one layer. When consolidated and finished, the sidewalks shall be of the thickness indicated. After concrete has been placed in the forms, a strike-off guided by side forms shall be used to bring the surface to proper section to be compacted. The concrete shall be consolidated by tamping and spading or with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, finish the surface with a wood or magnesium float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks. A scored surface shall be produced by brooming with a fiber-bristle brush in a direction transverse to that of the traffic, followed by edging.

3.3.3 Edge and Joint Finishing

All slab edges, including those at formed joints, shall be finished with an edger having a radius of 1/8 inch. Transverse joint shall be edged before brooming, and the brooming shall eliminate the flat surface left by the surface face of the edger. Corners and edges which have crumbled and areas which lack sufficient mortar for proper finishing shall be cleaned and filled solidly with a properly proportioned mortar mixture and then finished.

3.3.4 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 5/16 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.4 CURB AND GUTTER CONCRETE PLACEMENT AND FINISHING

3.4.1 Formed Curb and Gutter

Concrete shall be placed to the section required in a single lift. Consolidation shall be achieved by using approved mechanical vibrators. Curve shaped gutters shall be finished with a standard curb "mule".

3.4.2 Curb and Gutter Finishing

Approved slipformed curb and gutter machines may be used in lieu of hand placement.

3.4.3 Concrete Finishing

Exposed surfaces shall be floated and finished with a smooth wood float until true to grade and section and uniform in texture. Floated surfaces shall then be brushed with a fine-hair brush with longitudinal strokes. The edges of the gutter and top of the curb shall be rounded with an edging tool to a radius of 1/2 inch. Immediately after removing the front curb form, the face of the curb shall be rubbed with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The front curb surface, while still wet, shall be brushed in the same manner as the gutter and curb top. The top surface of gutter and entrance shall be finished to grade with a wood float.

3.4.4 Joint Finishing

Curb edges at formed joints shall be finished as indicated.

3.4.5 Surface and Thickness Tolerances

Finished surfaces shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge. Permissible deficiency in section thickness will be up to 1/4 inch.

3.5 SIDEWALK JOINTS

Sidewalk joints shall be constructed to divide the surface into rectangular areas. Transverse contraction joints shall be spaced at a distance equal to the sidewalk width or 5 feet on centers, whichever is less, and shall be continuous across the slab. Longitudinal contraction joints shall be constructed along the centerline of all sidewalks 10 feet or more in width. Transverse expansion joints shall be installed at sidewalk returns and opposite expansion joints in adjoining curbs. Where the sidewalk is not in contact with the curb, transverse expansion joints shall be installed as indicated. Expansion joints shall be formed about structures and features which project through or into the sidewalk pavement, using joint filler of the type, thickness, and width indicated. Expansion joints are not required between sidewalks and curb that abut the sidewalk longitudinally.

3.5.1 Sidewalk Contraction Joints

The contraction joints shall be formed in the fresh concrete by cutting a groove in the top portion of the slab to a depth of at least one-fourth of the sidewalk slab thickness, using a jointer to cut the groove, or by sawing a groove in the hardened concrete with a power-driven saw, unless otherwise approved. Sawed joints shall be constructed by sawing a groove in the concrete with a 1/8 inch blade to the depth indicated. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operations.

3.5.2 Sidewalk Expansion Joints

Expansion joints shall be formed with 1/2 inch joint filler strips. Joint filler in expansion joints surrounding structures and features within the sidewalk may consist of preformed filler material conforming to ASTM D1752 or building paper. Joint filler shall be held in place with steel pins or

other devices to prevent warping of the filler during floating and finishing. Immediately after finishing operations are completed, joint edges shall be rounded with an edging tool having a radius of 1/8 inch, and concrete over the joint filler shall be removed. At the end of the curing period, expansion joints shall be cleaned and filled with cold-applied joint sealant. Joint sealant shall be gray or stone in color. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.5.3 Reinforcement Steel Placement

Reinforcement steel shall be accurately and securely fastened in place with suitable supports and ties before the concrete is placed.

3.6 CURB AND GUTTER JOINTS

Curb and gutter joints shall be constructed at right angles to the line of curb and gutter.

3.6.1 Contraction Joints

Contraction joints shall be constructed directly opposite contraction joints in abutting portland cement concrete pavements and spaced so that monolithic sections between curb returns will not be less than 5 feet nor greater than 15 feet in length.

- a. Contraction joints (except for slip forming) shall be constructed by means of 1/8 inch thick separators and of a section conforming to the cross section of the curb and gutter. Separators shall be removed as soon as practicable after concrete has set sufficiently to preserve the width and shape of the joint and prior to finishing.
- b. When slip forming is used, the contraction joints shall be cut in the top portion of the gutter/curb hardened concrete in a continuous cut across the curb and gutter, using a power-driven saw. The depth of cut shall be at least one-fourth of the gutter/curb depth and 1/8 inch in width.

3.6.2 Expansion Joints

Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb and gutter. Expansion joints shall be provided in curb and gutter directly opposite expansion joints of abutting portland cement concrete pavement, and shall be of the same type and thickness as joints in the pavement. Where curb and gutter do not abut portland cement concrete pavement, expansion joints at least 1/2 inch in width shall be provided at intervals not less than 30 feet nor greater than 120 feet. Expansion joints shall be provided in nonreinforced concrete gutter at locations indicated. Expansion joints shall be sealed immediately following curing of the concrete or as soon thereafter as weather conditions permit. Expansion joints and the top 1 inch depth of curb and gutter contraction-joints shall be sealed with joint sealant. The joint opening shall be thoroughly cleaned before the sealing material is placed. Sealing material shall not be spilled on exposed surfaces of the concrete. Concrete at the joint shall be surface dry and

atmospheric and concrete temperatures shall be above 50 degrees F at the time of application of joint sealing material. Excess material on exposed surfaces of the concrete shall be removed immediately and concrete surfaces cleaned.

3.7 CURING AND PROTECTION

3.7.1 General Requirements

Protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. Protection shall be provided as necessary to prevent cracking of the pavement due to temperature changes during the curing period.

3.7.1.1 Impervious Sheeting Method

The entire exposed surface shall be wetted with a fine spray of water and then covered with impervious sheeting material. Sheets shall be laid directly on the concrete surface with the light-colored side up and overlapped 12 inches when a continuous sheet is not used. The curing medium shall not be less than 18-inches wider than the concrete surface to be cured, and shall be securely weighted down by heavy wood planks, or a bank of moist earth placed along edges and laps in the sheets. Sheets shall be satisfactorily repaired or replaced if torn or otherwise damaged during curing. The curing medium shall remain on the concrete surface to be cured for not less than 7 days.

3.7.1.2 Membrane Curing Method

A uniform coating of white-pigmented membrane-curing compound shall be applied to the entire exposed surface of the concrete as soon after finishing as the free water has disappeared from the finished surface. Formed surfaces shall be coated immediately after the forms are removed and in no case longer than 1 hour after the removal of forms. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water and the curing compound applied as soon as the free water disappears. Curing compound shall be applied in two coats by hand-operated pressure sprayers at a coverage of approximately 200 square feet/gallon for the total of both coats. The second coat shall be applied in a direction approximately at right angles to the direction of application of the first coat. The compound shall form a uniform, continuous, coherent film that will not check, crack, or peel and shall be free from pinholes or other imperfections. If pinholes, abrasion, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be resprayed. Necessary precautions shall be taken to insure that the concrete is properly cured at sawed joints, and that no curing compound enters the joints. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed before the concrete in the region of the joint is resprayed with curing compound. The method used for sealing the joint groove shall prevent loss of moisture from the joint during the entire specified curing period. Approved standby

facilities for curing concrete pavement shall be provided at a location accessible to the jobsite for use in the event of mechanical failure of the spraying equipment or other conditions that might prevent correct application of the membrane-curing compound at the proper time. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

3.7.2 Backfilling

After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted to conform to the surrounding area in accordance with lines and grades indicated.

3.7.3 Protection

Completed concrete shall be protected from damage until accepted. Repair damaged concrete and clean concrete discolored during construction. Concrete that is damaged shall be removed and reconstructed for the entire length between regularly scheduled joints. Refinishing the damaged portion will not be acceptable. Removed damaged portions shall be disposed of as directed.

3.7.4 Protective Coating

Protective coating, of linseed oil mixture, shall be applied to the exposed-to-view concrete surface after the curing period, if concrete will be exposed to de-icing chemicals within 6 weeks after placement. Concrete to receive a protective coating shall be moist cured.

3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying two coats of protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be by spray application at not more than 50 square yards/gallon for first application and not more than 70 square yards/gallon for second application, except that the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Coated surfaces shall be protected from vehicular and pedestrian traffic until dry.

3.7.4.2 Precautions

Protective coating shall not be heated by direct application of flame or electrical heaters and shall be protected from exposure to open flame, sparks, and fire adjacent to open containers or applicators. Material shall not be applied at ambient or material temperatures lower than 50 degrees F.

3.8 FIELD QUALITY CONTROL

Submit copies of all test reports within 24 hours of completion of the test.

3.8.1 General Requirements

Perform the inspection and tests described and meet the specified

requirements for inspection details and frequency of testing. Based upon the results of these inspections and tests, take the action and submit reports as required below, and any additional tests to insure that the requirements of these specifications are met.

3.8.2 Concrete Testing

3.8.2.1 Strength Testing

Provide molded concrete specimens for strength tests. Samples of concrete placed each day shall be taken not less than once a day nor less than once for every 250 cubic yards of concrete. The samples for strength tests shall be taken in accordance with ASTM C172/C172M. Cylinders for acceptance shall be molded in conformance with ASTM C31/C31M by an approved testing laboratory. Each strength test result shall be the average of 2 test cylinders from the same concrete sample tested at 28 days, unless otherwise specified or approved. Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength, and no individual strength test result falls below the specified strength by more than 500 psi.

3.8.2.2 Air Content

Determine air content in accordance with ASTM C173/C173M or ASTM C231/C231M. ASTM C231/C231M shall be used with concretes and mortars made with relatively dense natural aggregates. Two tests for air content shall be made on randomly selected batches of each class of concrete placed during each shift. Additional tests shall be made when excessive variation in concrete workability is reported by the placing foreman or the Government inspector. If results are out of tolerance, the placing foreman shall be notified and he shall take appropriate action to have the air content corrected at the plant. Additional tests for air content will be performed on each truckload of material until such time as the air content is within the tolerance specified.

3.8.2.3 Slump Test

Two slump tests shall be made on randomly selected batches of each class of concrete for every 250 cubic yards, or fraction thereof, of concrete placed during each shift. Additional tests shall be performed when excessive variation in the workability of the concrete is noted or when excessive crumbling or slumping is noted along the edges of slip-formed concrete.

3.8.3 Thickness Evaluation

The anticipated thickness of the concrete shall be determined prior to placement by passing a template through the formed section or by measuring the depth of opening of the extrusion template of the curb forming machine. If a slip form paver is used for sidewalk placement, the subgrade shall be true to grade prior to concrete placement and the thickness will be determined by measuring each edge of the completed slab.

3.8.4 Surface Evaluation

The finished surface of each category of the completed work shall be uniform in color and free of blemishes and form or tool marks.

3.9 SURFACE DEFICIENCIES AND CORRECTIONS

3.9.1 Thickness Deficiency

When measurements indicate that the completed concrete section is deficient in thickness by more than 1/4 inch the deficient section will be removed, between regularly scheduled joints, and replaced.

3.9.2 High Areas

In areas not meeting surface smoothness and plan grade requirements, high areas shall be reduced either by rubbing the freshly finished concrete with carborundum brick and water when the concrete is less than 36 hours old or by grinding the hardened concrete with an approved surface grinding machine after the concrete is 36 hours old or more. The area corrected by grinding the surface of the hardened concrete shall not exceed 5 percent of the area of any integral slab, and the depth of grinding shall not exceed 1/4 inch. Pavement areas requiring grade or surface smoothness corrections in excess of the limits specified above shall be removed and replaced.

3.9.3 Appearance

Exposed surfaces of the finished work will be inspected by the Government and any deficiencies in appearance will be identified. Areas which exhibit excessive cracking, discoloration, form marks, or tool marks or which are otherwise inconsistent with the overall appearances of the work shall be removed and replaced.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 17 24.00 10

PAVEMENT MARKINGS

04/08

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SYSTEM DESCRIPTION
 - 1.2.1 Paint Application Equipment
 - 1.2.1.1 Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines
 - 1.2.2 Reflective Media Dispenser
 - 1.2.3 Surface Preparation Equipment
 - 1.2.3.1 Sandblasting Equipment
 - 1.2.3.2 Waterblast Equipment
 - 1.2.4 Marking Removal Equipment
 - 1.2.4.1 Shotblasting Equipment
 - 1.2.4.2 Chemical Equipment
- 1.3 SUBMITTALS
- 1.4 QUALITY ASSURANCE
 - 1.4.1 Qualifications
 - 1.4.2 Traffic Controls
 - 1.4.3 Maintenance of Traffic
 - 1.4.3.1 Roads, Streets, and Parking Areas
- 1.5 DELIVERY, STORAGE, AND HANDLING
- 1.6 ENVIRONMENTAL REQUIREMENTS

PART 2 PRODUCTS

- 2.1 PAINT
- 2.2 REFLECTIVE MEDIA

PART 3 EXECUTION

- 3.1 SURFACE PREPARATION
 - 3.1.1 Cleaning Existing Pavement Markings
- 3.2 APPLICATION
 - 3.2.1 Paint
 - 3.2.1.1 Rate of Application
 - 3.2.1.2 Drying
 - 3.2.2 Reflective Media
- 3.3 MARKING REMOVAL
 - 3.3.1 Equipment Operation
 - 3.3.2 Cleanup and Waste Disposal

-- End of Section Table of Contents --

SECTION 32 17 24.00 10

PAVEMENT MARKINGS

04/08

PART 1 GENERAL

1.1 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 M 247 (2013) Standard Specification for Glass
Beads Used in Pavement Markings

ASTM INTERNATIONAL (ASTM)

ASTM D4280 (2012) Extended Life Type, Nonplowable,
Raised, Retroreflective Pavement Markers

ASTM D4505 (2012) Preformed Retroreflective Pavement
Marking Tape for Extended Service Life

ASTM D792 (2008) Density and Specific Gravity
(Relative Density) of Plastics by
Displacement

ASTM E28 (1999; R 2009) Softening Point of Resins
Derived from Naval Stores by Ring and Ball
Apparatus

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325 (Rev D; Notice 1) Beads (Glass Spheres)
Retro-Reflective (Metric)

FS TT-P-1952 (Rev E) Paint, Traffic and Airfield
Markings, Waterborne

1.2 SYSTEM DESCRIPTION

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Submit lists of proposed equipment, including descriptive data, and notifications of proposed Contractor actions as specified in this section. List of removal equipment shall include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

1.2.1 Paint Application Equipment

1.2.1.1 Self-Propelled or Mobile-Drawn Pneumatic Spraying Machines

The equipment to apply paint to pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. The machine shall have a speed during application not less than 5 mph, and shall be capable of applying the stripe widths indicated, at the paint coverage rate specified in paragraph APPLICATION, and of even uniform thickness with clear-cut edges. Equipment used for marking streets and highways shall be capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines or a combination of solid and intermittent lines using a maximum of two different colors of paint as specified. The paint applicator shall have paint reservoirs or tanks of sufficient capacity and suitable gauges to apply paint in accordance with requirements specified. Tanks shall be equipped with suitable air-driven mechanical agitators. The spray mechanism shall be equipped with quick-action valves conveniently located, and shall include necessary pressure regulators and gauges in full view and reach of the operator. Paint strainers shall be installed in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator shall be readily adaptable for attachment of an air-actuated dispenser for the reflective media approved for use. Pneumatic spray guns shall be provided for hand application of paint in areas where the mobile paint applicator cannot be used.

1.2.2 Reflective Media Dispenser

The dispenser for applying the reflective media shall be attached to the paint dispenser and shall operate automatically and simultaneously with the applicator through the same control mechanism. The dispenser shall be capable of adjustment and designed to provide uniform flow of reflective media over the full length and width of the stripe at the rate of coverage specified in paragraph APPLICATION, at all operating speeds of the applicator to which it is attached.

1.2.3 Surface Preparation Equipment

1.2.3.1 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. The compressor shall be capable of furnishing not less than 150 cfm of air at a pressure of not less than 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

1.2.3.2 Waterblast Equipment

The water pressure shall be specified at 2600 psi at 140 degrees F in order to adequately clean the surfaces to be marked.

1.2.4 Marking Removal Equipment

Equipment shall be mounted on rubber tires and shall be capable of removing markings from the pavement without damaging the pavement surface or joint sealant. Waterblasting equipment shall be capable of producing an adjustable, pressurized stream of water. Sandblasting equipment shall

include an air compressor, hoses, and nozzles. The compressor shall be equipped with traps to maintain the air free of oil and water.

1.2.4.1 Shotblasting Equipment

Shotblasting equipment shall be capable of producing an adjustable depth of removal of marking and pavement. Each unit shall be self-cleaning and self-contained, shall be able to confine dust and debris from the operation, and shall be capable of recycling the abrasive for reuse.

1.2.4.2 Chemical Equipment

Chemical equipment shall be capable of application and removal of chemicals from the pavement surface, and shall leave only non-toxic biodegradable residue.

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

- Equipment
- Composition Requirements
- Qualifications

SD-06 Test Reports

- Sampling and Testing

SD-07 Certificates

- Volatile Organic Compound (VOC)

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of chemicals.

1.4.2 Traffic Controls

Suitable warning signs shall be placed near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Small markers shall be placed along newly painted lines or freshly placed raised markers to control traffic and prevent damage to newly painted surfaces or displacement of raised pavement markers. Painting equipment shall be marked with large warning signs indicating slow-moving painting equipment in operation.

1.4.3 Maintenance of Traffic

1.4.3.1 Roads, Streets, and Parking Areas

When traffic must be rerouted or controlled to accomplish the work, the necessary warning signs, flagpersons, and related equipment for the safe passage of vehicles shall be provided.

1.5 DELIVERY, STORAGE, AND HANDLING

All materials shall be delivered and stored in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, and directions, all of which shall be plainly legible at time of use.

1.6 ENVIRONMENTAL REQUIREMENTS

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting. Operation shall cease during thunderstorms. Operation shall cease during rainfall, except for waterblasting and removal of previously applied chemicals. Waterblasting shall cease where surface water accumulation alters the effectiveness of material removal.

PART 2 PRODUCTS

2.1 PAINT

The paint shall be homogeneous, easily stirred to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of 6 months. Paints for roads, parking areas, and streets shall conform to FS TT-P-1952, color as indicated. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.

2.2 REFLECTIVE MEDIA

Reflective media for roads and streets shall conform to FS TT-B-1325, Type I, Gradation A or AASHTO M 247, Type I.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Thoroughly clean surfaces to be marked before application of the pavement marking material. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water or a combination of these methods as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion as directed. Areas of old pavement affected with oil or grease shall be scrubbed with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinsed thoroughly after each application. After cleaning, oil-soaked areas shall be sealed with cut shellac to prevent bleeding through the new paint. Pavement surfaces shall be allowed to dry, when water is used for cleaning, prior to striping or marking. Surfaces shall be re-cleaned, when work has been stopped due to rain.

3.1.1 Cleaning Existing Pavement Markings

In general, markings shall not be placed over existing pavement marking patterns. Remove existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns.

Deteriorated or obscured markings that are not misleading or confusing or interfere with the adhesion of the new marking material do not require removal. New preformed and thermoplastic pavement markings shall not be applied over existing preformed or thermoplastic markings. Whenever grinding, scraping, sandblasting or other operations are performed the work must be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans.

3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Paint temperature shall be maintained within these same limits. New asphalt pavement surfaces and new Portland concrete cement shall be allowed to cure for a period of not less than 30 days before applications of paint. Paint shall be applied pneumatically with approved equipment at rate of coverage specified. Provide guide lines and templates as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols. Edges of markings shall be sharply outlined.

3.2.1.1 Rate of Application

- a. Reflective Markings: Pigmented binder shall be applied evenly to the pavement area to be coated at a rate of 105 plus or minus 5 square feet/gallon. Glass spheres shall be applied uniformly to the wet paint on road and street pavement at a rate of 0.5 pounds of glass spheres per gallon of paint.

3.2.1.2 Drying

The maximum drying time requirements of the paint specifications will be strictly enforced to prevent undue softening of bitumen, and pickup, displacement, or discoloration by tires of traffic. If there is a delay in drying of the markings, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.2.2 Reflective Media

Application of reflective media shall immediately follow application of pigmented binder. Drop-on application of glass spheres shall be accomplished to insure that reflective media is evenly distributed at the specified rate of coverage. Should there be malfunction of either paint applicator or reflective media dispenser, operations shall be discontinued immediately until deficiency is corrected.

3.3 MARKING REMOVAL

Pavement marking, including plastic tape, shall be removed in the areas shown on the drawings. Removal of marking shall be as complete as possible without damage to the surface. Aggregate shall not be exposed by the removal process. After the markings are removed, the cleaned pavement

surfaces shall exhibit adequate texture for remarking as specified in paragraph SURFACE PREPARATION. Demonstrate removal of pavement marking in an area designated by the Contracting Officer. The demonstration area will become the standard for the remainder of the work.

3.3.1 Equipment Operation

Equipment shall be controlled and operated to remove markings from the pavement surface, prevent dilution or removal of binder from underlying pavement, and prevent emission of blue smoke from asphalt or tar surfaces.

3.3.2 Cleanup and Waste Disposal

The worksite shall be kept clean of debris and waste from the removal operations. Cleanup shall immediately follow removal operations in areas subject to air traffic. Debris shall be disposed of at approved sites.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 92 19

SEEDING

10/06

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DEFINITIONS
 - 1.2.1 Stand of Turf
- 1.3 RELATED REQUIREMENTS
- 1.4 SUBMITTALS
- 1.5 DELIVERY, STORAGE, AND HANDLING
 - 1.5.1 Delivery
 - 1.5.1.1 Seed Protection
 - 1.5.1.2 Fertilizer Delivery
 - 1.5.2 Storage
 - 1.5.2.1 Seed, and Fertilizer Storage
 - 1.5.2.2 Topsoil
 - 1.5.2.3 Handling
- 1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS
 - 1.6.1 Restrictions
- 1.7 TIME LIMITATIONS
 - 1.7.1 Seed

PART 2 PRODUCTS

- 2.1 SEED
 - 2.1.1 Classification
 - 2.1.2 Planting Dates
 - 2.1.3 Seed Purity
- 2.2 TOPSOIL
 - 2.2.1 On-Site Topsoil
 - 2.2.2 Off-Site Topsoil
 - 2.2.3 Composition
- 2.3 SOIL CONDITIONERS
 - 2.3.1 Aluminum Sulfate
 - 2.3.2 Sulfur
 - 2.3.3 Iron
 - 2.3.4 Peat
 - 2.3.5 Sand
 - 2.3.6 Perlite
 - 2.3.7 Composted Derivatives
 - 2.3.7.1 Particle Size
 - 2.3.7.2 Nitrogen Content
 - 2.3.8 Gypsum
 - 2.3.9 Calcined Clay
- 2.4 FERTILIZER
 - 2.4.1 Granular Fertilizer
 - 2.4.2 Hydroseeding Fertilizer
- 2.5 MULCH

- 2.5.1 Straw
- 2.5.2 Hay
- 2.5.3 Wood Cellulose Fiber Mulch or Hay Mulch
- 2.6 WATER
- 2.7 EROSION CONTROL MATERIALS
 - 2.7.1 Erosion Control Blanket
 - 2.7.2 Erosion Control Material Anchors

PART 3 EXECUTION

- 3.1 PREPARATION
 - 3.1.1 EXTENT OF WORK
 - 3.1.1.1 Topsoil
 - 3.1.1.2 Soil Conditioner Application Rates
 - 3.1.1.3 Fertilizer Application Rates
 - 3.2 SEEDING
 - 3.2.1 Seed Application Seasons and Conditions
 - 3.2.2 Seed Application Method
 - 3.2.2.1 Drill Seeding
 - 3.2.2.2 Hydroseeding
 - 3.2.3 Mulching
 - 3.2.3.1 Hay or Straw Mulch
 - 3.2.3.2 Mechanical Anchor
 - 3.2.3.3 Asphalt Adhesive Tackifier
 - 3.2.3.4 Asphalt Adhesive Coated Mulch
 - 3.2.4 Rolling
 - 3.2.5 Erosion Control Material
 - 3.2.6 Watering
 - 3.3 Overseeding
 - 3.4 RESTORATION

-- End of Section Table of Contents --

SECTION 32 92 19

SEEDING
10/06

PART 1 GENERAL

1.1 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 D4972 (2001; R 2007) pH of Soils

U.S. DEPARTMENT OF AGRICULTURE (USDA)

AMS Seed Act (1940; R 1988; R 1998) Federal Seed Act

DOA SSIR 42 (1996) Soil Survey Investigation Report No. 42, Soil Survey Laboratory Methods Manual, Version 3.0

1.2 DEFINITIONS

1.2.1 Stand of Turf

95 percent ground cover of the established species.

1.3 RELATED REQUIREMENTS

Section 31 00 00 EARTHWORK.

1.4 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wood cellulose fiber mulch or hay mulch

Fertilizer

Include physical characteristics, and recommendations.

SD-06 Test Reports

Topsoil composition tests (reports and recommendations).

SD-07 Certificates

State certification and approval for seed

SD-08 Manufacturer's Instructions

Erosion Control Materials

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

1.5.1.1 Seed Protection

Protect from drying out and from contamination during delivery, on-site storage, and handling.

1.5.1.2 Fertilizer Delivery

Deliver to the site in original, unopened containers bearing manufacturer's chemical analysis, name, trade name, trademark, and indication of conformance to state and federal laws. Instead of containers, fertilizer may be furnished in bulk with certificate indicating the above information.

1.5.2 Storage

1.5.2.1 Seed, and Fertilizer Storage

Store in cool, dry locations away from contaminants.

1.5.2.2 Topsoil

Prior to stockpiling topsoil, treat growing vegetation with application of appropriate specified non-selective herbicide. Clear and grub existing vegetation three to four weeks prior to stockpiling topsoil.

1.5.2.3 Handling

Do not drop or dump materials from vehicles.

1.6 TIME RESTRICTIONS AND PLANTING CONDITIONS

1.6.1 Restrictions

Do not plant when the ground is frozen, snow covered, muddy, or when air temperature exceeds 90 degrees Fahrenheit.

1.7 TIME LIMITATIONS

1.7.1 Seed

Apply seed within twenty four hours after seed bed preparation.

PART 2 PRODUCTS

2.1 SEED

2.1.1 Classification

Provide State-certified and/or State-approved seed of the latest season's crop delivered in original sealed packages, bearing producer's guaranteed analysis for percentages of mixtures, purity, germination, weedseed content, and inert material. Label in conformance with AMS Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will be

rejected. Field mixes will be acceptable when field mix is performed on site in the presence of the Contracting Officer.

2.1.2 Planting Dates

<u>Planting Season</u>	<u>Planting Dates</u>
Spring	April 1 - June 15
Fall	September 1 - October 15
Temporary Seeding	Anytime

2.1.3 Seed Purity

Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed.

Botanical Name	Common Name	Percent seed per pound
Poa Pratensis	Kentucky bluegrass	20
Lolium perenne	Perennial ryegrass	40
Festuca arundinacea	Kentucky 31 fescue	40

2.2 TOPSOIL

2.2.1 On-Site Topsoil

Surface soil stripped and stockpiled on site and modified as necessary to meet the requirements specified for topsoil in paragraph entitled "Composition." When available topsoil shall be existing surface soil stripped and stockpiled on-site in accordance with Section 31 00 00 EARTHWORK.

2.2.2 Off-Site Topsoil

Conform to requirements specified in paragraph entitled "Composition." Additional topsoil shall be furnished by the Contractor.

2.2.3 Composition

Containing from 5 to 10 percent organic matter as determined by the topsoil composition tests of the Organic Carbon, 6A, Chemical Analysis Method described in DOA SSIR 42. Maximum particle size, 3/4 inch, with maximum 3 percent retained on 1/4 inch screen. The pH shall be tested in accordance with ASTM D4972. Topsoil shall be free of sticks, stones, roots, and other debris and objectionable materials. Other components shall conform to the following limits:

Silt	25-50 percent
------	---------------

Clay	10-30 percent
Sand	20-35 percent
pH	5.5 to 7.0
Soluble Salts	600 ppm maximum

2.3 SOIL CONDITIONERS

Add conditioners to topsoil as required to bring into compliance with "composition" standard for topsoil as specified herein.

2.3.1 Aluminum Sulfate

Commercial grade.

2.3.2 Sulfur

100 percent elemental

2.3.3 Iron

100 percent elemental

2.3.4 Peat

Natural product of peat moss derived from a freshwater site and conforming to ASTM D4427 as modified herein. Shred and granulate peat to pass a 1/2 inch mesh screen and condition in storage pile for minimum 6 months after excavation.

2.3.5 Sand

Clean and free of materials harmful to plants.

2.3.6 Perlite

Horticultural grade.

2.3.7 Composted Derivatives

Ground bark, nitrolized sawdust, humus or other green wood waste material free of stones, sticks, and soil stabilized with nitrogen and having the following properties:

2.3.7.1 Particle Size

Minimum percent by weight passing:

No. 4 mesh screen	95
No. 8 mesh screen	80

2.3.7.2 Nitrogen Content

Minimum percent based on dry weight:

Fir Sawdust	0.7
-------------	-----

Fir or Pine Bark 1.0

2.3.8 Gypsum

Coarsely ground gypsum comprised of calcium sulfate dihydrate 61 percent, calcium 22 percent, sulfur 17 percent; minimum 96 percent passing through 20 mesh screen, 100 percent passing thru 16 mesh screen.

2.3.9 Calcined Clay

Calcined clay shall be granular particles produced from montmorillonite clay calcined to a minimum temperature of 1200 degrees F. Gradation: A minimum 90 percent shall pass a No. 8 sieve; a minimum 99 percent shall be retained on a No. 60 sieve; and a maximum 2 percent shall pass a No. 100 sieve. Bulk density: A maximum 40 pounds per cubic foot.

2.4 FERTILIZER

2.4.1 Granular Fertilizer

Organic, granular controlled release fertilizer containing the following minimum percentages, by weight, of plant food nutrients:

100 percent available nitrogen
70 percent available phosphorus
50 percent available potassium

2.4.2 Hydroseeding Fertilizer

Controlled release fertilizer, to use with hydroseeding and composed of pills coated with plastic resin to provide a continuous release of nutrients for at least 6 months and containing the following minimum percentages, by weight, of plant food nutrients.

100 percent available nitrogen
70 percent available phosphorus
50 percent available potassium

2.5 MULCH

Mulch shall be free from noxious weeds, mold, and other deleterious materials.

2.5.1 Straw

Stalks from oats, wheat, rye, barley, or rice. Furnish in air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Straw shall contain no fertile seed.

2.5.2 Hay

Air-dry condition and of proper consistency for placing with commercial mulch blowing equipment. Hay shall be sterile, containing no fertile seed.

2.5.3 Wood Cellulose Fiber Mulch or Hay Mulch

Use recovered materials of either paper-based (100 percent) or wood-based (100 percent) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate

visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2. Use with hydraulic application of grass seed and fertilizer.

2.6 WATER

Source of water shall be approved by Contracting Officer and of suitable quality for irrigation, containing no elements toxic to plant life. Water shall be available on MAFB from fire hydrants. Government to provide water free of charge with Contractor responsible for prudent use.

2.7 EROSION CONTROL MATERIALS

Erosion control material shall conform to the following:

2.7.1 Erosion Control Blanket

Use PPS Packaging Company Xcel Superior Erosion Control Blanket, or equal, passing governmental compliance review. Blanket to be installed on areas of 3:1 slope or greater or where shown on plans.

2.7.2 Erosion Control Material Anchors

Erosion control anchors shall be as recommended by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 EXTENT OF WORK

Provide soil preparation (including soil conditioners as required), fertilizing, seeding, and surface topdressing of all newly graded finished earth surfaces, unless indicated otherwise, and at all areas inside or outside the limits of construction that are disturbed by the Contractor's operations.

3.1.1.1 Topsoil

Provide 4 inches of off-site topsoil and/or on-site topsoil to meet indicated finish grade. After areas have been brought to indicated finish grade, incorporate fertilizer into soil a minimum depth of 4 inches by disking, harrowing, tilling or other method approved by the Contracting Officer. Remove debris and stones larger than 3/4 inch in any dimension remaining on the surface after finish grading. Correct irregularities in finish surfaces to eliminate depressions. Protect finished topsoil areas from damage by vehicular or pedestrian traffic.

3.1.1.2 Soil Conditioner Application Rates

Apply soil conditioners at rates as determined by laboratory soil analysis of the soils at the job site.

3.1.1.3 Fertilizer Application Rates

Apply fertilizer at rates as determined by laboratory soil analysis of the soils at the job site. For bidding purposes only apply at rates for the following:

Organic Granular Fertilizer 220 pounds per acre

Synthetic Fertilizer 200 pounds per acre

Hydroseeding Fertilizer 200 pounds per acre

3.2 SEEDING

3.2.1 Seed Application Seasons and Conditions

Immediately before seeding, restore soil to proper grade. Do not seed when ground is muddy, frozen, snow covered or in an unsatisfactory condition for seeding. If special conditions exist that may warrant a variance in the above seeding dates or conditions, submit a written request to the Contracting Officer stating the special conditions and proposed variance. Apply seed within twenty four hours after seedbed preparation. Sow seed by approved sowing equipment. Sow one-half the seed in one direction, and sow remainder at right angles to the first sowing.

3.2.2 Seed Application Method

Seeding method shall be drill seeding.

3.2.2.1 Drill Seeding

Seed shall be drilled at the rate of 300 pounds per 1000 square feet. Drill seed uniformly to average depth of 1/2 inch.

3.2.2.2 Hydroseeding

First, mix water and fiber. Wood cellulose fiber, paper fiber, or recycled paper shall be applied as part of the hydroseeding operation. Fiber shall be added at 1,000 pounds, dry weight, per acre. Then add and mix seed and fertilizer to produce a homogeneous slurry. Seed shall be mixed to ensure broadcasting at the rate of 300 pounds per 1000 square feet. When hydraulically sprayed on the ground, material shall form a blotter like cover impregnated uniformly with grass seed. Spread with one application with no second application of mulch.

3.2.3 Mulching

3.2.3.1 Hay or Straw Mulch

Hay or straw mulch shall be spread uniformly at the rate of 2 tons per acre. Mulch shall be spread by hand, blower-type mulch spreader, or other approved method. Mulching shall be started on the windward side of relatively flat areas or on the upper part of steep slopes, and continued uniformly until the area is covered. The mulch shall not be bunched or clumped. Sunlight shall not be completely excluded from penetrating to the ground surface. All areas installed with seed shall be mulched on the same day as the seeding. Mulch shall be anchored immediately following spreading.

3.2.3.2 Mechanical Anchor

Mechanical anchor shall be a V-type-wheel land packer; a scalloped-disk land packer designed to force mulch into the soil surface; or other suitable equipment.

3.2.3.3 Asphalt Adhesive Tackifier

Asphalt adhesive tackifier shall be sprayed at a rate between 10 to 13 gallons per 1000 square feet. Sunlight shall not be completely excluded from penetrating to the ground surface.

3.2.3.4 Asphalt Adhesive Coated Mulch

Hay or straw mulch may be spread simultaneously with asphalt adhesive applied at a rate between 10 to 13 gallons per 1000 square feet, using power mulch equipment which shall be equipped with suitable asphalt pump and nozzle. The adhesive-coated mulch shall be applied evenly over the surface. Sunlight shall not be completely excluded from penetrating to the ground surface.

3.2.4 Rolling

Immediately after seeding, firm entire area except for slopes in excess of 3 to 1 with a roller not exceeding 90 pounds for each foot of roller width. If seeding is performed with cultipacker-type seeder or by hydroseeding, rolling may be eliminated.

3.2.5 Erosion Control Material

Install in accordance with manufacturer's instructions, where indicated or as directed by the Contracting Officer.

3.2.6 Watering

Start watering areas seeded as required by temperature and wind conditions. Apply water at a rate sufficient to insure thorough wetting of soil to a depth of 2 inches without run off. During the germination process, seed is to be kept actively growing and not allowed to dry out.

3.3 Overseeding

Apply seed in accordance with applicable portions of paragraph entitled "Seed Application Method" at rates in accordance with paragraph entitled "Seed Composition."

3.4 RESTORATION

Restore to original condition existing turf areas which have been damaged during turf installation operations at the Contractor's expense. Keep clean at all times at least one paved pedestrian access route and one paved vehicular access route to each building. Clean other paving when work in adjacent areas is complete.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 11 00

WATER DISTRIBUTION

02/11

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 DESIGN REQUIREMENTS
 - 1.2.1 Water Distribution Mains
- 1.3 SUBMITTALS
- 1.4 DELIVERY, STORAGE, AND HANDLING
 - 1.4.1 Delivery and Storage
 - 1.4.2 Handling
 - 1.4.2.1 Miscellaneous Plastic Pipe and Fittings

PART 2 PRODUCTS

- 2.1 WATER DISTRIBUTION MAIN MATERIALS
 - 2.1.1 Piping Materials
 - 2.1.1.1 Polyvinyl Chloride (PVC) Plastic Piping
 - 2.1.2 Valves, Hydrants, and Other Water Main Accessories
 - 2.1.2.1 Gate Valves
 - 2.1.2.2 Fire Hydrants
 - 2.1.2.3 Valve Boxes
 - 2.1.2.4 Sleeve-Type Mechanical Couplings
 - 2.1.2.5 Tracer Wire for Nonmetallic Piping
 - 2.1.2.5.1 Restrained Joints
- 2.2 Tapping Sleeves
 - 2.2.1 Disinfection

PART 3 EXECUTION

- 3.1 INSTALLATION OF PIPELINES
 - 3.1.1 General Requirements for Installation of Pipelines
 - 3.1.1.1 Location of Water Lines
 - 3.1.1.2 Earthwork
 - 3.1.1.3 Pipe Laying and Jointing
 - 3.1.1.4 Installation of Tracer Wire
 - 3.1.1.5 Connections to Existing Water Lines
 - 3.1.2 Special Requirements for Installation of Water Mains
 - 3.1.2.1 Installation of PVC Plastic Water Main Pipe
 - 3.1.2.2 Installation of Valves and Hydrants
 - 3.1.3 Disinfection
- 3.2 FIELD QUALITY CONTROL
 - 3.2.1 Field Tests and Inspections
 - 3.2.2 Testing Procedure
 - 3.2.3 Special Testing Requirements
- 3.3 CLEANUP

-- End of Section Table of Contents --

SECTION 33 11 00

WATER DISTRIBUTION
02/11

PART 1 GENERAL

1.1 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 HB-17 (2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION
(AREMA)

AREMA Eng Man (2012) Manual for Railway Engineering

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA B300 (2010; Addenda 2011) Hypochlorites

AWWA B301 (2010) Liquid Chlorine

AWWA C104/A21.4 (2008; Errata 2010) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

AWWA C105/A21.5 (2010) Polyethylene Encasement for Ductile-Iron Pipe Systems

AWWA C110/A21.10 (2012) Ductile-Iron and Gray-Iron Fittings for Water

AWWA C111/A21.11 (2012) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

AWWA C115/A21.15 (2011) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

AWWA C151/A21.51 (2009) Ductile-Iron Pipe, Centrifugally Cast, for Water

AWWA C153/A21.53 (2011) Ductile-Iron Compact Fittings for Water Service

AWWA C500 (2009) Metal-Seated Gate Valves for Water Supply Service

AWWA C502 (2005) Dry-Barrel Fire Hydrants

AWWA C509	(2009) Resilient-Seated Gate Valves for Water Supply Service
AWWA C515	(2009) Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
AWWA C600	(2010) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2005) Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
AWWA C651	(2005; Errata 2005) Standard for Disinfecting Water Mains
AWWA C800	(2012) Underground Service Line Valves and Fittings
AWWA C900	(2007; Errata 2008) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Distribution
AWWA M23	(2002; 2nd Ed) Manual: PVC Pipe - Design and Installation

ASME INTERNATIONAL (ASME)

ASME B18.2.2	(2010) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2012) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A536	(1984; R 2009) Standard Specification for Ductile Iron Castings
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007) Standard Specification for Carbon

	and Alloy Steel Nuts (Metric)
ASTM B61	(2008) Standard Specification for Steam or Valve Bronze Castings
ASTM B62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C94/C94M	(2013a) Standard Specification for Ready-Mixed Concrete
ASTM D1599	(1999; R 2011) Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2774	(2012) Underground Installation of Thermoplastic Pressure Piping
ASTM D3139	(1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F477	(2010) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
	NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
NFPA 704	(2017) Standard System for the Identification of the Hazards of Materials for Emergency Response
	UNDERWRITERS LABORATORIES (UL)
UL 246	(2011; Reprint Feb 2013) Hydrants for Fire-Protection Service
UL 262	(2004; Reprint Oct 2011) Gate Valves for Fire-Protection Service
	UNI-BELL PVC PIPE ASSOCIATION (UBPPA)
UBPPA UNI-B-8	(2000) Recommended Practice for the Direct Tapping of Polyvinyl Chloride (PVC) Pressure Water Pipe (Nominal Diameters 6-12 Inch)

1.2 DESIGN REQUIREMENTS

1.2.1 Water Distribution Mains

Provide water distribution mains indicated as 6 inch lines of polyvinyl chloride (PVC) plastic pipe. Provide water main accessories and gate

valves as specified and where indicated. Submit design calculations of water piping.

Provide water distribution mains indicated as 4 through 12 inch diameter pipe sizes of polyvinyl chloride (PVC) plastic pipe. Also provide water main accessories, gate valves as specified and where indicated.

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Piping Materials

Water distribution main piping, fittings, joints, valves, couplings and joint restraints
Hydrants
Valve boxes

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on and rubber-gasketed bell-and-spigot joints. Include information concerning gaskets with submittal for joints and couplings.

SD-05 Design Data

Design Calculations of water piping

SD-06 Test Reports

Bacteriological Disinfection

Test results from commercial laboratory verifying disinfection

SD-07 Certificates

Water distribution main piping, fittings, joints, valves, couplings and joint restraints
Fire hydrants

Certificates shall attest that tests set forth in each applicable referenced publication have been performed, whether specified in that publication to be mandatory or otherwise and that production control tests have been performed at the intervals or frequency specified in the publication. Other tests shall have been performed within 3 years of the date of submittal of certificates on the same type, class, grade, and size of material as is being provided for the project.

SD-08 Manufacturer's Instructions

Delivery, storage, and handling
Installation procedures for water piping

1.4 DELIVERY, STORAGE, AND HANDLING

1.4.1 Delivery and Storage

Inspect materials delivered to site for damage. Unload and store with

minimum handling. Store materials on site in enclosures or under protective covering. Store plastic piping, jointing materials and rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes, fittings, valves and hydrants free of dirt and debris.

1.4.2 Handling

Handle pipe, fittings, valves, hydrants, and other accessories in a manner to ensure delivery to the trench in sound undamaged condition. Take special care to avoid injury to coatings and linings on pipe and fittings; make repairs if coatings or linings are damaged. Do not place any other material or pipe inside a pipe or fitting after the coating has been applied. Carry, do not drag pipe to the trench. Use of pinch bars and tongs for aligning or turning pipe will be permitted only on the bare ends of the pipe. The interior of pipe and accessories shall be thoroughly cleaned of foreign matter before being lowered into the trench and shall be kept clean during laying operations by plugging or other approved method. Before installation, the pipe shall be inspected for defects. Material found to be defective before or after laying shall be replaced with sound material without additional expense to the Government. Store rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.

1.4.2.1 Miscellaneous Plastic Pipe and Fittings

Handle Polyvinyl Chloride (PVC), pipe and fittings in accordance with the manufacturer's recommendations. Store plastic piping and jointing materials that are not to be installed immediately under cover out of direct sunlight.

Storage facilities shall be classified and marked in accordance with NFPA 704.

PART 2 PRODUCTS

2.1 WATER DISTRIBUTION MAIN MATERIALS

2.1.1 Piping Materials

2.1.1.1 Polyvinyl Chloride (PVC) Plastic Piping

- a. Pipe and Fittings: Pipe, AWWA C900, shall be plain end or gasket bell end, Pressure Class 150 (DR 18) with cast-iron-pipe-equivalent OD.
- b. Fittings for PVC pipe: Fittings shall be gray iron or ductile iron, AWWA C110/A21.10 or AWWA C153/A21.53, and have cement-mortar lining, AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that bell design shall be modified, as approved, for push-on joint suitable for use with PVC plastic pipe specified in this paragraph. Iron fittings and specials shall be cement-mortar lined in accordance with AWWA C104/A21.4. Fittings and specials may be of the same material as the pipe with elastomeric gaskets, all in conformance with AWWA C605 and AWWA C900.
- c. Joints and Jointing Material: Joints for pipe shall be push-on joints, ASTM D3139. Joints between pipe and metal fittings, valves, and other accessories shall be push-on joints ASTM D3139, or compression-type

joints/mechanical joints, ASTM D3139 and AWWA C111/A21.11. Provide each joint connection with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe, ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical joints for joint connections between pipe and metal fittings, valves, and other accessories, AWWA C111/A21.11, respectively, for push-on joints and mechanical joints. Mechanically coupled joints using a sleeve-type mechanical coupling, as specified in paragraph entitled "Sleeve-Type Mechanical Couplings," may be used as an optional jointing method in lieu of push-on joints on plain-end PVC plastic pipe, subject to the limitations specified for mechanically coupled joints using a sleeve-type mechanical coupling and to the use of internal stiffeners as specified for compression-type joints in ASTM D3139.

2.1.2 Valves, Hydrants, and Other Water Main Accessories

2.1.2.1 Gate Valves

AWWA C500, AWWA C509, AWWA C515, or UL 262. Unless otherwise specified, valves conforming to: (1) AWWA C500 shall be nonrising stem type with double-disc gates and mechanical-joint ends or push-on joint ends as appropriate for the adjoining pipe, (2) AWWA C509 or AWWA C515 shall be nonrising stem type with mechanical-joint ends or resilient-seated gate valves 3 to 12 inches in size, and (3) UL 262 shall be inside-screw type with operating nut, double-disc or split-wedge type gate, designed for a hydraulic working pressure of 250 psi, and shall have mechanical-joint ends or push-on joint ends as appropriate for the pipe to which it is joined. Materials for UL 262 valves shall conform to the reference standards specified in AWWA C500. Valves shall open by counterclockwise rotation of the valve stem. Stuffing boxes shall have O-ring stem seals, except for those valves for which gearing is specified, in which case use conventional packing in place of O-ring seal. Stuffing boxes shall be bolted and constructed so as to permit easy removal of parts for repair. In lieu of mechanical-joint ends and push-on joint ends, valves may have special ends for connection to cement piping or to sleeve-type mechanical coupling. Valve ends and gaskets for connection to sleeve-type mechanical coupling shall conform to the applicable requirements specified respectively for the joint or coupling. Valves shall be of one manufacturer.

2.1.2.2 Fire Hydrants

Dry-barrel type.

- a. Dry-Barrel Type Fire Hydrants: Dry-barrel type hydrants, AWWA C502 or UL 246, "Base Valve" design, shall have 6 inch inlet, 5 1/4 inch valve opening, one 4 1/2 inch pumper connection, and two 2 1/2 inch hose connections. Inlet shall have mechanical-joint end only; end shall conform to the applicable requirements as specified for the joint. Size and shape of operating nut, cap nuts, and threads on hose and pumper connections shall be as specified in AWWA C502/UL 246. Hydrants shall have frangible sections as mentioned in AWWA C502. The traffic type hydrant shall have special couplings joining upper and lower sections of hydrant barrel and upper and lower sections of hydrant stem and shall be designed to have the special couplings break from a force not less than that which would be imposed by a moving vehicle; hydrant shall operate properly under normal conditions.

2.1.2.3 Valve Boxes

Provide a valve box for each gate valve. Valve boxes shall be of cast iron of a size suitable for the valve on which it is to be used and shall be adjustable. Cast-iron boxes shall have a minimum cover and wall thickness of 3/16 inch. Provide a round head. Cast the word "WATER" on the lid. The least diameter of the shaft of the box shall be 5 1/4 inches. Cast-iron box shall have a heavy coat of bituminous paint.

2.1.2.4 Sleeve-Type Mechanical Couplings

Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat; two follower rings; two resilient tapered rubber gaskets; and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. For PVC plastic pipe, the middle ring shall be of cast-iron; and the follower rings shall be of malleable or ductile iron. Malleable and ductile iron shall, conform to ASTM A47/A47M and ASTM A536, respectively. Gaskets shall be designed for resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type, ASTM A307, Grade A, with nuts, ASTM A563, Grade A; or round-head square-neck type bolts, ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts, ASME B18.2.2. Bolts shall be 5/8 inch in diameter; minimum number of bolts for each coupling shall be 5 for 6 inch pipe, 6 for 6 inch pipe. Bolt holes in follower rings shall be of a shape to hold fast the necks of the bolts used. Mechanically coupled joints using a sleeve-type mechanical coupling shall not be used as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint. Mechanical couplings shall provide a tight flexible joint under all reasonable conditions, such as pipe movements caused by expansion, contraction, slight setting or shifting in the ground, minor variations in trench gradients, and traffic vibrations. Couplings shall be of strength not less than the adjoining pipeline.

2.1.2.5 Tracer Wire for Nonmetallic Piping

Provide bare copper or aluminum wire not less than 0.10 inch in diameter in sufficient length to be continuous over each separate run of nonmetallic pipe.

2.1.2.5.1 Restrained Joints

Provide joint restraint devices at fittings. In general, solid ring restraints shall be used whenever possible. Split restraints may be used when connecting to existing systems, for special cases, and when a solid ring restraint is not available for the application. All joint restraint devices shall be epoxy coated (min. 6 mils), utilize the "E Coat" coating system as specified by EBBA Iron, Inc. All bolts, rods, etc., shall be COR-Blue, epoxy coated, stainless steel, or fluoropolymer coated per EBBA Iron, Inc., and the Ford Meter Box Co., Inc. specifications.

- a. For DI pipe to DI push-on fittings: Fitting Joint Restraints shall be EBAA Series 1100HD, or equal.
- b. For DI pipe to DI MJ fittings: Fitting joint restraints shall be

EBAA MEGALUG Series 1100, Series 1100SD, or equal.

c. For PVC pipe to DI push-on fittings: Fitting joint restraints shall be EBAA Series 15PF00, or equal.

d. For PVC pipe to DI MJ fittings: Fitting joint restraints shall be EBAA Series 2000PV, Series 2000SV, Series 15PF00, or equal.

e. For PVC pipe to PVC push-on fittings: Fitting joint restraints shall be EBAA Series 2500, or equal.

Provide joint restraint devices at pipe bells. In general, split restraints may be used when connecting to existing systems, for special cases, and when a solid ring restraint is not available for the application. All joint restraint devices shall be epoxy coated (min. 6 mils), utilize the "E Coat" coating system as specified by the Ford Meter Box Co., Inc., or utilize the "Mega Bond" coating system as specified by EBBA Iron, Inc. All bolts, rods, etc. shall be COR-Blue, epoxy coated, stainless steel, or fluoropolymer coated per EBBA Iron, Inc. and the Ford Meter Box Co., Inc. specifications.

2.2 Tapping Sleeves

Tapping sleeves of the sizes indicated for connection to existing main shall be the cast gray, ductile, or malleable iron, split-sleeve type with flanged or grooved outlet, and with bolts, follower rings and gaskets on each end of the sleeve. Construction shall be suitable for a maximum working pressure of 150 psi. Bolts shall have square heads and hexagonal nuts. Longitudinal gaskets and mechanical joints with gaskets shall be as recommended by the manufacturer of the sleeve. When using grooved mechanical tee, it shall consist of an upper housing with full locating collar for rigid positioning which engages a machine-cut hole in pipe, encasing an elastomeric gasket which conforms to the pipe outside diameter around the hole and a lower housing with positioning lugs, secured together during assembly by nuts and bolts as specified, pretorqued to 50 foot-pound.

2.2.1 Disinfection

Chlorinating materials shall conform to the following:

Chlorine, Liquid: AWWA B301.

Hypochlorite, Calcium and Sodium: AWWA B300.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES

3.1.1 General Requirements for Installation of Pipelines

These requirements shall apply to all pipeline installation except where specific exception is made in the "Special Requirements..." paragraphs.

3.1.1.1 Location of Water Lines

Where the location of the water line is not clearly defined by dimensions on the drawings, do not lay water line closer horizontally than 10 feet from any sewer line. Where water lines cross under gravity sewer lines, encase sewer line or water line fully in concrete for a distance of at least 10 feet on each side of the crossing, unless sewer line is made of pressure pipe with rubber-gasketed joints and no joint is located within 3

feet horizontally of the crossing.

3.1.1.2 Earthwork

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.1.3 Pipe Laying and Jointing

Remove fins and burrs from pipe and fittings. Before placing in position, clean pipe, fittings, valves, and accessories, and maintain in a clean condition. Provide proper facilities for lowering sections of pipe into trenches. Do not under any circumstances drop or dump pipe, fittings, valves, or any other water line material into trenches. Cut pipe in a neat workmanlike manner accurately to length established at the site and work into place without springing or forcing. Replace by one of the proper length any pipe or fitting that does not allow sufficient space for proper installation of jointing material. Blocking or wedging between bells and spigots will not be permitted. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying. Grade the pipeline in straight lines; avoid the formation of dips and low points. Support pipe at proper elevation and grade. Secure firm, uniform support. Wood support blocking will not be permitted. Lay pipe so that the full length of each section of pipe and each fitting will rest solidly on the pipe bedding; excavate recesses to accommodate bells, joints, and couplings. Provide anchors and supports where necessary for fastening work into place. Make proper provision for expansion and contraction of pipelines. Keep trenches free of water until joints have been properly made. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Do not lay pipe when conditions of trench or weather prevent installation. Depth of cover over top of pipe shall not be less than 2 1/2 feet.

3.1.1.4 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe. Attach wire to top of pipe in such manner that it will not be displaced during construction operations.

3.1.1.5 Connections to Existing Water Lines

Make connections to existing water lines after approval is obtained and with a minimum interruption of service on the existing line. Make connections to existing lines under pressure in accordance with the recommended procedures of the manufacturer of the pipe being tapped as indicated.

3.1.2 Special Requirements for Installation of Water Mains

3.1.2.1 Installation of PVC Plastic Water Main Pipe

Installation of PVC Plastic Water Main Pipe and Associated Fittings: Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines"; with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

- a. Jointing: Make push-on joints with the elastomeric gaskets specified for this type of joint, using either elastomeric-gasket bell-end pipe

or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to metal fittings, valves, and other accessories, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings, valves, and other accessories in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.

- b. Offset: Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Contracting Officer, but shall not exceed 5 degrees.
- c. Pipe Anchorage: Provide thrust restraints for pipe anchorage conforming to either AWWA C111/A21.11 or AWWA C153/A21.53.
- d. Fittings: Install in accordance with AWWA C605.

3.1.2.2 Installation of Valves and Hydrants

- a. Installation of Valves: Install gate valves, AWWA C509 or AWWA C515, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509 or AWWA C515. Install gate valves on PVC water mains in accordance with the recommendations for appurtenance installation in AWWA M23, Chapter 7, "Installation." Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.
- b. Installation of Hydrants: Install hydrants, except for metal harness, in accordance with AWWA C600 for hydrant installation and as indicated. Make and assemble joints as specified for making and assembling the same type joints between pipe and fittings. Provide metal harness as specified under pipe anchorage requirements for the respective pipeline material to which hydrant is attached. Install hydrants with the 4 1/2 inch connections facing the adjacent paved surface. If there are two paved adjacent surfaces, contact the Contracting Officer for further instructions.

3.1.3 Disinfection

Prior to disinfection, obtain Contracting Officer approval of the proposed

method for disposal of waste water from disinfection procedures. Disinfect new water piping and existing water piping affected by Contractor's operations in accordance with AWWA C651. Fill piping systems with solution containing minimum of 50 parts per million of available chlorine and allow solution to stand for minimum of 24 hours. Flush solution from the systems with domestic water until maximum residual chlorine content is within the range of 0.2 and 0.5 parts per million, or the residual chlorine content of domestic water supply. Obtain at least two consecutive satisfactory bacteriological samples from new water piping, analyze by a certified laboratory, and submit the results prior to the new water piping being placed into service. Disinfection of systems supplying nonpotable water is not required.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

Prior to hydrostatic testing, obtain Contracting Officer approval of the proposed method for disposal of waste water from hydrostatic testing. The Contracting Officer will conduct field inspections and witness field tests specified in this section. The Contractor shall perform field tests, and provide labor, equipment, and incidentals required for testing. The Contractor shall produce evidence, when required, that any item of work has been constructed in accordance with the drawings and specifications.

3.2.2 Testing Procedure

Test water mains in accordance with the applicable specified standard, except for the special testing requirements given in paragraph entitled "Special Testing Requirements." Test PVC plastic water mains made with PVC plastic water main pipe in accordance with the requirements of AWWA C605 for pressure and leakage tests. The amount of leakage on pipelines made of PVC plastic water main pipe shall not exceed the amounts given in AWWA C605, except that at joints made with sleeve-type mechanical couplings, no leakage will be allowed.

3.2.3 Special Testing Requirements

For pressure test, use a hydrostatic pressure 50 psi greater than the maximum working pressure of the system, except that for those portions of the system having pipe size larger than 2 inches in diameter, hydrostatic test pressure shall be not less than 150 psi. Hold this pressure for not less than 2 hours. Prior to the pressure test, fill that portion of the pipeline being tested with water for a soaking period of not less than 24 hours. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test.

3.3 CLEANUP

Upon completion of the installation of water lines, and appurtenances, all debris and surplus materials resulting from the work shall be removed.

-- End of Section --

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SECTION TABLE OF CONTENTS

DIVISION 33 - UTILITIES

SECTION 33 40 00

STORM DRAINAGE UTILITIES

02/10

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 DELIVERY, STORAGE, AND HANDLING
 - 1.3.1 Delivery and Storage
 - 1.3.2 Handling

PART 2 PRODUCTS

- 2.1 PIPE FOR CULVERTS AND STORM DRAINS
 - 2.1.1 Concrete Pipe
 - 2.1.2 PVC Pipe
 - 2.1.2.1 Type PSM PVC Pipe
- 2.2 MISCELLANEOUS MATERIALS
 - 2.2.1 Concrete
 - 2.2.2 Mortar
 - 2.2.3 Frame and Cover for Gratings
 - 2.2.4 Joints
 - 2.2.4.1 Flexible Watertight Joints
 - 2.2.4.2 PVC Plastic Pipes
- 2.3 STEEL LADDER
- 2.4 HYDROSTATIC TEST ON WATERTIGHT JOINTS
 - 2.4.1 Concrete and PVC Pipe

PART 3 EXECUTION

- 3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES
 - 3.1.1 Trenching
 - 3.1.2 Removal of Rock
 - 3.1.3 Removal of Unstable Material
- 3.2 BEDDING
 - 3.2.1 Concrete Pipe Requirements
 - 3.2.2 PVC Plastic Pipe
- 3.3 PLACING PIPE
 - 3.3.1 Concrete and PVC Pipe
- 3.4 JOINTING
 - 3.4.1 Concrete Pipe
 - 3.4.1.1 Flexible Watertight Joints
- 3.5 DRAINAGE STRUCTURES
 - 3.5.1 Manholes and Inlets
 - 3.5.2 Walls and Headwalls
- 3.6 STEEL LADDER INSTALLATION
- 3.7 BACKFILLING
 - 3.7.1 Backfilling Pipe in Trenches
 - 3.7.2 Backfilling Pipe in Fill Sections

- 3.7.3 Movement of Construction Machinery
- 3.7.4 Compaction
 - 3.7.4.1 General Requirements
 - 3.7.4.2 Minimum Density
- 3.7.5 Determination of Density
- 3.8 PIPELINE TESTING
 - 3.8.1 Leakage Tests
 - 3.8.2 Post-Installation Video Recording Inspection

-- End of Section Table of Contents --

SECTION 33 40 00

STORM DRAINAGE UTILITIES

02/10

PART 1 GENERAL

1.1 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 HB-17 (2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

ASTM INTERNATIONAL (ASTM)

ASTM C1103 (2003; R 2009) Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

ASTM C14 (2011) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe

ASTM C231/C231M (2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C270 (2012a) Standard Specification for Mortar for Unit Masonry

ASTM C443 (2011) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

ASTM C478M (2013) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)

ASTM C655 (2012b) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

ASTM C76 (2013a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

ASTM C923 (2008; R 2013) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals

ASTM C924	(2002; R 2009) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C990	(2009) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM D1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1557	(2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³) (2700 kN-m/m ³)
ASTM D1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2167	(2008) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2321	(2011) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2729	(2011) Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3034	(2008) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	(2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3350	(2012) Polyethylene Plastics Pipe and Fittings Materials
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM F1417	(2011a) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F477	(2010) Standard Specification for

Elastomeric Seals (Gaskets) for Joining
Plastic Pipe

ASTM F794

(2003; R 2009) Standard Specification for
Poly(Vinyl Chloride) (PVC) Profile Gravity
Sewer Pipe and Fittings Based on
Controlled Inside Diameter

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL
PROCEDURES:

SD-03 Product Data

Non-shrink Grout
Manholes, Frames and Covers
Pipe Materials and Fittings

Placing Pipe

Submit printed copies of the manufacturer's recommendations for
installation procedures of the material being placed, prior to
installation.

Video Recording; G

SD-04 Samples

SD-07 Certificates

Resin Certification
Pipeline Testing
Hydrostatic Test on Watertight Joints
Determination of Density
Frame and Cover for Gratings

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery and Storage

Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.3.2 Handling

Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

PART 2 PRODUCTS

2.1 PIPE FOR CULVERTS AND STORM DRAINS

Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.

2.1.1 Concrete Pipe

Manufactured in accordance with and conforming to ASTM C76, Class V RCP.

2.1.2 PVC Pipe

Submit the pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, prior to installation of the pipe.

2.1.2.1 Type PSM PVC Pipe

ASTM D3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.

2.2 MISCELLANEOUS MATERIALS

2.2.1 Concrete

Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements for 4000 psi concrete under Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE. The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches. Air content shall be determined in accordance with ASTM C231/C231M. The concrete covering over steel reinforcing shall not be less than 1 inch thick for covers and not less than 1-1/2 inches thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches between steel and ground. Expansion-joint filler material shall conform to ASTM D1751, or ASTM D1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.

2.2.2 Mortar

Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar but in no case shall exceed 1 gallon of water per sack of cement. Water shall be clean and free of harmful acids, alkalis, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.

2.2.3 Frame and Cover for Gratings

Submit certification on the ability of frame and cover or gratings to carry the imposed live load. Frame and cover for gratings shall be cast gray

iron, ASTM A48/A48M, Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26/B26M, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans. The word "Storm Sewer" shall be stamped or cast into covers so that it is plainly visible.

2.2.4 Joints

2.2.4.1 Flexible Watertight Joints

- a. Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for preformed flexible joint sealants shall conform to ASTM C990, and rubber-type gaskets shall conform to ASTM C443. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches.
- b. Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443. Certified copies of test results shall be delivered to the Contracting Officer before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.

2.2.4.2 PVC Plastic Pipes

Joints shall be elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.

2.3 STEEL LADDER

Steel ladder shall be provided where the depth of the storm drainage structure exceeds 12 feet. These ladders shall be not less than 16 inches in width, with 3/4 inch diameter rungs spaced 12 inches apart. The two stringers shall be a minimum 3/8 inch thick and 2-1/2 inches wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

2.4 HYDROSTATIC TEST ON WATERTIGHT JOINTS

2.4.1 Concrete and PVC Pipe

A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to ASTM C990 or ASTM C443. Test requirements for joints in clay pipe shall conform to ASTM C425. Test requirements for joints in PVC, PE, and PP plastic pipe shall conform to ASTM D3212.

PART 3 EXECUTION

3.1 EXCAVATION FOR PIPE CULVERTS, STORM DRAINS, AND DRAINAGE STRUCTURES

Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Section 31 00 00 EARTHWORK and the requirements specified below.

3.1.1 Trenching

The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 24 inches to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheet piling and bracing, where required, shall be placed within the trench width as specified, without any overexcavation. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Government.

3.1.2 Removal of Rock

Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches or 1/2 inch for each foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Section 31 00 00 EARTHWORK.

3.1.3 Removal of Unstable Material

Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the Contracting Officer, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheet piling, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Government.

3.2 BEDDING

The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

3.2.1 Concrete Pipe Requirements

When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in native on-site material.

3.2.2 PVC Plastic Pipe

Bedding for PVC pipe shall meet the requirements of ASTM D2321. Use Class IB or II material for bedding, haunching, and initial backfill.

3.3 PLACING PIPE

Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (percent)
Plastic (PVC, HDPE and PP)	5

Note post installation requirements of paragraph DEFLECTION TESTING in PART 3 of this specification for all pipe products including deflection testing requirements for flexible pipe.

3.3.1 Concrete and PVC Pipe

Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.

3.4 JOINTING

3.4.1 Concrete Pipe

3.4.1.1 Flexible Watertight Joints

Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.

3.5 DRAINAGE STRUCTURES

3.5.1 Manholes and Inlets

Construction shall be of reinforced concrete or precast reinforced concrete complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated.

3.5.2 Walls and Headwalls

Construction shall be as indicated.

3.6 STEEL LADDER INSTALLATION

Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet vertically, and shall be installed to provide at least 6 inches of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.

3.7 BACKFILLING

3.7.1 Backfilling Pipe in Trenches

After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation equal to the midpoint (spring line) of RCP or has reached an elevation of at least 12 inches above the top of the pipe for flexible pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches. Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the Contracting Officer, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.

3.7.2 Backfilling Pipe in Fill Sections

For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet, whichever is less. After the backfill has reached at least 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches. Use select granular material for this entire region of backfill for flexible pipe installations.

3.7.3 Movement of Construction Machinery

When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.

3.7.4 Compaction

3.7.4.1 General Requirements

Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.

3.7.4.2 Minimum Density

Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.

- a. Under streets and parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
- b. Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
- c. Under nontraffic areas, density shall be not less than that of the surrounding material.

3.7.5 Determination of Density

Testing is the responsibility of the Contractor and performed at no additional cost to the Government. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D6938. When ASTM D6938 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications. ASTM D6938 results in a wet unit weight of soil and ASTM D6938 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D6938. Test results shall be furnished the Contracting Officer. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

3.8 PIPELINE TESTING

3.8.1 Leakage Tests

Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for concrete pipes shall conform to ASTM C924. Low pressure air testing for plastic pipe shall conform to ASTM F1417. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C1103. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Contracting Officer. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 0.2 gallons per inch in diameter per 100 feet of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.

3.8.2 Post-Installation Video Recording Inspection

One hundred percent of all reinforced concrete pipe installations shall be checked for joint separations, soil migration through the joint, cracks greater than 0.01 inches, settlement and alignment. One hundred percent of all flexible pipes (HDPE, PVC, CMP, PP) shall be checked for rips, tears, joint separations, soil migration through the joint, cracks, localized bucking, bulges, settlement and alignment.

- a. Replace pipes having cracks greater than 0.1 inches in width or deflection greater than 5 percent deflection. An engineer shall evaluate all pipes with cracks greater than 0.01 inches but less than 0.10 inches to determine if any remediation or repair is required. RCP with crack width less than 0.10 inches and located in a non-corrosive environment (pH 5.5) are generally acceptable. Repair or replace any pipe with crack exhibiting displacement across the crack, exhibiting bulges, creases, tears, spalls, or delamination.
- b. Reports: The deflection results and final post installation inspection report shall include: a copy of all video taken, pipe location identification, equipment used for inspection, inspector name, deviation from design, grade, deviation from line, deflection and deformation of flexible pipe systems, inspector notes, condition of joints, condition of pipe wall (e.g. distress, cracking, wall damage dents, bulges, creases, tears, holes, etc.).

-- End of Section --