

SECTION 02012

**SUBSURFACE INVESTIGATION AND TESTING**

**PART 1 - GENERAL**

1.0 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1557	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb Rammer and 18 in. drop
ASTM D 1586	Penetration Test and Split Barrel Sampling of Soils
ASTM D 2216	Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixture
ASTM D 2487	Classification of Soils for Engineering Purposes
ASTM D 2937	Density of Soil in Place by the Drive Cylinder Method
ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.1 GENERAL

The work specified herein consists of the obtaining of undisturbed samples in accordance with ASTM D 2937, disturbed samples in accordance with ASTM D 1586, determination of water content, determination of in-place density and determination of moisture-density relationships.

1.2 LOCATION OF TESTING SITES

Testing sites shall be located throughout all bases and shall consist of obtaining test samples along the centerline of existing roadways (or along other portions of the roadway cross sections, as specified in individual task orders) at a frequency not less than every 100 feet. Test sites are estimated to be between one half mile and six miles long.

2.0 SAMPLING

Samples shall be taken of the roadway cross section down to and including the first one foot of existing subgrade, except that in no case will holes be drilled deeper than ten feet.

## 2.2 UNDISTURBED SAMPLES

Samples shall be obtained per ASTM D 2937 using a 6 inch I.D. by 30 inch pitcher barrel or approved method for 30 inch long samples.

## 2.3 DISTURBED SAMPLES

Samples, if required by individual task orders, shall be obtained in accordance with ASTM 1586 using as ASTM Standard split spoon penetrometer (2 inch O.D. by 1 3/8 inch I.D. by 24 inches in length). a 140 pound safety hammer with 30 inches of freefall using an automatic system or a cathead and rope (maximum of 2 wraps) is required for conducting the SPT's.

## 2.4 TESTING

The following tests will be conducted on all samples taken. A report in accordance with applicable ASTM Standards will be prepared and furnished the Contracting Officer's Representative. Testing shall be the responsibility of the Contractor and shall be conducted by an approved commercial testing laboratory. The laboratory shall provide a copy of the report, signed by an authorized person, to the Contracting Officer's Representative, at the time that it is furnished to the Contractor.

## 2.5 MOISTURE CONTENT

Moisture content of each distinctly different type of soil or soil/aggregate mixture encountered shall be determined in accordance with ASTM D 2216.

## 2.5 MOISTURE-DENSITY RELATIONSHIPS

Moisture-Density Relation for the subgrade and any subbase layers shall be determined in accordance with ASTM D 1557.

## 2.6 IN-PLACE DENSITY

In-Place Density of subgrade and subbase layers shall be determined in accordance with ASTM D 2937.

## 2.7 SOIL CLASSIFICATION

Engineering classification for each distinctly different type of soil will be obtained in accordance with ASTM D 2487.

## 2.8 DRILL SETUP AND DEMOBILIZATION

Drill setup shall consist of all operations necessary to put the drill rig in operation, including erecting the drill rig and providing associated equipment, water supply and other items as required. Demobilization shall consist of the removal from the site of all plant and equipment and temporary installations after completion of the work and restoration of the work sites as nearly as possible to their original condition.

## 2.9 HANDLING OF DRILL CORES

The Contractor shall prepare a safe place for handling and storing cores at the drill site as approved by the Contracting Officer's Representative.

### 3.0 CARE AND DELIVERY OF SAMPLES

Core boxes required for the storage and preservation of the cores shall be furnished by the Contractor. Each core box will contain the entire core from one hole. The Contractor shall be solely responsible for preserving all samples in good condition. He shall keep descriptive labels and designations on boxes clean and legible until final delivery of samples to the approved laboratory.

\*\*\*\*\*END OF SECTION\*\*\*\*\*

SECTION 02230

CLEARING AND GRUBBING  
06/97

PART 1 GENERAL

1.1 DEFINITIONS

1.1.1 Clearing

Clearing shall consist of the felling, trimming, and cutting of trees into sections and the satisfactory disposal of the trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.

1.1.2 Grubbing

Grubbing shall consist of the removal and disposal of stumps, roots larger than 75 mm 3 inches in diameter, and matted roots from the designated grubbing areas.

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-18 Records

Materials Other Than Salable Timber; FIO.

Written permission to dispose of such products on private property shall be filed with the Contracting Officer.

1.3 MEASUREMENT

1.3.1 Measured Clearing

Clearing shall be measured in acres of clearing actually performed. Areas of light brush, shrubs, and other vegetation that can be cut with a brush hook, scythe, or mowing machine shall not be measured as clearing.

1.3.2 Measured Grubbing

Grubbing shall be measured in acres of grubbing actually performed. Areas where tree roots and timber are less than 75 mm 3 inches in diameter and areas where roots of brush, shrubs, and other vegetation can be removed by plowing shall not be measured as grubbing.

1.3.3 Measured Clearing and Grubbing

Clearing and grubbing shall be measured in hectares acres of clearing and

grubbing actually performed.

#### 1.3.4 Measured Tree Removal

Tree removal shall be measured by the number of trees of stated sizes removed from areas outside the clearing and grubbing areas. The size shall be determined by the average diameter of the trunk 1 m 4 feet above the ground line. The size of stumps designated for removal as trees shall be determined by the diameter of the trunk 1 m 4 feet above the ground line. The diameter shall be measured to the nearest 25 mm.full inch.

#### 1.4 PAYMENT

##### 1.4.1 Paid Clearing

Payment for clearing will be made at the contract unit price per hectare acre for clearing, and this price shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the work specified herein.

##### 1.4.2 Paid Grubbing

Payment for grubbing will be made at the contract unit price per hectare acre for grubbing, and this price shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the work specified herein.

##### 1.4.3 Paid Clearing and Grubbing

Payment will be made at the contract unit price for clearing and grubbing, and this price shall constitute full compensation for all labor, equipment, tools, and incidentals necessary to complete the work specified herein.

##### 1.4.4 Paid Tree Removal

Payment for tree removal will be made at the contract unit price for removing trees, or stumps designated as trees, that are outside the area designated for clearing or grubbing in accordance with the following schedule of sizes:

#### PART 2 PRODUCTS (Not Applicable)

#### PART 3 EXECUTION

##### 3.1 CLEARING

Trees, stumps, roots, brush, and other vegetation in areas to be cleared shall be cut off flush with or below the original ground surface, except such trees and vegetation as may be indicated or directed to be left standing. Trees designated to be left standing within the cleared areas shall be trimmed of dead branches 40 mm 1-1/2 inches or more in diameter and shall be trimmed of all branches the heights indicated or directed. Limbs and branches to be trimmed shall be neatly cut close to the bole of the tree or main branches. Cuts more than 40 mm 1-1/2 inches in diameter shall be painted with an approved tree-wound paint. Trees and vegetation to be left standing shall be protected from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by

such other means as the circumstances require. [Clearing shall also include the removal and disposal of structures that obtrude, encroach upon, or otherwise obstruct the work.]

### 3.2 GRUBBING

Material to be grubbed, together with logs and other organic or metallic debris not suitable for foundation purposes, shall be removed to a depth of not less than 455 mm 18 inches below the original surface level of the ground in areas indicated to be grubbed and in areas indicated as construction areas under this contract, such as areas for buildings, and areas to be paved. Depressions made by grubbing shall be filled with suitable material and compacted to make the surface conform with the original adjacent surface of the ground.

### 3.3 TREE REMOVAL

Where indicated or directed, trees and stumps that are designated as trees shall be removed from areas outside those areas designated for clearing and grubbing. This work shall include the felling of such trees and the removal of their stumps and roots as specified in paragraph GRUBBING. Trees shall be disposed of as specified in paragraph DISPOSAL OF MATERIALS.

### 3.4 DISPOSAL OF MATERIALS

#### 3.4.1 Salable Timber

All felled timber from which saw logs, pulpwood, posts, poles, ties, mine props, or cordwood can be produced shall be considered as salable timber, and shall be trimmed of limbs and tops, sawed into salable lengths of 2 meters, 6 feet, and stockpiled at locations as directed. The disposal of the stockpiled timber will be by the Government.

#### 3.4.2 Materials Other Than Salable Timber

Logs, stumps, roots, brush, rotten wood, and other refuse from the clearing and grubbing operations, except for salable timber, shall be disposed of outside the limits of Government-controlled land at the Contractor's responsibility, except when otherwise directed in writing. Such directive will state the conditions covering the disposal of such products and will also state the areas in which they may be placed.

-- End of Section --

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SECTION 02241  
AGGREGATE BASE COURSE  
**04/92**

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 29	(1991a) Unit Weight and Voids in Aggregate
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1996) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils Page 1
ASTM D 5255	(1992) Certification of Personnel Engaged in the Testing of Soil and Rock
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

CESPK PAM 415-1-2	Construction Control Manual
COE CRD-C 171	Determining Percentage of Crushed Particles in Aggregate

1.2 DEFINITIONS

1.2.1 Aggregate Base

Aggregate base as used herein is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

1.2.2 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 Procedure C

abbreviated hereinafter as percent laboratory maximum dry density.

### 1.3 GENERAL

The work specified herein consists of the construction of an aggregate base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans. Sources of all materials shall be selected well in advance of the time that materials will be required in the work.

### 1.4 UNIT PRICES

#### 1.4.1 Measurement

The quantity of graded, crushed aggregate base course completed and accepted will be measured in cubicmeters. yards. The volume of graded, crushed aggregate base course in place and accepted will be determined by the average job thickness obtained in accordance with paragraph THICKNESS CONTROL and the dimensions indicated.

#### 1.4.2 Payment

##### 1.4.2.1 Quantity of Graded, Crushed Aggregate Base Course

Quantity of graded, crushed aggregate base course, as specified above, will be paid for at the contract unit price (square yards), including the furnishing of all other necessary labor and incidentals.

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### 1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL

#### SD-01 Data

Plant, Equipment, Machines, and Tools; FIO.

List of proposed equipment to be used in performance of construction work including descriptive data.

#### SD-09 Reports

Sampling and Testing; FIO. Field Density; FIO.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.

#### SD-18 Records

Waybills and Delivery Tickets; FIO. Coarse Aggregate; FIO.

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used. A notification stating which type of coarse aggregate is to be used.

## 1.6 WAYBILLS AND DELIVERY TICKETS

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all aggregates actually used in the construction.

## 1.7 WEATHER LIMITATIONS

Base shall not be constructed when the atmospheric temperature is less than 2 degrees C, 35 degrees F. Base shall not be constructed on subgrades or subbases that are frozen or contain frost. If the temperature falls below 2 degrees C, 35 degrees F, completed areas shall be protected against any detrimental effects of freezing.

## 1.8 PLANT, EQUIPMENT, MACHINES, AND TOOLS

### 1.8.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified.

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### 1.8.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 9072 kg (10 tons), with a minimum weight of 53 kg/cm (300 pounds/inch) width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

### 1.8.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be loaded to weigh a minimum of 11,400 kg (25,000 pounds) and have four or more tires. Tires shall be inflated to a minimum pressure of 420 kPa (60 psi). The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

### 1.8.4 Mechanical Spreader

Mechanical spreader shall be self-propelled or attached to a propelling unit capable of moving the spreader and material truck. The device shall be steerable and shall have variable speeds forward and reverse. The spreader and propelling unit shall be carried on tracks, rubber tires, or drum-type steel rollers that will not disturb the underlying material. The spreader shall contain a hopper, an adjustable screed, and outboard bumper rolls and be designed to have a uniform, steady flow of material from the hopper. The spreader shall be capable of laying material without segregation across the full width of the lane to a uniform thickness and to a uniform loose density so that when compacted, the layer or layers shall conform to thickness and grade requirements indicated. The Contracting Officer may require a demonstration of the spreader prior to approving use in performance of the work.

### 1.8.5 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

#### 1.8.6 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

#### 1.8.7 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 3.66 meter (12 foot) 12-foot straightedge for each bituminous paver, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have 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 pavement.

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### 1.9 STOCKPILING MATERIALS

Materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at locations designated. Before stockpiling of material, storage sites shall be cleared, and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

#### 1.10 SAMPLING AND TESTING

##### 1.10.1 General Requirements

Sampling and testing shall be performed by an approved commercial testing laboratory subject to approval and meeting the requirements of ASTM D 3740. Testing personnel shall be certified for the requirements outlined in ASTM D 5255. No work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed as specified herein after to insure that materials and compaction meet specified requirements. Field test information shall be submitted on a "Density Test Log" which shall include but not be limited to the following: test date, test number, feature of work, station/location, offset, elevation, in-place dry unit weight, moisture content, percent compaction, pass or fail, test method, and gradation.

##### 1.10.2 Test Results

Copies of test results shall be furnished to the Contracting Officer within 24 hours of completion of tests. Results shall verify that materials comply with this specification. When a material source is changed, the new material will be tested for compliance. When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified as directed by the Contracting Officer.

##### 1.10.3 Sampling

Aggregate samples for laboratory tests shall be taken in accordance with ASTM D 75.

##### 1.10.4 Field Density with Moisture Content

Field in-place density shall be determined in accordance with ASTM D 1556. Calibration curves and calibration test results shall be furnished within 24 hours of the conclusion of the tests. Perform two tests per each increment or fraction of 1000 square meters/1000 square yards placed during each 8 hour shift.

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#### 1.10.5 Gradation with Atterberg Limits

Before starting work, at least one sample of material shall be tested in accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11. Atterberg limits shall be determined by the test method outlined in ASTM D 4318. After the initial test, perform two sets of tests, on compacted material, for every 5 field density tests.

#### 1.10.6 Moisture-Density Relationship

Moisture-density relationships from bulk samples shall be established with the test method outlined in ASTM D 1557, Procedure C. Perform one test for every 5 field density tests (with not less than 1 test for each type of material).

#### 1.10.7 Degradation Tests

Degradation tests shall be performed on bulk samples in accordance with ASTM C 131. One test shall be run for every five field density tests (with not less than 1 test for each type of material).

### PART 2 PRODUCTS

#### 2.1 MATERIALS

##### 2.1.1 Aggregates

Aggregates shall consist of crushed stone, crushed gravel, angular sand, or other approved material. Aggregates shall be durable and sound, free from lumps of clay, organic matter, objectionable coatings, and other foreign material. Material retained on a 4.75 mm No. 4 sieve shall be known as coarse aggregate and that passing the 4.75 mm No. 4 sieve shall be known as binder material.

##### 2.1.1.1 Coarse Aggregate

Only one type of coarse aggregate shall be used on the project. Coarse aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 40 percent after 500 revolutions when tested in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3.

a. Crushed Gravel: Crushed gravel shall be manufactured from gravel particles 50 percent of which by weight are retained on the maximum size gradation sieve specified.

b. Crushed Stone: Crushed stone retained on each sieve specified shall contain the crushed pieces and freshly fractured faces as required under COE CRD-C 171.

2.1.2 Binder Material

Binder material shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate. Liquid-limit and plasticity-index requirements shall apply to any component that is blended to meet the required gradation and shall also apply to the completed course. The portion of any component or of the completed course passing the 0.425 mm No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 25 and a plasticity index not greater than 5.

2.1.3 Gradation

Requirements for gradation specified shall apply to the completed base course. The aggregates shall have a 25 mm 1-inch maximum size and shall be continuously graded within the following limits:

Sieve Designation	Percent by Weight Passing Square-mesh Sieve (a)(b)(c)
1 - Inch	100
3/4 Inch	87-100
No. 4	30-65
No. 30	5-35
No. 200	0-12

(a) Similar to Class 2 Aggregate Base, 3/4-inch Maximum as specified in Section 26 of the State of California Department of Transportation *Standard Specifications*.

(b) Particles having diameters less than No. 200 standard sieve shall not be in excess of 3 percent by weight of the total sample tested.

© The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction in accordance with ASTM C 127 and ASTM C 128 when aggregates of varying specific gravities are used.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the base is constructed in more than one layer, the previously constructed layer shall be cleaned 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. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided 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

Aggregates shall be obtained from off-site sources.

3.3 PREPARATION OF UNDERLYING COURSE

3.3.1 General Requirements

Before constructing aggregate base course, the previously constructed

underlying course shall be cleaned of foreign substances. Ruts or soft, yielding spots that may appear in the underlying course, areas having inadequate compaction, and deviations of the surface shall be corrected. Stabilization may be accomplished by mixing base course material into the underlying course and compacting by approved methods. Properly compacted material will be considered as part of the underlying course. Finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until base course is placed.

#### 3.3.2 Grade Control

Underlying material shall be excavated to sufficient depth for the required base course thickness so that the finished base course with the subsequent surface course will meet the fixed grade. Finished and completed area shall conform to the lines, grades, cross section, and dimensions indicated.

### 3.4 INSTALLATION

#### 3.4.1 Mixing and Placing

Materials shall be mixed by the stationary plant, traveling plant, or road mix method and placed in such a manner as to obtain uniformity of the aggregate base course material and at a uniform optimum water content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to ensure a satisfactory base course.

#### 3.4.2 Edges of Base Course

Approved material shall be placed along edges of aggregate base course in such quantities as will compact to 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 1-foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of base course.

#### 3.4.3 Compaction

Each layer of aggregate base course shall be compacted. Water content shall be maintained at optimum. Density of compacted mixture shall be at least 98 percent of the laboratory maximum dry density. Rolling shall begin 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. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

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#### 3.4.4 Layer Thickness

Compacted thickness of the aggregate course shall be as indicated. No layer shall be in excess of 6 inches nor less than 3 inches in compacted thickness.

#### 3.4.6 Finishing

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to

completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

#### 3.4.6.1 Smoothness

Surface of each layer shall show no deviations in excess of 3/8 inch when tested with the 12-foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

#### 3.4.6.2 Thickness Control

Compacted thickness of the base course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected 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.

### 3.5 FIELD QUALITY CONTROL

#### 3.5.1 Field Density With Moisture Content

Perform two field density tests with moisture contents for each increment or fraction of 1000 square yards placed during each 8 hour shift.

#### 3.5.2 Gradation With Atterberg Limits

Before starting work, at least one sample of material shall be tested for gradation and Atterberg limit compliance. After the initial test, perform two sets of tests, on compacted material, for every 5 field density tests.

#### 3.5.3 Moisture-Density Relationship

Perform one moisture-density relationship test for every 5 field density tests (with not less than 1 test for each type of material).

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#### 3.5.4 Degradation Tests

One degradation test shall be run for every five field density tests (with not less than 1 test for each type of material).

#### 3.5.5 Smoothness

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 12-foot straightedge. Measurements shall also be taken perpendicular to the road centerline at 50 foot intervals.

#### 3.5.6 Thickness

Thickness of the base course shall be measured at intervals in such a manner as to ensure one measurement for each 250 square yards of base course. Measurements shall be made by taking differential elevations at preselected locations between the subgrade and the top of the completed base course. Locations and subgrade elevations shall be delivered to the Corps QA Inspector prior to base course placement. Locations and top of base course elevations shall be delivered to the Corps QA Inspector within

24 hours of base course completion.

3.6 TRAFFIC

Completed portions of the area may be opened to traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment shall not be permitted except when necessary to construction, and then the area shall be protected against marring or damage to the completed work.

3.7 MAINTENANCE

The aggregate base course shall be maintained in a satisfactory condition until accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact.

3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for the base course material that is removed for the required correction of defective areas, and waste material and debris shall be disposed of as directed.

-- End of Section --

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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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136	(1996) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 1140	(1992) Amount of Material in Soils Finer than the No. 200 (75-micrometer) Sieve
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) content of Soil and Rock
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged In the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	(1995a) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5255	(1992) Certification of Personnel Engaged in the Testing of Soil and Rock
ASTM D 5268 Purposed	(1992; R 1996) Topsoil Used for Landscaping
ASTM E 329	(1990) Evaluation of Testing and Inspection Agencies as Used in Construction

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

EM 385-1-1	Safety and Health Requirements Manual
CESPK PAM 415-1-2	Construction Control Manual

## 1.2 MEASUREMENT

### 1.2.1 Excavation

The unit of measurement for excavation and borrow will be the cubic yard, computed by the average end area method from cross sections taken before and after the excavation and borrow operations. The volume to be paid for will be the number of cubic yards of material measured in its original position and removed from the excavation and borrow areas, including the excavation for ditches, gutters, and channel changes, when the material is acceptably utilized or disposed of as herein specified. The measurements will include authorized excavation of rock, authorized excavation of unsatisfactory subgrade soil, and the volume of loose, scattered rocks and boulders collected within the limits of the work; allowance will be made on the same basis for selected backfill ordered as replacement. The measurement will not include the volume of subgrade material or other material that is scarified or plowed and reused in-place, and will not include the volume excavated without authorization or the volume of any material used for purposes other than directed. The volume of overburden stripped from borrow pits and the volume of excavation for ditches to drain borrow pits, unless used as borrow material, will not be measured for payment. The measurement will not include the volume of any excavation performed prior to the taking of elevations and measurements of the undisturbed grade.

### 1.2.2 Topsoil Requirements

Separate excavation, hauling, and spreading or piling of topsoil and related miscellaneous operations will be considered subsidiary obligations of the Contractor, covered under the contract unit price for excavation.

## 1.3 PAYMENT

Payment will constitute full compensation for all labor, material, and equipment, tools, supplies, and incidentals necessary to complete the work.

### 1.3.1 Classified Excavation

Classified excavation will be paid for at the contract unit prices per cubic yard for common or rock excavation.

### 1.3.2 Unclassified Excavation

Unclassified excavation will be paid for at the contract unit prices per cubic yard.

### 1.3.3 Borrow

Borrow will be paid for at the contract unit price per cubic yard.

## 1.4 DEFINITIONS

### 1.4.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP, GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, and CL. Satisfactory materials for grading shall have a maximum particle size of 2 inches in any dimension. The portion passing the No. 40 standard sieve shall have a liquid limit of no greater than 35 when tested in accordance with ASTM D 4318.

### 1.4.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and

material classified as satisfactory which contains root and other organic matter or frozen material. The Contracting Officer's Representative shall be notified of any contaminated materials.

#### 1.4.3 Unstable Materials

Materials that rut or shove under the wheels of construction equipment due to excessive moisture are unstable and unsatisfactory. Potentially unstable materials are fine grained soils with moisture contents near or above the plastic limit of 5 or more percent above the ASTM D 1557 optimum water content. Unstable materials are also indicated by waving, rutting, and shoving under the wheels and rollers of construction equipment. Unstable material may be encountered at this site during construction. Unstable material will require discing and drying and/or replacement and disposal. No additional compensation shall be forthcoming for the extra construction effort, time loss, or any other costs of remediation for unstable conditions.

#### 1.4.4 Degree of Compaction

Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 Procedure C abbreviated herein as the percent of laboratory maximum density.

#### 1.4.5 Topsoil

Material suitable for topsoils obtained from offsite areas and meeting the percentages outlined in Table 1 of ASTM D 5268 is defined as topsoil.

### 1.5 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-08 Statements

Earthwork; GA.

Procedure and location for disposal of unused satisfactory material.  
Proposed source of borrow material.

#### SD-09 Reports

Testing; FIO.

Within 24 hours of conclusion of physical tests, 2 copies of test results, including calibration curves and results of calibration tests. Information shall be submitted on a DENSITY Test Log@ which shall include but not be limited to the following: test date, test number, feature of work, station/ location, offset, elevation, in place dry unit weight, moisture content, percent compaction, pass or fail, test method, and soil classification.

#### SD-13 Certificates

Testing; FIO.

Qualifications of the commercial testing laboratory or Contractor's testing facilities in accordance with ASTM D 3740 and ASTM E 329. Qualifications of testing personnel in accordance with ASTM D 5255.

SD-18 Records

Earthwork; GA.

Notification of encountering rock in the project. Advance notice on the opening of excavation or borrow areas. Advance notice on shoulder construction for rigid pavements.

1.6 SUBSURFACE DATA

Subsurface soil boring logs are as shown in the Task Order.

1.7 CLASSIFICATION OF EXCAVATION

Excavation specified shall be done on a classified basis, in accordance with the following designations and classifications.

1.7.1 Common Excavation

Common excavation shall include the satisfactory removal and disposal of all materials not classified as rock excavation.

1.8 BLASTING

Blasting will not be permitted.

1.9 UTILIZATION OF EXCAVATED MATERIALS

Unsatisfactory materials removed from excavations shall be disposed of in designated waste disposal or spoil areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding (as backfill), and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed of in designated areas approved for surplus material storage or designated waste areas as directed. Newly designated waste areas on Government-controlled land shall be cleared and grubbed before disposal of waste material thereon. Coarse rock from excavations shall be stockpiled and used for constructing slopes or embankments adjacent to streams, or sides and bottoms of channels and for protecting against erosion. No excavated material shall be disposed of to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 STRIPPING OF TOPSOIL

Where indicated or directed, topsoil shall be stripped to a depth of 2 inches. Topsoil shall be spread on areas already graded and prepared for topsoil, or transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later, or at locations indicated or specified. Topsoil shall be kept separate from other excavated materials, brush, litter, objectionable weeds, roots, stones larger than 2 inches in diameter, and other materials that would interfere with planting and maintenance operations. Any surplus of topsoil from excavations and grading shall be stockpiled in locations indicated or removed from the site as shown in the Task Order.

3.2 GENERAL EXCAVATION

The Contractor shall perform excavation of every type of material encountered within the limits of the project to the lines, grades, and elevations indicated and as specified. Deep excavation shall be conducted in conformance with the safety requirements of Section 25 of EM 385-1-1. Grading

shall be in conformity with the typical sections shown and the tolerances specified in paragraph FINISHING. Satisfactory excavated materials shall be transported to and placed in fill or embankment within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Such excavated material and the satisfactory material ordered as replacement shall be included in excavation. Surplus satisfactory excavated material not required for fill or embankment shall be disposed of in areas approved for surplus material storage or designated waste areas. Unsatisfactory excavated material shall be disposed of in designated waste or spoil areas. During construction, excavation and fill shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from borrow areas.

### 3.2.1 Unstable Materials

The Corps Field Representative (QA) will be notified when unstable materials are encountered so that measurements can be taken and excavation quantities agreed to. No additional compensation shall be forthcoming for excavation or over-excavation performed without the knowledge and authorization of the Contracting Officer's Representative. No additional compensation shall be forthcoming for the excavation, overexcavation, and replacement of material rendered unstable by Contractor managed operations. A modification to the Task Order will be authorized for instances where there are substantial conflicts between the exploration logs and the materials encountered during construction.

### 3.2.2 Ditches, Gutters, and Channel Changes

Excavation of ditches, gutters, and channel changes shall be accomplished by cutting accurately to the cross sections, grades, and elevations shown. Ditches and gutters shall not be excavated below grades shown. Excessive open ditch or gutter excavation shall be backfilled with satisfactory, thoroughly compacted, material or with suitable stone or cobble to grades shown. Material excavated shall be disposed of as shown or as directed, except that in no case shall material be deposited less than 4 feet from the edge of a ditch. The Contractor shall maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

### 3.2.3 Drainage Structures

Excavations shall be made to the lines, grades, and elevations shown, or as directed. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm, level, stepped, or serrated surface. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, the bottom of the excavation shall not be disturbed. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

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## 3.3 SELECTION OF BORROW MATERIAL

Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas shown or from other approved sources, either private or within the limits of the project site, selected by the Contractor. Unless otherwise provided in the contract, the Contractor shall obtain from the owners the right to procure material, pay royalties and other charges involved, and bear the expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Government-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written

approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris thereon shall be considered related operations to the borrow excavation.

### 3.4 OPENING AND DRAINAGE OF EXCAVATION AND BORROW PITS

The Contractor shall notify the Contracting Officer sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Except as otherwise permitted, borrow pits and other excavation areas shall be excavated providing adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed of as directed. Borrow pits shall be neatly trimmed and drained after the excavation is completed. The Contractor shall ensure that excavation of any area, operation of borrow pits, or dumping of spoil material results in minimum detrimental effects on natural environmental conditions.

### 3.5 BACKFILL

Backfill adjacent to any and all types of structures shall be placed and compacted to at least 95 percent laboratory maximum dry density. Materials shall be placed and compacted in such a manner as to prevent wedging action or eccentric loading upon or against the structure. Ground surface on which backfill is to be placed shall be prepared as specified in paragraph PREPARATION OF GROUND SURFACE FOR EMBANKMENTS. Compaction requirements for backfill materials shall also conform to the applicable portions of paragraphs PREPARATION OF GROUND SURFACE FOR EMBANKMENTS, EMBANKMENTS, and SUBGRADE PREPARATION, and Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment.

### 3.6 PREPARATION OF GROUND SURFACE FOR EMBANKMENTS

#### 3.6.1 General Requirements

Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; plowed, disced, or otherwise broken up to a depth as shown in the Task Order; pulverized; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 95 percent laboratory maximum dry density. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated as required

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just prior to placement of embankment materials to assure adequate bond between embankment material and the prepared ground surface.

#### 3.6.2 Frozen Material

Embankment shall not be placed on a foundation which contains frozen material, or which has been subjected to freeze-thaw action. This prohibition encompasses all foundation types, including the natural ground, all prepared subgrades (whether in an excavation or on an embankment) and all layers of previously placed and compacted earth fill which become the foundations for successive layers of earth fill. All material that freezes or has been subjected to freeze-thaw action during the construction work, or during periods of temporary shutdowns, such as, but not limited to, nights, holidays, weekends, winter shutdowns, or earthwork operations, shall be removed to a depth that is acceptable to the Contracting Officer and replaced with new material. Alternatively, the material will be thawed, dried, reworked, and recompacted to the specified criteria before additional material is placed. The Contracting Officer will determine when placement of fill shall cease due to cold weather. The Contracting Officer may elect to use average daily air temperatures, and/or physical observation of the soils for his determination. Embankment material shall

not contain frozen clumps of soil, snow, or ice.

### 3.7 EMBANKMENTS

#### 3.7.1 Earth Embankments

Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with any dimension greater than 3 inches. The material shall be placed in successive horizontal layers of loose material not more than 8 inches in depth. Each layer shall be spread uniformly on a soil surface that has been moistened or aerated as necessary, and scarified or otherwise broken up so that the fill will bond with the surface on which it is placed. After spreading, each layer shall be plowed, disked, or otherwise broken up; moistened or aerated as necessary; thoroughly mixed; and compacted to at least 90 percent laboratory maximum density for cohesive materials or 95 percent laboratory maximum density for cohesionless materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical with those requirements specified in paragraph SUBGRADE PREPARATION. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other equipment well suited to the soil materials being compacted.

### 3.8 SUBGRADE PREPARATION

#### 3.8.1 Construction

Subgrade shall be shaped to line, grade, and cross section, and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain specified compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut section shall be excavated to a depth of 6 inches below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required

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grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified.

#### 3.8.2 Compaction

Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Except for paved areas and railroads, each layer of the embankment shall be compacted to at least 95 percent of laboratory maximum density. Compaction shall be performed on materials that are within 2 percent of the optimum water content.

##### 3.8.2.1 Subgrade for Railroads

Subgrade for railroads shall be compacted to at least 95 percent laboratory maximum dry density. Compaction shall be performed on materials that are within 2 percent of the optimum water content.

##### 3.8.2.2 Subgrade for Pavements

Subgrade for pavements shall be compacted to at least 95 percent of laboratory maximum dry density for the depth below the surface of the pavement shown. When more than one soil classification is present in the subgrade, the top 6" of subgrade shall be scarified, windrowed, thoroughly blended, reshaped, and compacted as shown in the Task Order. Compaction shall be performed on materials that are within 2 percent of the optimum water content.

##### 3.8.2.3 Subgrade for Shoulders

Subgrade for shoulders shall be compacted to at least 95 percent of laboratory

maximum dry density for the full depth of the shoulder. Compaction shall be performed on materials that are within 2 percent of the optimum water content.

### 3.9 SHOULDER CONSTRUCTION

Shoulders shall be constructed of satisfactory excavated or borrow material or as otherwise shown or specified. Shoulders shall be constructed as soon as possible after adjacent paving is complete, but in the case of rigid pavements, shoulders shall not be constructed until permission of the Contracting Officer has been obtained. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified in paragraph SUBGRADE PREPARATION above, for specific ranges of depth below the surface of the shoulder. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and that no damage of any kind is done to the adjacent completed pavement. The completed shoulders shall be true to alignment and grade and shaped to drain in conformity with the cross section shown.

### 3.10 FINISHING

The surface of excavations, embankments, and subgrades shall be finished to a smooth and compact surface in accordance with the lines, grades, and cross sections or elevations shown. The degree of finish for graded areas shall be within 0.1 foot of the grades and elevations indicated except that the degree of finish for subgrades shall be specified in paragraph SUBGRADE PREPARATION. Gutters and ditches shall be finished in a manner that will result in effective

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drainage. The surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

### 3.11 PLACING TOPSOIL

On areas to receive topsoil, the compacted subgrade soil shall be scarified to a 2 inch depth for bonding of topsoil with subsoil. Topsoil then shall be spread evenly to a thickness of 6 inches and graded to the elevations and slopes shown. Topsoil shall not be spread when frozen or excessively wet or dry. Material required for topsoil in excess of that produced by excavation within the grading limits shall be obtained from offsite areas.

### 3.12 TESTING

Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. If the Contractor elects to establish testing facilities, no work requiring testing will be permitted until the Contractor's facilities have been inspected and approved by the Contracting Officer. Cost incurred for inspections required will be charged to the Contractor. Field in-place density shall be determined in accordance with ASTM D 1556. When test results indicate, as determined by the Contracting Officer, that compaction is not as specified, the material shall be removed, replaced and recompacted to meet specification requirements. Tests on recompacted areas shall be performed to determine conformance with specification requirements. Inspections and test results shall be certified by a registered professional civil engineer. These certifications shall state that the tests and observations were performed by or under the direct supervision of the engineer and that the results are representative of the materials or conditions being certified by the tests. The following number of tests, if performed at the appropriate time, will be the minimum acceptable for each type operation.

#### 3.12.1 Fill and Backfill Material Gradation

#### 3.12.2 In-Place Densities

- a. Two tests per each lift for each increment or fraction of 2000 square yards, placed during each 8 hour shift for areas compacted by other than

hand-operated machines. Water contents shall be determined by the test method outlined in ASTM D 2216.

b. One random test at each location, of each lift of fill or backfill areas compacted by hand-operated machines.

c. One test per each lift of embankment or backfill for roads, airfields.

d. One test per each lift of embankment or backfill for railroads.

### 3.12.3 Gradation with Atterberg Limits

One test for every five in-place density tests. From compacted material, the gradation of fill and backfill material shall be determined in accordance with ASTM C 136 and ASTM D 1140, as applicable. Atterberg limits shall be determined in accordance with the test method outlined in ASTM D 4318

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### 3.12.4 Moisture-Density Relationships with Gradation, Atterberg Limits, Specific Gravity, and Classification

One test for every five field density tests, with not less than one for each type of material.

### 3.12.5 Subgrade Testing

#### 3.12.5.1 Field Density with Moisture Content

a. Two tests per lift for each increment or fraction of 1000 square yards, placed during each 8 hour shift for areas compacted by other than hand-operated machines.

b. One random test at each location, of each lift of fill or backfill areas compacted by Hand-operated machines.

#### 3.12.5.2 Gradation with Atterberg Limits

Two tests for every five in-place density tests. From compacted material, the gradation of fill and backfill material shall be determined in accordance with ASTM C 136 and ASTM D 1140, as applicable. Atterberg limits shall be determined in accordance with the test method outlined in ASTM D 4318.

#### 3.12.5.3 Moisture-Density Relationships with Gradation, Atterberg Limits, Specific Gravity, and Classification.

One test for every five field density tests, with not less than one for each type of material.

#### 3.12.5.4 Tolerance Tests for Subgrades

Checks on the degree of finish specified in paragraph SUBGRADE PREPARATION shall be made at the edges and centerlines of subgrade areas, in both the longitudinal and transverse directions, at 50 foot intervals during construction of the subgrade.

### 3.13 SUBGRADE AND EMBANKMENT PROTECTION

During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained to drain effectively at all times. The finished subgrade shall not be disturbed by traffic or other operation and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. The storage or stockpiling of materials on the

finished subgrade will not be permitted. No subbase, base course, ballast, or pavement shall be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on an unstable subgrade.

----End of Section----

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SECTION 02316

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II

SECTION 02316

EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS

**11/97**

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1990) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1992) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1993) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3740	(1996) Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock As Used in Engineering Design and Construction
ASTM D 5255	(1992) Certification of Personnel Engaged in The Testing of Soil and Rock
ASTM E 329	(1990) Evaluation of Testing and Inspection Agencies as Used in Construction

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EM 385-1-1	Safety and Health Requirements Manual
CESPK PAM 415-1-2	Construction Control Manual

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1.2 MEASUREMENT AND PAYMENT

Measurement and payment shall be based on completed work performed in accordance with the drawings and specifications.

1.2.1 Trench Excavation

Trench excavation shall be the number of linear meters feet measured along the centerline of the trench and excavated to the depths and widths specified for the particular size of pipe. No increase shall be made for the extra width required at manholes and similar structures. Payment for trench excavation, as so measured, shall constitute full payment for excavation and backfilling, including specified overdepth except in rock or unstable trench bottoms. Unstable trench bottoms shall be replaced by select granular material and paid for as specified below. Trench excavation shall also include the additional width at manholes and similar structures, the furnishing, placing and removal of sheeting and bracing, pumping and bailing, and all incidentals necessary to complete the work required by this section.

### 1.2.2 Shielding and Bracing

No additional compensation shall be forthcoming for any required shielding and bracing. Shielding and bracing shall be considered as part of the work to be performed.

### 1.2.3 Select Granular Material

Select granular material shall be measured in place as the actual cubic meters yards replacing wet or unstable material in trench bottoms within the limits shown. The unit price shall include furnishing and placing the granular material, excavation and disposal of unsatisfactory material, and additional requirements for sheeting and bracing, pumping, bailing, cleaning, and other incidentals necessary to complete the work. Payment for select granular material will be made in addition to the bid price for trench excavation.

### 1.3 DEGREE OF COMPACTION

Degree of compaction shall be expressed as a percentage of the maximum dry density obtained by Test Procedure C presented in ASTM D 1557.

### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL

#### SD-09 Reports

Field Density Tests; FIO. Testing of Backfill Materials; FIO.

Copies of all laboratory and field test reports within 24 hours of the completion of the test.

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## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Satisfactory Materials

Satisfactory materials shall comprise any materials classified by ASTM D 2487 as GW, GP,GM, GP-GM, GW-GM, GC, GP-GC, GM-GC, SW, SP, SM, SW-SM, SC, SW-SC, SP-SM, SP-SC, and CL. Materials shall be free from roots and other organic matter, trash, debris, and frozen materials and stones larger than 2 inches. The portion passing the No. 40 standard sieve shall have a liquid limit of no greater than 35 when tested in accordance with ASTM D 4318.

#### 2.1.2 Unsatisfactory Materials

Materials which do not comply with the requirements for satisfactory materials are unsatisfactory. Man-made fills, and backfills of otherwise satisfactory materials from previous construction are unsatisfactory until compacted to the densities specified herein. Any materials that will not readily compact to the densities specified herein are stable and unstatisfactory. The Contracting Officer's Representative shall be notified of any contaminated materials.

#### 2.1.3 Unstable Material

Materials that cannot be properly compacted or will not support construction equipment or conduits and their appurtenances due to excessive moisture are

unstable. Potentially unstable materials are fine grained soils with moisture contents near or above the plastic limit of 5 or more percent above the ASTM D 1557 optimum water content. Unstable materials are also indicated by waving, rutting, and shoving under the wheels and rollers of construction equipment. Unstable material may be encountered at this site during construction. Unstable conditions in excavations shall be mitigated as specified herein after.

#### 2.1.4 Select Granular Material

Select granular material shall consist of sands, gravels, crushed gravel, or crushed stone composed of hard, tough and durable particles. Select granular material shall be graded in accordance with the ASTM C 33 gradation for size 67 concrete coarse aggregate.

#### 2.1.5 Initial Backfill Material

Initial backfill material shall consist of the material specified by the conduit or coating manufacture for the particular trench configuration and loading condition. Where conflicts in specifications exist, the better material or alternative shall be utilized. In the absence of a conduit or coating manufacture's specifications, initial backfill shall consist of select granular material; controlled low strength material, or sand. Select granular shall be used for bridging and general bedding and initial backfill. Controlled low strength material shall be used for bridging and bedding and

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initial backfill under heavily loaded areas and buildings. Sand shall be used as bedding and initial backfill for conduits that are coated for corrosion protection.

##### 2.1.5.1 Sand

Sand shall conform to ASTM C 33 requirements for concrete fine aggregate. Additionally, sand shall have an in place water content of less than 7 percent as determined by ASTM D 2216.

#### 2.2 PLASTIC MARKING TAPE

Plastic marking tape shall be acid and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch. Tape shall have a minimum strength of 1750 psi lengthwise and 1500 psi crosswise. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be of a type specifically manufactured for marking and locating underground utilities. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion. Tape color shall be as specified in TABLE 1 and shall bear a continuous printed inscription describing the specific utility.

TABLE 1. Tape Color

Red:	Electric
Yellow:	Gas, Oil, Dangerous Materials
Orange:	Telephone, Telegraph, Television, Police, and Fire Communications
Blue:	Water Systems
Green:	Sewer Systems

### 3.1 EXCAVATION

Excavation shall be performed to the lines and grades indicated. Excavation shall be made in compliance with the safety requirements of Section 25 of EM 385-1-1. Earth excavation shall include removal and disposal of material not classified as rock excavation. During excavation, material satisfactory for backfilling shall be stockpiled in an orderly manner at a distance from the banks of the trench, but in no instance closer than 3 feet. Excavated material not required or not satisfactory for backfill shall be removed from the site and disposed of off government controlled land. Grading shall be done as may be necessary to prevent surface water from flowing into the excavation, and any water accumulating shall be removed to maintain the stability of the bottom and sides of the excavation. No additional compensation shall be forthcoming for the excavation and replacement of materials from unauthorized overexcavation or materials rendered unsatisfactory by Contractor managed operations. No additional compensation shall be forthcoming for material excavation and replacement due to the Contractor's failure to protect, drain, or dewater the project site. A

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change in the contract price shall be considered for incidents where unsatisfactory materials are encountered at depths and locations that are in conflict with the contract exploration logs. Overexcavation shall be backfilled in accordance with paragraph BACKFILLING AND COMPACTION.

#### 3.1.1 Trench Excavation Requirements

The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, and of such width as recommended in the manufacturer's installation manual. Where no manufacturer's installation manual is available, trench walls shall be made vertical. Trench walls more than 5 feet high shall be shored, cut back to a stable slope, or provided with equivalent means of protection for employees who may be exposed to moving ground or cave in. Trench walls which are cut back shall be excavated to at least the angle of repose of the soil. The trench wall to pipe distance below the top of the pipe shall not exceed 6 inches. Where recommended trench widths are exceeded, redesign, stronger pipe, or special installation procedures shall be utilized by the Contractor. The cost of redesign, stronger pipe, or special installation procedures shall be borne by the Contractor without any additional cost to the Government.

##### 3.1.1.1 Bottom Preparation

Trenches shall be overexcavated to provide sufficient clearance for the bedding material below the bottom of the conduits. The bottoms of trenches shall be accurately graded to provide uniform bearing and support for the bedding material beneath each section of the pipe. Stones shall be removed to avoid point bearing on conduits.

##### 3.1.1.2 Removal of Unyielding Material

Where unyielding material is encountered in the bottom of the trench, such material shall be removed to provide sufficient clearance for bedding material below the conduits.

##### 3.1.1.3 Removal of Unstable Material

Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material as provided in paragraph BACKFILLING

AND COMPACTION. When removal of unstable material is required due to the Contractor's fault or neglect in performing the work, the resulting material shall be excavated and replaced by the Contractor without additional cost to the Government.

#### 3.1.1.4 Excavation for Appurtenances

Excavation for manholes, catch-basins, inlets, or similar structures shall be sufficient to permit the placement and removal of forms for the full length and width of structure footings and foundations as shown. Rock shall be cleaned of loose debris and cut to a firm surface either level, stepped, or

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serrated, as shown or as directed. Loose disintegrated rock and thin strata shall be removed. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is to be placed.

#### 3.1.1.5 Jacking, Boring, and Tunneling

Unless otherwise indicated, excavation shall be by open cut except that sections of a trench may be jacked, bored, or tunneled if, in the opinion of the Corps QA Inspector, the pipe, cable, or duct can be safely and properly installed and backfill can be properly compacted in such sections. The Contractor shall vertically and horizontally locate all underground utilities in the vicinity of the operation and shall repair any broken or damaged utilities or pavement at no cost to the government. The Contractor shall obtain all permits and clearances for the operation. All excavations shall be completely backfilled, compacted, and graded upon completion of testing.

#### 3.1.2 Stockpiles

Stockpiles of satisfactory materials and waste materials shall be placed separately and graded. Stockpiles shall be kept in a neat and well drained condition, giving due consideration to drainage at all times. The ground surface at stockpile locations shall be cleared, grubbed, and sealed by rubber-tired equipment, excavated satisfactory and unsatisfactory materials shall be separately stockpiled. Stockpiles of satisfactory materials shall be protected from contamination which may destroy the quality and fitness of the stockpiled material. If the Contractor fails to protect the stockpiles, and any material becomes unsatisfactory, such material shall be removed and replaced with satisfactory material from approved sources at no additional cost to the Government. Locations of stockpiles shall be subject to prior approval of the Corps QA field representative.

### 3.2 BACKFILLING AND COMPACTION

Backfill material shall consist of satisfactory material, select granular material, or initial backfill material as required. Backfill shall be placed in layers not exceeding 6 inches loose thickness for compaction by hand operated machine compactors, and 8 inches loose thickness for other than hand operated machines, unless otherwise specified. Each layer shall be compacted to 95 percent maximum dry densities, unless otherwise specified.

#### 3.2.1 Trench Backfill

Trenches shall be backfilled to the grade shown. The trench shall be backfilled to 2 feet above the top of pipe prior to performing the required

pressure tests. The joints and couplings shall be left uncovered during the pressure test and trust blocks shall be allowed to cure for 48 hours prior to testing. Backfilling shall not be completed until all specified tests are performed and passed.

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#### 3.2.1.1 Replacement of Unyielding Material

Unyielding material removed from the bottom of the trench shall be replaced with initial backfill material.

#### 3.2.1.2 Replacement of Unstable Material

Unstable material removed from the bottom of the trench or excavation shall be replaced or bridged with select granular material or controlled low strength material as directed.

#### 3.2.1.3 Bedding and Initial Backfill

Bedding shall consist of initial backfill material placed to the thickness shown. Care shall be taken to ensure thorough compaction of the bedding under the haunches of the pipe. Initial backfill material shall be placed and compacted with approved tampers to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up evenly on both sides of the pipe for the full length of the pipe. With the exception of controlled low strength material, initial backfill shall be placed in 6 inch loose lifts, each lift compacted with an approved hand-operated vibratory plate-type compactor until no additional surface elevation changes occur.

#### 3.2.1.4 Final Backfill

The remainder of the trench, except for special materials for roadways, shall be filled with satisfactory material. Placed conduits shall be protected from crushing by construction vehicles during subsequent construction operations. The Contractor shall repair damaged lines at no additional cost to the Government. Backfill material shall be placed and compacted as follows:

- a. Under paved areas and shoulders: backfill shall be placed and compacted to a minimum of 95 percent of the maximum laboratory dry density, full depth. Water flooding or jetting methods of compaction will not be permitted.
- b. Sidewalks, Turfed or Seeded Areas and Miscellaneous Areas: Backfill shall be deposited and compacted to 90 percent maximum Dry density. Compaction by water flooding or jetting will not be permitted. This requirement shall also apply to all other areas not specifically designated above.

#### 3.2.2 Backfill for Appurtenances

After the manhole, catchbasin, inlet, or similar structure has been constructed and the concrete has been allowed to cure for 7 days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be brought up evenly on all sides of the structure to prevent eccentric loading and excessive stress.

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### 3.3 SPECIAL REQUIREMENTS

Special requirements for both excavation and backfill relating to the specific utilities are as follows:

#### 3.3.1 Gas Distribution

Trenches shall be excavated to a depth that will provide not less than 24 inches of cover in excavation. Trenches shall be graded as specified for pipe-laying requirements provided with Task Order.

#### 3.3.2 Water Lines

Trenches shall be of a depth to provide a minimum cover of 2 feet from the existing ground surface, or from the indicated finished grade, whichever is lower, to the top of the pipe. Thrust shall be placed at the joints as shown on the contract drawings for each Task Order; care shall be taken to keep thrust block concrete clear of the joint interfaces and bolted connections. Thrust blocks shall be allowed to cure for a minimum of 48 hours prior to pressure testing.

#### 3.3.3 Heat Distribution System

Initial backfill material shall be free of stones larger than 1/4 inch in any dimension.

#### 3.3.4 Electrical Distribution System

Direct burial cable and conduit or duct line shall have a minimum cover of 24 inches from the finished grade, unless otherwise indicated. If special trenching requirements for direct-burial electrical cables and conduits are required they will be so specified in the Task Order.

#### 3.3.5 Plastic Marking Tape

Warning tapes shall be installed directly above the pipe, at a depth of 12 inches below finished grade unless otherwise shown.

### 3.4 TESTING

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Testing shall be performed by an independent commercial testing laboratory that has been inspected by the National Institute of Standards and Technology (NIST) for compliance with ASTM E 329, ASTM D 3740, and ASTM C 1077, as applicable. Testing personnel shall meet the requirements outlined in ASTM D 5255. No work requiring testing will be permitted until the personnel and testing facilities have been approved by the Contracting Officer. Information shall be submitted on a "Density Test Log" which shall include but not be limited to the following: Test date, test number, feature of work, station/location, offset, elevation, in dry unit weight, moisture content, percent compaction, pass or fail, test method, and soil classification.

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#### 3.4.1 In-Place Densities

Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2922. When ASTM D 2922 is used, the calibration curves shall be checked and adjusted if necessary by the procedure described in ASTM D 2922, paragraph ADJUSTING CALIBRATION CURVE. ASTM D 2922 results in a wet unit weight of soil and when using this method ASTM D 3017 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 D 3017. Calibration checks, using ASTM D 1556 and ASTM D 2216, for both the density and moisture gauges shall be made at the beginning of a job and on each different type of material encountered; a minimum one calibration check shall be performed for each set of five nuclear compaction tests.

#### 3.4.2 Moisture-Density Relationships

Moisture-Density relationships shall be determined by the test method outlined in ASTM D 1557, Procedure C.

#### 3.4.3 Gradation, Atterberg Limits, and Classification

Gradation testing aggregates shall be performed by the test method outlined in ASTM C 136. Gradation testing for soil materials shall be performed in accordance with ASTM D 422. Atterberg limits shall be determined by ASSTM D 4318. Classification shall be determined by the test method outlined in ASTM D 2487.

#### 3.4.4 Miscellaneous Testing

Wear tests for select granular material and controlled low-strength material aggregate shall be performed in accordance with ASTM C 131. Aggregates shall have a loss of no greater than 40 percent when tested with 500 revolutions. A minimum of two compressive strength tests shall be in accordance with ASTM C 39 for each source of controlled low strength material. Sieve size analysis for sand and controlled low-strength material aggregate shall be performed in accordance with ASTM C 136.

#### 3.4.5. Testing Schedule

The following number of tests, if performed at the appropriate time, shall be the minimum acceptable for each type operation.

- a. Field density and moisture content: for utility trenches, perform one test for each lift or each increment or fraction of 200 feet. For isolated utility appurtenances, one random test during backfilling operations at each location.
- b. Moisture-density relationship with gradation, atterberg limits, and classification: from a bulk sample; one set of tests for every 5 field density tests (with not less than 1 test for each type of material).

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- c. Miscellaneous granular materials: for select granular material and controlled low-strength materials; perform a minimum of two random sieve analyses and two wear tests for each material source. Perform a minimum of two sieve size analyses and two water content tests for in place sand, if used for bedding and initial backfill. A minimum of two compressive strength tests shall be performed for each source of controlled low strength material.

#### 3.4.6 Displacement of Sewers

After other required tests have been performed and the trench backfill compacted to 2 feet above the top of the pipe, the pipe shall be inspected to determine whether significant displacement has occurred. This inspection shall be conducted in the presence of the Corps Field QA Representative. Pipe sizes larger than 36 inches shall be entered and examined, while smaller diameter

pipe shall be inspected by shining a light or laser between manholes or manhole locations, or by the use of television cameras passed through the pipe. If, in the judgement of the Corps Field Representative, the interior of the pipe shows poor alignment or any other defects that would cause improper functioning of the system, the defects shall be remedied as directed at no additional cost to the Government.

-- End of Section --

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II

SECTION 02513

BITUMINOUS COURSE  
(CENTRAL-PLANT HOT MIX)

PART 1 GENERAL

1.2 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 88	(1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Course Aggregate
ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996) Resistance to Degradation of Small-Sized Course Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 5	(1995) Penetration of Bituminous Materials
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 242	(1995) Mineral Filler for Bituminous Paving Mixtures
ASTM D 1559	(1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
ASTM D 2041	(1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
ASTM D 3381	(1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 3666	(1996a) Minimum Requirement for Agencies Testing and Inspecting Bituminous Paving Materials

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DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

CESPK PAM 415-1-2	Construction Control Manual
COE CRD-C 171	Determining Percentage of Crushed Particles in Aggregate

1.2 UNIT PRICES

1.2.1 Measurement

1.2.1.1 Intermediate- and Wearing-Course Tonnage

The amount paid for will be the number of square yards of bituminous mixture used in the accepted work. Bituminous mixture shall be weighed after mixing. No deduction will be made for weight of bituminous materials incorporated herein.

1.2.1.2 Correction Factor for Aggregates Used

Quantities of paving mixtures called for are based on aggregates having a specific gravity of 2.70 as determined in accordance with the Apparent Specific Gravity paragraphs in ASTM C 127 and ASTM C 128. Correction in tonnage of intermediate- and wearing-course mixtures shall be made to compensate for the difference in the tonnage of mixtures used in the project, when specific gravities of aggregates used in mixtures are more than 2.75 and less than 2.65. Tonnage paid for will be the number of tons used, proportionately corrected for specific gravities, using 2.70 as the base correctional factor.

#### 1.2.2 Payment

Quantities of intermediate- and wearing-course mixtures, determined as specified above, will be paid for at respective contract unit prices. Payment shall constitute full compensation for preparing or reconditioning the base course or existing pavement; for furnishing all materials, equipment, plant, and tools; and for labor and other incidentals necessary to complete work required.

#### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL

##### SD-09 Reports

Bituminous Pavement; FIO.

Copies of test results.

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#### 1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

##### 1.4.1 Mixing Plants

Mixing plant shall be a weigh-batch, continuous-mix type or dryer drum type and operated so as to produce a mixture within the job-mix formula. The plant shall have a minimum capacity of 100 tons per hour.

##### 1.4.2 Other Equipment

###### 1.4.2.1 Spreaders

Bituminous-materials spreaders shall be self-propelled, capable of producing a finished surface conforming to the smoothness requirements specified hereinafter. The use of a spreader that leaves indentations or other objectionable irregularities in the freshly-laid mix is not permitted.

###### 1.4.2.2 Blowers and Brooms

Blowers and brooms shall be of the power type suitable for cleaning the surface to be paved.

###### 1.4.2.3 Saws

Saws shall be of the power type, capable of rapidly cutting pavement and trimming joints and edges of pavement.

###### 1.4.2.4 Small Tools

Small tools available on the work shall consist of the following: rakes, lutes, shovels, tampers, smoothing irons, pavement cutters, portable heater for heating small tools, wood sandles and stilt sandals of standard type, and other small tools as may be required. A sufficient number shall be available at all times. The lutes shall be constructed of metal and shall consist of a plate or sheet 36 x 4 inches attached to a handle properly braced. Hand tampers shall weigh not less than 25 pounds and have a tamping face not larger than 50 square inches.

#### 1.4.2.5 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 12-foot straightedge for each bituminous paver. The straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box-girder cross section with flat bottom reinforced to insure rigidity and accuracy. Straightedges shall have handles to facilitate movement on the pavement.

#### 1.4.3 Rollers

The minimum number of rollers for each spreader shall be one 2-axle tandem roller and one pneumatic-tired roller, with separate operator for each roller.

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##### 1.4.3.1 Steel Wheeled Rollers

Steel-wheel rollers shall be a self-propelled 2-axle tandem roller weighing not less than 10 tons. The rollers shall have adjustable wheel scrapers, water tanks, and sprinkling apparatus to keep the wheels sufficiently wet to prevent the bituminous mixture from sticking to the wheels. The rollers shall be capable of reversing without backlash and shall be free from worn parts. The roller wheels shall not have flat or pitted areas or projections that will leave marks in the pavement.

##### 1.4.3.2 Pneumatic-tired Rollers

Pneumatic-tired rollers shall be self-propelled and shall consist of two axles on which are mounted multiple pneumatic-tired wheels in such manner that the rear group of wheels will not follow in the tracks of the forward group but spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth and capable of being inflated to at least 60 psi. Construction of roller shall be such that each wheel can be loaded to a minimum of 3,000 pounds.

#### 1.5 WEATHER LIMITATIONS

Bituminous course shall be constructed only when base course and existing pavement is dry. Unless otherwise directed, bituminous course shall not be constructed when temperature of the surface of existing pavement or base course is below 40 degrees F.

## PART 2 PRODUCTS

### 2.1 AGGREGATES

Aggregates shall consist of crushed stone, crushed gravel, screenings, sand, and mineral filler. Aggregates shall have a satisfactory service record in bituminous pavement construction, and the source selected shall be approved by the Contracting Officer. The combined aggregates and

mineral filler shall meet the requirements of subsequent paragraphs AGGREGATE GRADATION and COMPOSITION OF MIXTURE.

2.1.1 Coarse Aggregates

Coarse aggregate shall consist of clean, sound, durable particles meeting the following requirements:

- a. Degradation not greater than 40 percent after 500 revolutions when tested in accordance with ASTM C 131.
- b. Loss not greater than 12 percent after five cycles of testing in accordance with ASTM C 88, using sodium sulfate.
- c. Aggregate fractured faces shall be tested in accordance with COE CRD-C 171.

2.1.2 Fine Aggregates

Fine aggregate shall consist of clean, sound, durable, angular particles produced by crushing stone or gravel that meet the requirements for wear and soundness specified for coarse aggregates. This requirement shall apply to material before blending with natural sand when blending is necessary.

2.1.3 Mineral Filler

Material passing the No. 200 sieve shall be known as mineral filler, and shall conform to ASTM D 242.

2.1.4 Aggregate Gradation

The aggregate gradation as determined by ASTM C 136 shall fall within the limits of the following:

Sieve Designation	Percent by Weight Passing Square-mesh Sieve (a)
3/4-inch	100
1/2-inch	95-100
3/8-inch	80-95
No. 4	59-66
No. 8	43-49
No. 30	22-27
No. 200	3-8

(a) Similar to the California Gradation for 2-inch maximum, medium per section 39 of the California Department of Transportation *Standard Specifications*.

2.2 BITUMINOUS MATERIAL

Bituminous material to be mixed with the mineral aggregates shall be paving asphalt conforming to ASTM D 3381, Viscosity-Graded Asphalt Cement for Use in Pavement Construction as listed in Table of the ASTM D 3381, Requirements for Asphalt Cement Viscosity-Graded at 140 degrees F. Paving asphalt viscosity grade shall be **AR-4000**. Certified results of tests conducted in accordance with ASTM D 5 shall be submitted in advance of any paving, showing the penetration at 77 degrees F for the AR grades of asphalt that will

actually be used in the paving mix of this project. In addition, the penetration range at 77 degrees F shall be 25.

## 2.3 COMPOSITION OF MIXTURE

### 2.3.1 Job-Mix Formula

The job-mix formula shall be performed in accordance with ASTM D 1559 and shall be submitted by the Contractor a minimum of 30 days prior to the commencement of paving operations. No bituminous mixture shall be

Page 5

manufactured until it has been approved by the Contracting Officer's Representative. Data shall be presented with respect to the asphalt cement content in tabulated form, as well as graphical form, and shall include curves for unit weight, percent voids of total mix, percent voids filled, stability, and the optimum asphalt content. Additionally, the formula shall indicate the percentage and specific gravity of each bin fraction of aggregate, percentage absorption and specific gravity of asphalt, temperature of the mixture as discharged from the mixer; and test results which show that the job mix formula will produce a bituminous mixture which meets all requirements of this specification. The Contractor may, at its option, use ASTM D 2041 to determine the theoretical specific gravity for the paving mixture. If ASTM D 2041 is used, the physical test properties of the paving mixture shall meet the requirements of TABLE 1, located herein after, regardless of whether the aggregates are absorptive or non-absorptive. Previously established test results will be acceptable provided that the tests were performed within the last six months. The asphalt in the job-mix formula shall be between 4.5% and 7.5% of the weight of the total mix. If requested by the Contracting Officer, samples of the aggregates and asphalt shall be submitted for approval of the job-mix formula.

### 2.3.2 Test Properties of Bituminous Mixtures

### 2.3.3 Nonabsorptive Aggregate

When the water absorption value of the entire blend of aggregate does not exceed 2.5 percent as determined by ASTM C 127 and ASTM C 128, aggregate is designated as nonabsorptive. The test method outlined in ASTM D 2041 may be utilized for the determination of the theoretical maximum specific gravity and density of the paving mixture providing that the mixture meets the requirements of Table 1. The apparent specific gravity shall be used in computing the voids total mix and voids filled with bitumen. Stability and flow shall be determined in accordance with ASTM D 1559. The mixture shall meet the requirements of Table 1 herein.

Test Property	50-Blow Compaction
Stability, minimum, pounds	1000
Flow, 1/100-inch units	8 minimum, 20 maximum
Voids total mix, percent	3-5
Voids filled with bitumen, percent	75-85

### 2.3.4 Absorptive Aggregate

When the water absorption value of the entire blend of aggregate exceeds 2.5 percent as determined in ASTM C 127 and ASTM C 128, the aggregate is designated as absorptive. The test method outlined in ASTM D 2041 may be utilized for the determination of the theoretical maximum specific gravity and density of the paving mixture providing that the mixture meets the

requirements of Table 2. Bulk-impregnated specific gravity shall be used in computing the percentages of voids total mix and voids filled with bitumen. Stability and flow shall be determined in accordance with ASTM D 1559. The mixture shall meet the requirements in Table 2, herein.

TABLE 2. ABSORPTIVE AGGREGATE MIXTURE

Test Property	50-Blow Compaction
Stability, minimum, pounds	1000
Flow, 1/100-inch units	8 minimum, 20 maximum
Voids total mix, percent	2-4
Voids filled with bitumen, percent	80-90

2.3.5 Stripping of Aggregates

After 24 hours immersion in water bath controlled at a temperature of 140 degrees F., the retained stability of job-mix formula test specimens shall be at least 75 percent of the stability of companion specimens prepared for the job-mix formula when tested in accordance with ASTM D 1559. If the retained stability is less than the required 75 percent, the aggregates shall be either rejected or treated by one of the following procedures until the retained stability reaches the required 75 percent: (1) Addition of heat-stable additives to bitumen; (2) addition of hydrated lime, or other cementitious material containing free lime, as a portion of the mineral filler.

PART 3 EXECUTION

3.1 SAMPLING AND TESTING

The testing laboratory and all field and laboratory testing personnel shall meet the requirements specified in ASTM D 3666. Aggregate sampling shall be performed in accordance with ASTM D 75. Bituminous materials shall be sampled in accordance with ASTM D 140. All 4-inch in diameter core samples shall be suitable to determine conformance with stability, density, thickness and other specified requirements. An approved core drill shall be used for cutting samples. The Contractor shall furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed, to the satisfaction of the Contracting Officer's Representative.

3.1.1 Testing Frequency

All sampling and control testing for construction of the pavement shall be performed by the Contractor in accordance with the requirements outlined in Chapter 4 of CESPCK PAM 415-1-2.

a. Asphalt: Collect a 1 quart sample of asphalt and the refinery certification. Resample anytime the bituminous material source changes.

b. Aggregate: Collect a minimum of two 50 pound samples of mix aggregate from the hot bins; one sample at the beginning of each 8-hour shift and the other at mid-shift. Each 50 pound sample shall be split in half. The two half-samples (from the beginning and mid-shift) shall be labeled and packed separately and submitted to the Contracting Officer within 24 hours of sampling. Retain two half-samples for QC testing.

c. Hot Mix: Collect a minimum of two 70 pound samples of hot mix from the belt or transport truck; one sample at the beginning of each 8-hour shift and the other at mid-shift. Each 70 pound sample shall be split in half. The two half-samples (from the beginning and mid-shift) shall be labeled and packed separately and submitted to the Contracting Officer within 24 hours of sampling. Retain two half-samples for QC testing.

d. Core Specimens: Collect 1 set of 5 cores per each hot mix sample collected (if possible, 2 cores from the centerline of joints). Number cores and note the locations obtained on the as-built drawings. From each set, 2 cores shall be submitted to the Corps Field Representative (preferably 1 core from a joint centerline). Retain remaining cores for QC testing. Testing shall be in accordance with the Marshall test procedures of ASTM D 1559 and shall meet or surpass the requirements specified hereinbefore. No payment will be made for areas of pavement deficient in composition, density, or thickness until they are removed and replaced by the Contractor as directed by the Contracting Officer's Representative.

e. Smoothness Testing: Perform testing at 50 foot intervals along the section centerlines of the parking areas and access ways as specified in the paragraph SURFACE REQUIREMENTS.

### 3.2 TREATMENT OF UNDERLYING SURFACE

Prior to laying a bituminous course, the underlying surface shall be cleaned of loose and foreign matter by sweeping with power sweepers, power brooms, and hand brooms, as directed. The surface to be paved shall receive a prime coat conforming to Section 02558 BITUMINOUS TACK AND PRIME COATS.

### 3.3 MIXING TEMPERATURE

Temperature of asphalt and aggregate at time of mixing shall not exceed 163 degrees C/325 degrees F when asphalt is added.

### 3.4 TRANSPORTATION OF BITUMINOUS MIXTURE

The bituminous mixture shall be transported from the mixing plant to the site in trucks having tight, clean, smooth bodies with a minimum coating of concentrated solution of hydrated lime and water to prevent adhesion of the mixture. Each load of mixture shall be covered with canvas or other suitable material to protect the mixture from the weather and to prevent loss of heat. Mixtures having temperatures greater than 325 degrees F, mixtures having temperatures less than 245 degrees F, or mixtures which foam or show indications of moisture will be rejected. Hauling over freshly laid material is not permitted.

### 3.5 PLACING

Contact surfaces of previously constructed pavement, curbs, manholes, or other structures shall be sprayed with a thin coat of bituminous tack coat in accordance with Section 02558 BITUMINOUS TACK AND PRIME COATS. The mechanical spreader shall be adjusted and its speed regulated so that the

course being placed will be smooth and continuous without tears and pulling. The course will be of such depth that after compaction, the cross section, grade, and contour will be as shown on the drawings. In areas where the use of machine spreading is impractical, the mixture shall be spread by hand. Unless otherwise directed, placing shall begin on the high side of areas with a one-way slope or along the centerline of areas with a crowned section and shall be in the direction of the main traffic flow. Placing of the mixture shall be as continuous as possible, and the speed of placing shall be adjusted to permit proper rolling.

### 3.6 COMPACTION OF ASPHALT MIXTURE

Compaction of asphalt mixture shall be accomplished by the steel wheel rollers and pneumatic-tired roller specified above.

#### 3.6.1 Rolling

Rolling shall begin as soon after placing as the mixture will support the roller without undue displacement. Breakdown rolling shall consist of at least three coverages of a layer of asphalt mixture with a steel wheel roller, immediately followed by at least three coverages with a pneumatic-tired roller. A coverage is defined to be as many passes in either direction as may be necessary to cover the entire width of lane with overlap between passes. Each layer shall be additionally compacted by a final rolling of not less than one coverage with a 2-axle tandem roller. The speed of the rollers shall not exceed 3 miles per hour and rolling shall be performed in such a manner to avoid cracking, shoving, or displacement of the hot mixture.

##### 3.6.1.1 Vibratory Steel Wheeled Rollers

Use of vibratory steel wheel roller for breakdown and finish rolling is subject to prior approval. Vibratory roller shall be operated with the vibratory units off for finish rolling. The maximum weight of the vibratory roller shall not exceed 5 tons.

##### 3.6.1.2 Mixture Density

The bituminous mixture shall be compacted to at least 95 percent of the density of the laboratory specimen of the same mixture subjected to 50 blows of a standard Marshall hammer on each side of the specimen. In areas not accessible to the roller the mixture shall be compacted with hot hand tampers. The compacted surface shall be smooth and free from roller marks, ruts, humps, depressions, or irregularities.

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##### 3.6.1.3 Compacted Thickness

The mixture shall be placed in one lift and compacted to the thicknesses indicated within the tolerances specified herein.

### 3.7 JOINTS AND EDGES

Joints between old and new pavements or between successive day's work, or joints that have become cold because of delay, shall be made to insure continuous bond between old and new sections of course. All joints shall have the same texture, density, and smoothness as other sections of course. Contact surfaces of previously constructed pavements that have become coated with dust, sand or other objectionable material shall be

cleaned by brushing or cut back with approved power saw, as directed. The surface against which new material is placed shall be sprayed with a thin, uniform coat of bituminous tack coat.

#### 3.7.1 Transverse Joints

The roller shall pass over the unprotected end of freshly placed mixture only when placing of course is discontinued or when delivery of mixture is interrupted to the extent that unrolled material may become cold. In all cases, edge of the previously placed course shall be sawn back to expose an even, vertical surface the full thickness of the course.

#### 3.7.2 Longitudinal Joints

Edges of previously placed strip that have cooled or are irregular, honeycombed, poorly compacted, damaged, or otherwise defective, and unsatisfactory sections of the joint shall be sawn back to expose clean, sound surface for full thickness of the course as directed.

#### 3.7.3 Pavement Edges

Edges of pavement adjacent to shoulders shall be trimmed neatly to line. An earth berm of selected material not less than 0.3 foot wide shall be placed against and to the full height of the pavement surface as soon as practicable after final rolling has been completed and pavement has sufficiently hardened.

### 3.8 PROTECTION OF PAVEMENT

No vehicular traffic shall be permitted on the pavement for at least 6 hours after final rolling.

### 3.9 SURFACE REQUIREMENTS

The finished surface shall not vary more than 1/4-inch from a 12-foot straightedge. The straightedge shall be furnished by the Contractor. Defective areas and any other areas that impound surface water shall be corrected by and at the expense of the Contractor. Straightedge testing shall be performed as a Contractor Quality Control requirement to demonstrate compliance.

-- End of Section --

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SECTION 02558

BITUMINOUS TACK AND PRIME COATS

12/96

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 SOCIETY OF TESTING AND MATERIALS (ASTM)

ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 2397	(1994) Cationic Emulsified Asphalt
ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors
ASTM D 3666	(1996a) Minimum Requirement for Agencies Testing and Inspecting Bituminous Paving Materials

## 1.2 UNIT PRICES

### 1.2.1 Measurement

The bituminous material paid for will be the measured quantities used in the accepted work, provided that the measured quantities are not 10 percent over the specified application rate. Any amount of bituminous material more than 10 percent over the specified application rate for each application will be deducted from the measured quantities, except for irregular areas where hand spraying of the bituminous material is necessary. Measured quantities shall be expressed in square yards at 15.6 degrees C.

### 1.2.2 Payment

The quantities of bituminous material, determined as specified above, will be paid for at the respective contract unit prices. Payment shall constitute full compensation for all operations necessary to complete the work as specified herein.

## 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTALS

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## PROCEDURES:

SD-09 Reports

Tests; FIO.

Copies of all test results for bituminous materials, within 24 hours of completion of tests. Certified copies of the manufacturer's test reports indicating compliance with applicable specified requirements, not less than 30 days before the material is required in the work.

SD-18 Records

Waybills and Delivery Tickets; FIO.

Waybills and delivery tickets, during progress of the work.

#### 1.4 PLANT, EQUIPMENT, MACHINES AND TOOLS

##### 1.4.1 General Requirements

Plant, equipment, machines and tools used in the work shall be subject to approval and shall be maintained in a satisfactory working condition at all times.

##### 1.4.2 Bituminous Distributor

The distributor shall have pneumatic tires of such size and number to prevent rutting, shoving or otherwise damaging the base course surface or other layers in the pavement structure. The distributor shall be designed and equipped to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates with an allowable variation from the specified rate of not more than plus or minus 5 percent, and at variable widths. Distributor equipment shall include a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. The distributor shall be equipped to circulate and agitate the bituminous material during the heating process.

##### 1.4.3 Power Brooms and Power Blowers

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

#### 1.5 WEATHER LIMITATIONS

Bituminous coat shall be applied only when the surface to receive the bituminous coat is dry. Bituminous coat shall be applied only when the atmospheric temperature in the shade is 10 degrees C/50 degrees F or above and when the temperature has not been below 2 degrees C/35 degrees F for the 12 hours prior to application.

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#### PART 2 PRODUCTS

##### 2.1 TACK COAT

Emulsified asphalt shall conform to ASTM D 977, Grade SS-1. Cationic emulsified asphalt shall conform to ASTM D 2397, Grade CSS-1.

##### 2.2 PRIME COAT

Emulsified asphalt shall conform to ASTM D 977, Grade SS-1. Cationic emulsified asphalt shall conform to ASTM D 2397, Grade CSS-1.

#### PART 3 EXECUTION

##### 3.1 PREPARATION OF EMULSION

Bituminous materials for emulsions shall be diluted by adding equal volumes of bituminous material and compatible water. If the bituminous material is to be diluted in the field, first test the mix by placing equal volumes of emulsion and water in a glass quart jar (do not use a metal container, as it could cause the mixture to "break") and mix for one minute. If the

mixture "breaks", a different source of water or bituminous material is required.

### 3.2 PREPARATION OF SURFACE

Immediately before applying the bituminous coat, all loose material, dirt, clay, or other objectionable material shall be removed from the surface to be treated. The surface shall be dry and clean at the time of treatment.

### 3.3 APPLICATION RATE

The exact quantities within the range specified, which may be varied to suit field conditions, will be determined by the Contracting Officer.

#### 3.3.1 Tack Coat

Bituminous material for the tack coat shall be applied in quantities of not less than 0.05 gallon nor more than 0.15 gallon per square yard of pavement surface.

#### 3.3.2 Prime Coat

Bituminous material for the prime coat shall be applied in quantities of not less than 0.15 gallon nor more than 0.40 gallon per square yard of pavement surface.

### 3.4 APPLICATION TEMPERATURE

#### 3.4.1 Viscosity Relationship

Asphalt application temperature shall provide an application viscosity

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between 10 and 60 seconds, Saybolt Furol, or between 20 and 120 square mm/sec, 20 and 120 centistokes, kinematic. The temperature viscosity relation shall be furnished to the Contracting Officer.

#### 3.4.2 Temperature Ranges

The viscosity requirements shall 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

### 3.5 APPLICATION

Following preparation and subsequent inspection of the surface, the bituminous coat shall be applied at the specified rate with uniform distribution over the surface to be treated. All areas and spots missed by the distributor shall be properly treated with the hand spray. Until the succeeding layer of pavement is placed, the surface shall be maintained by protecting the surface against damage and by repairing deficient areas at no additional cost to the Government. If required, clean dry sand shall be spread to effectively blot up any excess bituminous material. To obtain uniform application of the prime coat on the surface treated at the junction of previous and subsequent applications, building paper shall be spread on the surface for a sufficient distance back from the ends of each application to start and stop the prime coat on the paper. Immediately

after application, the building paper shall be removed and destroyed.

### 3.6 CURING PERIOD

Following application of the bituminous material and prior to application of the succeeding layer of pavement, the bituminous coat shall be allowed to cure and to obtain evaporation of any volatiles or moisture. Prime coat shall be allowed to cure without being disturbed for a period of at least 48 hours or longer, as may be necessary to attain penetration into the treated course.

### 3.7 FIELD QUALITY CONTROL

Field quality control shall be conducted by an agency meeting the requirements outlined in ASTM D 3666. Samples of the bituminous material shall be tested for compliance with the applicable specified requirements. One sample shall be obtained and tested by the Contractor.

### 3.8 SAMPLING AND TESTING

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing will be permitted until the facilities have been inspected and approved.

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#### 3.8.1 Sampling

The samples of bituminous material, unless otherwise specified, shall be in accordance with ASTM D 140. Sources from which bituminous materials are to be obtained shall be selected and notification thereof furnished the Contracting Officer's Representative within 15 days after the award of the contract.

#### 3.8.2 Calibration Test

The Contractor shall 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. Calibration of the bituminous distributor shall be in accordance with ASTM D 2995.

#### 3.8.3 Sampling and Testing During Construction

Quality control sampling and testing shall be performed as required in Paragraph FIELD QUALITY CONTROL.

-- End of Section --



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II

SECTION 02561

ASPHALT SLURRY SEAL  
**10/91**

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 127

(1988; R 1993) Specific Gravity and Absorption

of Coarse Aggregate

ASTM C 128	(1993) Specific Gravity and Absorption of Fine Aggregate
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 150	(1995) Portland Cement
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 140	(1993) Sampling Bituminous Materials
ASTM D 242	(1985; R 1990) Mineral Filler for Bituminous Paving Mixtures
ASTM D 977	(1991) Emulsified Asphalt
ASTM D 1073	(1994) Fine Aggregate for Bituminous Paving Mixtures
ASTM D 1250	(1980; R 1990) Petroleum Measurement Tables
ASTM D 2397	(1994) Cationic Emulsified Asphalt
ASTM D 2419	(1991) Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2995	(1993) Determining Application Rate of Bituminous Distributors
ASTM D 3666	(1996a) Minimum Requirement for Agencies Testing and Inspecting Bituminous Paving Materials
ASTM D 3910	(1990) Design, Testing, and Construction of Slurry Seal

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ASTM D 4318	(1993) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4791	(1995) Flat or Elongated Particles in Coarse Aggregate

INTERNATIONAL SLURRY SURFACING ASSOCIATION (ISSA)

ISSA TB-102	(1990) Mixing, Setting and Water Resistance Test to Identify "Quick-Set" Emulsified Asphalts
-------------	--

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS

COE CRD-C 171	Determining Percentage of Crushed Particles in Aggregate
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1.2 MEASUREMENT

Bituminous material and aggregate to be paid for will be the measured quantities in square yards used in the accepted work.

1.3 PAYMENT

Quantities of bituminous material, aggregate, and filler, determined as

specified in paragraph MEASUREMENT, will be paid for at the respective contract unit prices. Such payment shall constitute full compensation for all operations necessary to complete the work as specified herein.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

##### SD-01 Data

Mixing and Application Machine; FIO. Job Mix Formula (JMF)FIO. Details and data on the make, type, and capacity of the slurry seal machine. A copy of the mixture proportions.

##### SD-14 Samples

Sampling and Testing; FIO.

At least 30 days prior to placement of the slurry mixture, representative samples in the following quantities:

Aggregate or aggregates which can be combined to form the specified gradation: 100 pounds.

Asphalt emulsion: 2 gallons.

Mineral filler (if required): 10 pounds.  
Additional samples of materials, as required.

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##### SD-09 Reports

Sampling and Testing; FIO.

A quality control report within 24 hours of each day of construction. The quality control test shall include tabulated test results showing asphalt cement content, moisture content, and aggregate gradation of all samples tested. A diagram identifying the location of each slurry sample taken.

##### SD-13 Certificates

Materials; FIO.

The material supplier's statement that the supplied material meets specified requirements. Each certificate shall be signed by an official authorized to certify in behalf of material supplier and shall identify quantity and date or dates of shipment or delivery to which the certificates apply.

##### SD-18 Records

Waybills and Delivery Tickets; FIO.

Copies of waybills or delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all aggregates and bituminous materials actually used in the construction.

#### 1.5 DELIVERY AND STORAGE

Materials delivered to the site shall be inspected for contamination and damage, unloaded, and stored with a minimum of handling. Aggregates and mineral fillers shall be stockpiled to prevent segregation, contamination, or accumulation of excess moisture. Emulsion shall be stored in a manner to prevent freezing, entrance of water, or breaking of the emulsion. Materials that are determined by the Contracting Officer to be contaminated, segregated, or damaged, or which fail to meet specification requirements shall be removed from the job site and replaced at no additional cost to the Government.

#### 1.6 WAYBILLS AND DELIVERY TICKETS

Copies of waybills and delivery tickets shall be submitted during the progress of the work. Before the final statement is allowed, the Contractor shall file with the Contracting Officer certified waybills and delivery tickets for all materials used in the work covered by this section. The Contractor shall not remove bituminous material from storage tanks until measurements of the remaining quantity have been determined.

#### 1.7 WEATHER LIMITATIONS

Slurry seal shall not be applied if air or pavement temperatures are below 60 degrees F or if there is any possibility that the slurry will freeze before

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it has cured. No slurry seal shall be placed if rain is probable before the slurry seal will have sufficiently cured to prevent damage.

#### 1.8 EQUIPMENT

Machines, tools, and equipment used in the performance of the work will be approved by the Contracting Officer before the work is started and shall be maintained in satisfactory condition.

##### 1.8.1 Mixing and Application Machine

The slurry mixing and application machine (slurry seal machine) shall be a self-propelled, continuous flow mixing unit capable of accurately delivering a predetermined proportion of aggregate, water, mineral filler, and asphalt emulsion to the mixing chamber and of discharging the thoroughly mixed product on a continuous basis. The machine shall be capable of prewetting the aggregate immediately prior to mixing with the emulsion. The mixing unit of the machine shall be capable of thoroughly blending all ingredients.

##### 1.8.1.1 Fines Feeder

The slurry seal machine shall be equipped with a fines feeder that provides an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer at the same time and location as the aggregate. The fines feeder shall be used whenever added mineral filler is a part of the aggregate blend.

##### 1.8.1.2 Fogging

The slurry seal machine shall be equipped with a water pressure system and fog-type spray bar adequate for complete fogging of the pavement surface. The spray bar shall be so mounted on the mixing machine that fogging will immediately precede application of the slurry seal mix.

##### 1.8.1.3 Storage Capacity on Machine

The hoppers shall contain sufficient storage capacity of all materials

required to produce a minimum of 5 tons of slurry seal.

#### 1.8.1.4 Slurry Spreading Equipment

A variable-width mechanical-type squeegee spreader box shall be attached to the slurry seal mixing machine. The spreader box shall be equipped and maintained with flexible material in contact with the pavement surface to prevent loss of slurry seal from the spreader box on varying grades and crown. The spreader box shall be capable of adjustments to assure uniform spread. The spreader box shall be equipped for lateral distribution of the slurry mixture within the spreader box regardless of spreader box width or crown or bank of the pavement surface. The spreader box shall be kept clean, and buildup of asphalt and aggregate on either squeegee or spreader box shall not be permitted. At the Contractor's option, burlap drags or

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other drags may be provided. If used, the drag shall be cleaned or replaced as needed to prevent accumulations or crust of slurry seal mix on the drag.

#### 1.8.2 Bituminous Distributors

Bituminous distributors for applying tack coat shall be self-propelled and shall be designed and equipped to distribute asphalt emulsion uniformly on various widths of the pavement surface at readily determined and controlled rates ranging from 0.05 to 2.00 gallons per square yard, with a pressure range of 25 to 75 psi. Allowable variation from any specified rate shall not exceed 5.0 percent.

#### 1.8.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall be self-propelled and have wheels mounted on two axles in such a manner that the rear group of wheels will not follow in the tracks of the forward group. Tires shall be uniformly inflated to a minimum tire pressure of 50 psi. Rollers shall be equipped with water tanks and sprinkler apparatus which shall be used to keep the wheels damp and prevent adherence of bituminous materials to the wheels.

#### 1.8.4 Cleaning Equipment

Cleaning equipment shall consist of power brooms, power blowers, power vacuums, air compressors, hand brooms, and other equipment as needed. The equipment shall be suitable for cleaning the surface and cracks in the existing pavement.

#### 1.8.5 Hand Tools

Hand tools shall consist of hand squeegees, shovels, and other equipment as necessary to perform the work.

### PART 2 PRODUCTS

#### 2.1 BITUMINOUS MATERIAL

Bituminous material shall be emulsified asphalt conforming to ASTM D 977, Type SS-1; or to ASTM D 2397, Type CSS-1; or to quick set mixing grade ISSA TB-102.

#### 2.2 MINERAL AGGREGATE

Mineral aggregate shall consist of crushed stone and crushed gravel. The portion of materials retained on the No. 4 sieve shall be known as coarse

aggregate; the portion passing the No. 4 sieve and retained on the No. 200 sieve as fine aggregate; and the portion passing the No. 200 sieve as mineral filler. Two or more aggregates from different sources or of different types may be blended to produce the required gradation. When two or more aggregates are so blended, each shall meet the quality requirements stated herein. When tested in accordance with ASTM D 4318, aggregate shall be nonplastic. The aggregate shall have a sand equivalent of 45 or greater when tested in accordance with ASTM D 2419. Aggregate shall conform to the gradation given in

Table I, which is similar to the gradation specified in Section 37 of the State of California Department of Transportation **Standard Specifications**, when tested in accordance with ASTM C 136.

TABLE I. AGGREGATE GRADATION

Percent Passing

Sieve Size	Gradation
3/8-in.	-----
No. 4	100
No. 8	78-95
No. 16	55-80
No. 30	35-60
No. 50	20-40
No. 100	10-22
No. 200	4-12

2.2.1 Fine Aggregate

The fine aggregate shall conform to the physical and supplementary requirements of ASTM D 1073, except as modified herein. Fine aggregate produced by crushing gravel shall have at least 90 percent by weight of crushed particles having two or more fractured faces in the portion retained on the No. 30 sieve. This requirement shall apply to material before blending with other aggregates when blending is necessary.

2.2.2 Particle Shape of Crushed Aggregate

The quantity of flat and elongated particles in any sieve size shall not exceed 20 percent by weight, when determined in accordance with ASTM D 4791 and COE CRD-C 171.

2.3 MINERAL FILLERS

Mineral fillers, such as hydrated lime or portland cement, shall be added to the aggregate blend, if needed, to meet the gradation requirements or to improve the workability of the slurry seal mixture. Mineral fillers shall meet the gradation requirements of ASTM D 242. Portland cement shall conform to ASTM C 150, Type I or II.

2.4 WATER

Water for the slurry seal mixture shall be potable.

2.5 TACK COAT

Tack coat shall consist of one part emulsified asphalt and up to three parts water. The same type and grade of asphalt emulsion shall be used in the tack coat as used to make slurry seal, unless otherwise directed.

## 2.6 SLURRY SEAL MIXTURE

### 2.6.1 Job Mix Formula (JMF)

The exact proportions of asphalt emulsion, aggregate, water, and mineral filler to be used in the preparation of the slurry seal shall be determined by laboratory mix design in accordance with ASTM D 3910 and shall be furnished by the Contractor. A copy of the JMF shall be submitted to the Contracting Officer for approval 30 days before the slurry seal mixture is placed.

### 2.6.2 Properties

The slurry seal JMF shall possess workability and stability properties consistent with the application requirements of paragraph PREPARATION AND APPLICATION OF SLURRY SEAL and, in addition, shall meet the consistency test requirement of a 1 inch flow and the wet track abrasion test requirement of not more than 75 grams per square foot abrasion loss when tested in accordance with ASTM D 3910. If quick set emulsion is used, the slurry seal mixture shall pass when using project aggregate and tested in accordance with ISSA TB-102. If it is established that a mixture meeting these requirements cannot be produced from the furnished materials, these materials shall be replaced.

### 2.6.3 Setting Time

The mixture shall attain an initial set in not less than 15 minutes nor more than 12 hours when tested in accordance with ASTM D 3910. The setting time may be regulated by the addition of mineral fillers or chemical agents provided that provision for their inclusion is contained in the JMF.

## PART 3 EXECUTION

### 3.1 PREPARATION OF SURFACE

Prior to application of the slurry seal, the existing pavement surface shall be cleaned, accumulation of water removed, and unsatisfactory areas repaired. As directed, weak areas or soft spots indicated by alligator cracking, pot holes, or any cracking indicating a structural deficiency shall be removed and replaced to match the grade of the existing pavement section. Cracks in the surface not due to structural deficiencies shall be cleaned by blowing out with compressed air. Cracks larger than 1/4 inch in width shall be filled by squeegeeing in a slurry of fine sand and asphalt emulsion. Cracks larger than 1/8 inch but less than 1/4 inch in width shall be filled with asphalt emulsion. The final surface of the filled cracks shall be 1/8 to 1/4 inch below the pavement surface. Any excess material shall be removed from the pavement surface prior to placement of the slurry seal.

#### 3.1.1 Removal of Contamination, Traffic Paint, and Vegetation

All dust, dirt, oil, grease, fuel, loose or flaky traffic paint, vegetation, and other objectionable material shall be removed from the pavement surface. Grease-contaminated and oil-contaminated areas which

cannot be cleaned shall be removed and replaced with new bituminous pavement. All vegetation shall be completely removed, and these areas treated with an approved herbicide.

#### 3.1.2 Preparation and Application of Tack Coat

#### 3.1.2.1 Calibration of Bituminous Distributor

The Contractor shall 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 tack coat material to the prepared surface. Calibration of the bituminous distributor shall be in accordance with ASTM D 2995.

#### 3.1.2.2 Tack Coat Application

After the surface has been prepared for the slurry seal, a tack coat shall be applied with a bituminous distributor at the rate of 0.05 to 0.10 gallon per square yard of surface. The tack coat shall be allowed to cure before the slurry seal is applied.

#### 3.1.3 Wetting Pavement Surface

Immediately prior to application of the slurry seal, the surface of the pavement and all crack faces shall be moistened with a fog spray of water from the spray bar on the slurry seal machine. No free water shall be on the surface of the pavement following the fog spray. The rate of application of the fog spray shall be adjusted during the day to suit pavement temperatures, surface texture, humidity, and dryness of the pavement surface.

#### 3.1.4 Trial Application

Prior to apply the slurry seal, a test section at least 200 feet long and 20 feet wide shall be placed by the Contractor using the approved materials. The slurry seal shall be placed and rolled in accordance with the specified requirements. Tests shall be made to determine the asphalt cement and moisture contents and the aggregate gradation. If test results are satisfactory, the test section shall remain in place as part of the completed slurry seal. If tests indicate that the slurry seal does not conform to specification requirements, necessary adjustments to the slurry seal machine and application procedures shall be made immediately, and additional test sections shall be constructed and samples shall be taken and tested for conformance with specification requirements. If tests indicate that the slurry seal does not conform to specification requirements, the test section shall be removed at no cost to the Government, and the material disposed of off of Government-controlled land. In no case shall the Contractor start full production of slurry seal without approval.

### 3.2 PREPARATION AND APPLICATION OF SLURRY SEAL

#### 3.2.1 Calibration of Slurry Seal Machine

The slurry seal machine shall be calibrated in the presence of the Corps QA Field Representative to assure that it will produce and apply a mixture which conforms to the JMF. Commercial slurry seal machines shall be provided with a method of calibration by the manufacturer. Because of varying mechanical properties, each machine may have a different calibration procedure. However, a calibration method based on a revolution counter on any shaft which is mechanically interlocked with the emulsion pump, water pump, fines feeder, and the aggregate conveyor can be used to determine the relative quantities of each component per revolution for various gate openings, metering, valve

opening, or sprocket sizes. The slurry seal machine shall be calibrated with the project materials prior to the start of work, or whenever there is a change in materials.

### 3.2.2 Preparation

The slurry seal shall be mixed and applied with a slurry machine. A minimum amount of water shall be used as necessary to obtain a workable and homogenous mixture. The mixture shall be of proper consistency with no segregation when deposited on the surface of the pavement and no additional materials shall be added to the mixture. The slurry mixture shall show no signs of uncoated aggregate or premature breaking of emulsion when applied to the pavement surface. The total time of mixing shall not exceed 2 minutes.

### 3.2.3 Application

Sufficient quantities of the slurry seal mixture shall be fed into the spreader box such that a uniform and complete coverage of the pavement is obtained. The slurry seal machine shall be operated at such a speed that the amount of slurry in the spreader box shall remain essentially constant. The slurry shall be applied in such a manner that the minimum thickness will not be less than 1/8 inch. When multiple applications are required, each application shall be thoroughly cured before another application is placed. No oversized aggregate particles shall be allowed in the slurry seal mixture, and no buildup of cured slurry seal mix shall be allowed to collect in the spreader box. Streaks shall not be left in the finished surface.

#### 3.2.3.1 Joints

The longitudinal joint between adjacent lanes shall have no visible lap, pinholes, or uncovered areas. Thick spots caused by overlapping shall be smoothed immediately with hand squeegees before the emulsion breaks. Overlaps which occur at transverse joints shall also be smoothed before the emulsion breaks, so that a uniform surface is obtained which contains no breaks or discontinuities. Whenever possible, joints should be made while the slurry seal mixture applied in the first pass is still semifluid and workable. If operations preclude fresh working of joints, the previously laid pass shall be sufficiently cured in order to support the spreader box without scarring, tearing, or scraping.

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#### 3.2.3.2 Stability of Slurry Mixture

The slurry seal mixture shall possess sufficient stability so that segregation or premature breaking of emulsion in spreader box does not occur. The mixture shall be homogenous following mixing and spreading, shall be free of bleeding of water or of emulsion, and free of segregation of emulsion and aggregate fines from the coarser aggregate fraction.

#### 3.2.3.3 Hand Application

Areas which cannot be reached with the slurry seal machine shall be treated with hand squeegees to provide complete and uniform coverages. All areas shall be tacked and fogged prior to placing slurry seal by hand. Close attention should be given during hand squeegee spreading of slurry seal mixture. Overworking will sometimes cause partial breaking of the emulsion before the final spreading is completed; this results in a nonuniform material that will have poor appearance and low durability.

## 3.3 ROLLING

As soon as the slurry seal has cured sufficiently to prevent displacement or pickup by wheel traffic, it shall be rolled with the pneumatic roller. A minimum of 5 coverages shall be applied, and, when required, rolling shall continue until all ridges have been smoothed out and a uniform surface is obtained.

#### 3.4 CURING

Completed slurry seal shall be protected from traffic by barricades and markers until the slurry seal has cured. Areas which are damaged by traffic or from other causes shall be repaired by the Contractor at no cost to the Government.

#### 3.5 SAMPLING AND TESTING

##### 3.5.1 Sampling

Samples of slurry seal materials shall be furnished by the Contractor at no expense to the Government. Sampling of aggregates, unless otherwise specified, shall be in accordance with the requirements of ASTM D 75. Sampling of bituminous material, unless otherwise specified, shall be in accordance with the requirements of ASTM D 140. Additional samples of materials shall be furnished as required.

##### 3.5.2 Testing

Materials shall be tested to establish compliance with the specified requirements. Quality control testing shall be the responsibility of the Contractor and shall be performed by an approved independent commercial testing laboratory or by Contractor testing, subject to approval and meeting the requirements outlined in ASTM D 3666. At least 30 days prior to the use of materials in the work, certified copies of the test results specified herein

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and in referenced publications shall be submitted for approval. In addition for each day that slurry seal is placed, a minimum of one sample of slurry seal shall be taken from the discharge chute of the slurry seal machine and tested to determine asphalt cement content, moisture content, and aggregate gradation. Slurry seal mixture that fails to meet the mix design proportions shall be rejected.

##### 3.5.3 Calibration Test

The Contractor shall furnish all equipment and materials and labor necessary to calibrate the slurry seal machine. All calibrations shall be made with the approved job materials and prior to applying the slurry seal materials to the prepared surface. A copy of the calibration test results shall be submitted before the slurry seal machine is used on the job.

#### 3.6 CLEANUP

On completion of work, all trash, discarded slurry seal material, or other refuse shall be collected and removed from the site and disposed of off Government-controlled land at the Contractor's expense.

-- End of Section --



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SECTION 02568

RUBBER RAILROAD CROSSING PADS (TRANSITION)

PART 1	GENERAL	
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## 1.1 Applicable Publications

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

Riedel Omni Products, Inc.

Goodyear Hi-Miler Rubber Railroad Crossing Pads

RFR Industries, Inc.

American Railway Engineers Association (ABEA) - Manual for Railway Engineering

American Society for Testing and Materials (ASTM)

ASTM D 395 Rubber Property-Compression Set

ASTM D 573 Rubber Deterioration in an Air Oven

ASTM D 746 Brittleness and Temperature of Plastics and Elastomers By Impact

ASTM D 1171 Rubber deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimen)

ASTM D 2000 Rubber Products in Automotive Applications

## 1.2 Measurement

Measurement will be by the number of linear feet used in the completed and accepted work. No measurement will be made for wasted material in work determined defective.

### 1.2.1 Payment

Rubber pads installed and accepted, including all labor and material will be paid for at the respective contract price in the bidding schedule

## 1.3 Definitions

Full depth heavy duty crossing pads will be used.

## 1.4 Submittals

Government approval is required for submittals with a "GA" designation; submittals having a "FIO" designation are for information only. The following shall be submitted in accordance with the Section: SUBMITTAL PROCEDURES

Page 1

SD-14 Samples

Materials; GA

Samples of the material to be used will be submitted to the Contracting Officer for approval, 30 days prior to its use. No material will be allowed to be used until it has been approved.

## PART 2 PRODUCTS

### 2.1 Materials

#### 2.1.1 Rubber Pads

Rubber pads will conform to the manufacturers recommendations and will be 2 1/2 inches thick with longitudinal shims or full depth rubber and molded anti-skid and shock absorbing design in the top surface.

#### 2.1.2 Railroad Ties

Railroad ties will be 8 foot 6 inches minimum or 9 foot maximum, square cut and set on 18 inches centers

#### 2.1.3 Bolted Rail Joints

Eliminate all bolted rail joints in crossing area and use continuous welded rails. No bolted

#### 2.1.4 Spikes

Spike into ties-not shims. Spikes will be a full 6 inches into the 7 inch tie. Spikes will be galvanized, 12 inch in length.

### PART 3 EXECUTION

#### 3.1 General Requirements

Pads will be fastened to the substructure and ties by use of galvanized drive spikes or bolts recommended by the manufacturer, used in conjunction with integrated washers. Molded rubber plugs will be used to cover the fastener heads. One center pad will fit between the rails and two side pads are required for each three linear foot of track.

#### 3.2 Instalation

Refer to manufacturers recommendations.

-----END OF SECTION-----

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## SECTION 02579

**PARTIAL DEPTH (Spall) REPAIRS OF RIGID PAVEMENTS****PART 1 GENERAL**

## 1.1 SCOPE OF WORK

This specification shall be used for partial depth repairs using Portland Cement Concrete (pcc) and Epoxy concrete. Epoxy mortar repairs shall be performed for repairs less than 0.03 cubic feet and pcc repairs for repairs equal to and greater than 0.03 cubic feet. For full depth repairs used "Section 02754 CONCRETE PAVEMENT FOR SMALL PROJECTS.

## 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 M 182 (1991) Burlap Cloth Made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 31	(1991) Making and Curing Concrete Test Specimens in the Field
ASTM C 39	(1993) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 131	(1989) Resistance to Abrasion of Small Size Coarse Aggregate by Abrasion & Impact in the Los Angeles Machine
ASTM C 136	(1995a) Sieve Analysis of Fine and Coarse Aggregates
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 171	(1995) Sheet Materials for Curing Concrete
ASTM C 173	(1994a) Air Content of Freshly Mixed Concrete by

the Volumetric Method

ASTM C 192 (1990a) Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 231 (1991b) Air Content of Freshly Mixed Concrete by the Pressure Method

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ASTM C 260 (1994) Air-Entraining Admixtures for Concrete

ASTM C 494 (1992) Chemical Admixtures for Concrete

ASTM C 881 (1990) Epoxy-Resin-Base Bonding Systems for Concrete

ASTM D 75 (1987; R 1992) Sampling Aggregates

CORPS OF ENGINEERS (COE)

COE CRD-C 104 (1980) Method of Calculation of the Fineness Modulus of Aggregate

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

## 1.2 UNIT PRICES

### 1.2.1 Measurement

#### 1.2.1.1 Concrete

The quantity of concrete to be paid for will be the number of square yards placed in the completed and accepted patched areas.

#### 1.2.1.3 Epoxy-Resin Grout

The quantity of epoxy-resin grout material to be paid for will be the number of square yards, placed in the completed and accepted patched areas.

### 1.2.2 Payment

#### 1.2.2.1 Concrete

The quantity of concrete, measured as specified, will be paid for at the contract unit price. The unit price for concrete will include full compensate for furnishing labor; aggregates and other materials, except epoxy-resin grout; tools and equipment; and for performing work involved in patching the pavements as specified.

#### 1.2.2.3 Epoxy-Resin Grout

The quantity of epoxy-resin grout determined as specified will be paid for at the contract unit price, which price will include all costs of handling, hauling, storage at the site, labor, materials, tools and equipment, and for performing work involved in placing epoxy-resin grout on the surface of the existing pavement to be patched.

## 1.3 DESIGN

The concrete mixtures shall be designed to produce concrete having an average compressive strength as indicated in paragraph "3.1.3 Portland

Cement Concrete and Mortar Mixtures". The concrete mixtures shall be designed to secure an air content by volume of 4 percent, plus or minus 1 percent, based on measurements made on concrete immediately after discharge from the mixer in conformance with ASTM C 231. Mix design studies and tests shall be made in accordance with ASTM C 39 and ASTM C 192, and the test results submitted for approval. The coarse aggregate shall have a percentage of wear not to exceed 30 percent after 500 revolutions when teste in accordance with ASTM C 131.

#### 1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

##### SD-01 Data

Patching System; GA.

Three copies of the proposed mix design, 14-days prior to placement. The mix design shall indicate the weight of each ingredient of the mixture. No concrete shall be placed prior to approval of the proposed mix design. No deviation from the approved job-mix formula will be permitted without prior approval.

##### SD-09 Reports

Patching System; GA.

Three copies of test results, shall be provided within 24 hours of physical completion of laboratory testing. Manufacturer's certifications may be submitted rather than laboratory test results for proposed materials. Certificates should certify compliance with the appropriate specification referenced herein. No materials shall be placed without prior approval from the Corps QA Field Representative.

#### 1.5 EQUIPMENT; APPROVAL AND MAINTENANCE

Dependable and sufficient equipment that is appropriate and adequate to accomplish the work specified shall be assembled at the site of the work a sufficient time before the start of paving to permit thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required. The equipment shall be maintained in good working condition.

#### 1.6 SAMPLING AND LABORATORY TESTING OF MATERIALS

Sampling and testing shall be performed by an approved commercial laboratory or by the Contractor subject to approval. Should the Contractor elect to establish testing facilities, no work requiring testing shall be permitted until the Contractor's facilities have been inspected and approved. The first laboratory inspection shall be at the expense of the Government and the cost of any subsequent inspection resulting from failure of the first inspection shall be at the expense of the Contractor. Such

costs shall be deducted from the total amount due the Contractor. All testing shall be performed at no additional cost to the Government.

#### 1.6.1 Cement

Cement shall be tested 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, provided the cement is the product of a mill with a record for the production of high-quality cement for the past 3 years.

#### 1.6.2 Aggregate

Aggregate samples for laboratory testing shall be taken in conformance with ASTM D 75 and tested in accordance with ASTM C 136.

#### 1.6.3 Joint-Sealing Materials

Joint-sealing materials shall be tested for conformance with the referenced applicable material specification.

#### 1.6.4 Epoxy-Resin Grout

Epoxy-resin grout shall be tested for conformance with ASTM C 881.

### 1.7 DELIVERY AND STORAGE OF MATERIALS

#### 1.7.1 Cement

Cement may be furnished in bulk or in suitable bags used for packaging cements and shall be stored in a manner to prevent absorption of moisture.

#### 1.7.2 Aggregates

Aggregates shall be handled and stored in a manner to avoid breakage, segregation, or contamination by foreign materials.

#### 1.7.3 Epoxy-Resin Grout

Epoxy-resin grout shall be delivered to the site in such manner as to avoid damage or loss. Storage areas shall be 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. The ambient temperature in the storage area of the epoxy materials shall at no time be higher than 100 degrees F.

### 1.8 WEATHER LIMITATIONS

Concrete shall not be placed when weather conditions detrimentally affect the quality of the finished product. No concrete shall be placed when the air temperature is below 40 degrees F in the shade. When air temperature is likely to exceed, 90 degrees F, the concrete shall have a temperature not exceeding 90 degrees F when deposited, and the surface of such placed concrete shall be kept 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

Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, or a combination thereof.

#### 2.1.1.2 Quality

Aggregate as delivered to the mixers shall consist of clean, hard, unweathered, and uncoated particles. Dust and other coatings shall be removed from the coarse aggregates by adequate washing.

#### 2.1.1.3 Particle Shape

Particles of the coarse aggregate shall be generally spherical or cubical in shape. The coarse aggregate shall have a percentage of wear not to exceed 30 percent after 500 revolutions when tested in accordance with ASTM C 131.

#### 2.1.1.4 Size and Grading

The maximum nominal size of the coarse aggregate shall be 1/2 inch. The coarse aggregate shall be well graded within the limits specified, and when tested in accordance with ASTM C 136, shall conform to the following grading requirements as delivered to the batching hoppers:

Sieve designation U.S. Standard square mesh	Percentage by weight passing individual sieves 4 to 1/2 inch
3/4 inch	100
1/2 inch	90-100
3/8 inch	40-70
No. 4	0-15
No. 8	0-5

#### 2.1.2 Fine Aggregate

##### 2.1.2.1 Composition

Fine aggregate shall consist of either natural sand, manufactured sand, or a combination of natural and manufactured sand, and shall be composed of clean, hard, durable particles.

##### 2.1.2.2 Particle Shape

Particles of the fine aggregate shall be generally spherical or cubical in shape.

##### 2.1.2.3 Grading

Grading of the fine aggregate as delivered to the mixer shall conform to the following requirements when tested in accordance with ASTM C 136.

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
No. 100	2-10

In addition, the fine aggregate, as delivered to the mixer, shall have a fineness modulus of not less than 2.40 nor more than 2.90, when calculated in accordance with COE CRD-C 104.

#### 2.1.3 Air-Entraining Admixture

Air-entraining admixture shall conform to ASTM C 260.

#### 2.1.4 Cement

Cement shall be portland cement conforming to ASTM C 150, Type II, low alkali.

#### 2.1.5 High-Early-Strength Portland Cement

ASTM C 150, Type III with tricalcium aluminate limited to 5 percent, low alkali. Type III cement shall be used only in isolated instances and only when approved in writing.

#### 2.1.6 Curing Materials

##### 2.1.6.1 Burlap

Burlap shall conform to AASHTO M 182.

##### 2.1.6.2 Curing Compound

Membrane-forming curing compound shall be a pigmented type conforming to COE CRD-C 300.

##### 2.1.6.3 Waterproof Blanket Materials

Waterproof blanket materials shall conform to ASTM C 171, Type optional, color white.

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#### 2.1.7 Epoxy-Resin Grout

Epoxy-resin grout shall be a two-component material formulated to meet the requirements of ASTM C 881, Type I or II. Type I material shall be used when pavement, materials, or atmospheric temperatures are 70 degrees F or above. Type II material shall be used when pavement, materials, or atmospheric temperatures are below 70 degrees F.

#### 2.1.8 Water

Water shall be clean, fresh, and 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.

### **PART 3 EXECUTION**

#### 3.1 REPAIRING PARTIAL DEPTH SPALLS ALONG JOINTS, CRACKS, AND OTHER AREAS

Mixing, placing, consolidating, and finishing of repair material and application of curing procedures shall take place only in the presence of a Government representative. It shall be the Contractor's responsibility to inform the Government of his work schedule each day so a Government representative will be there as needed to meet the above requirement. No

mixing or placing of repair materials shall take place when the temperature of the repair material or of the pavement temperature exceeds 100 degrees F.

### 3.1.1 Preparation

Where directed, spalls along joints of new slabs, along edges of adjacent existing concrete, and other locations shall be repaired by first making a vertical sawcut at least 2-inches outside the spalled area and to a depth of at least 2-inches. Saw cuts shall be straight lines forming rectangular areas in line with the jointing pattern. Sawcut runouts (kerfs) beyond the edges of the repair cavity shall be cleaned and filled, as approved, with epoxy resin conforming to ASTM C881, Type IV, Grade 2, after the curing period is over. The concrete within the sawcut lines or between the sawcut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least 1-inch depth of visually sound concrete, and to provide at least 2 in. total depth from the pavement surface throughout. Removal shall be performed using light jackhammers, maximum weight of 30 lb. The cavity thus formed shall be thoroughly cleaned with high pressure water jets supplemented with compressed air to remove all loose material. The cavity shall be kept completely moist for the 24 hours immediately before the application of portland cement repair material. All free water shall be blown from the cavity immediately before placing the bond coat. Immediately before filling the cavity, a prime coat shall be applied to the cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Prime coat for portland cement repairs shall be a neat cement grout and for epoxy resin repairs shall be epoxy resin, Type III, Grade 1 conforming to ASTM C881.

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### 3.1.2 Filling

The cavity shall be filled with portland cement concrete or mortar or with epoxy resin mortar, immediately after the prime coat is applied--before it begins to dry. Portland cement concrete shall be used for larger spalls, those more than 1/3 cu. ft. in size after removal operations, provided there is no dimension less than 3-in.; portland cement mortar shall be used for all other spalls greater than 0.03 cu. ft.; and epoxy resin mortar or type III, Grade 3 epoxy resin for those spalls less than 0.03 cu. ft. in size after removal operations. Portland cement concretes and mortars shall be very low slump mixtures, with 1/2-inch or less slump, proportioned, mixed, placed, and consolidated by vigorous tamping, supplemented by use of small diameter immersion vibrators, all as specified or directed. Grate tampers (jitterbugs) shall not be used. The concrete or mortar, while still green but sufficiently hardened to bear a man's weight without appreciable imprint shall be floated to a true even plane. Hand floating shall be supplemented with an approved vibratory compactor for small patches (up to 8.0 sq. ft.) and with an approved disc-type mechanical float which has integral impact mechanism for larger patches. Under no conditions shall any water or dry cement be added to the surface at any time before curing commences. The finished surface of repairs shall have a texture matching the surrounding pavement surface. The surfaces shall be checked for grade and shall meet the grade of the surrounding pavement and shall not deviate more than 1/8 inch from a true plane surface in the repair area.

### 3.1.3 Portland Cement Concrete and Mortar Mixtures

The Contractor shall be responsible for developing mixture proportions; this shall be performed by an approved commercial laboratory. Concrete shall conform to the materials and production requirements specified for paving concrete, except as otherwise specified herein. Water-cement ratio

of the concrete shall not exceed 0.40, the mixture shall be designed to produce concrete having at least 4000 psi at 14 days, and shall contain the greatest proportion of coarse aggregate, ASTM C33 size No. 4 and size No 67, practical to use, as approved. Mixture proportions developed for concrete and mortar shall be submitted for approval before starting construction. Mortar shall consist of the following materials, proportioned by weight as follows:

- 1.00 part portland cement
- 1.15 to 1.25 parts fine aggregate
- 1.80 to 2.00 parts coarse aggregate--max. size 3/4 in.
- Water--Max. w/c ratio 0.33
- Air entraining admixture as required

Water reducing admixture conforming to ASTM C 494 Type A, may be used in concrete and mortar, as approved.

#### 3.1.4           Batching and Mixing Portland Cement Mixtures

Portland cement concrete shall be mixed in a continuous batching and mixing plant conforming to ASTM C685 or in drum type mixers or in pugmills, neither the drum type or pugmill mixers to be over 4 sack size. Mortar shall be mixed in a horizontal shaft mortar mixer. All measuring, batching, and mixing procedures and equipment shall be subject to specific approval.

All materials shall be batched by weight, except that water and admixtures may be batched by volume. Each dry material may be prebatched for each batch and supplied in waterproof containers. Mixing shall be performed adjacent to the repair areas. Batches shall not exceed 0.5 cu. yd. in size. Ready-mix concrete or conventional truck mixers shall not be used. If the materials and procedures are approved in writing, latex modified concrete mixtures may be used for repairing spalls less than 1/3-cu. ft. in size.

#### 3.1.5           Epoxy Resins

Epoxy resin mortars shall be made with Type III, Grade 1 epoxy resin, using proportions and mixing, placing, and curing procedures as recommended by the manufacturer and approved by the Contracting Officer. The epoxy resin materials shall be placed in the cavity in layers not over 2-in. thick. The time interval between placement of additional layers shall be such that the temperature of the epoxy resin material does not exceed 140 degrees F. at any time during hardening. Mechanical vibrators and hand tampers shall be used to consolidate the epoxy resin mortar. Any repair material on the surrounding surfaces shall be removed before it hardens.

##### 3.1.5.1       Mixing Epoxy-Resin Grout Components

Epoxy-resin grout components shall be mixed in the proportions recommended by the manufacturer. The components shall be conditioned to 20 degrees C 70 degrees F to 30 degrees C 85 degrees F for 48 hours prior to mixing. The two epoxy components shall be mixed with a power-driven, explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. The polysulfide-curing-agent component shall be added gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. The rate of stirring shall be such that the entrained air is a minimum.

##### 3.1.5.2       Tools and Equipment

Tools and equipment used further in the work shall be thoroughly cleaned before the epoxy-resin grout sets.

### 3.1.5.3 Health and Safety Precautions

The following health and safety precautions shall be followed:

a. Full face shields shall be provided for all mixing and blending operations and for placing operations as required.

b. Protective coveralls and neoprene-coated gloves shall be provided for all workmen engaged in the operations.

c. Protective creams of a suitable nature for the operation shall be supplied.

d. Adequate fire protection shall be maintained at all mixing and placing operations.

e. Smoking or the use of spark- or flame-producing devices shall be prohibited within 15 meters 50 feet of mixing and placing operations.

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f. The mixing, placing, or storage of epoxy-resin grout or solvent shall be prohibited within 15 meters 50 feet of any vehicle, equipment aircraft, or machinery that could be damaged from fire or could ignite vapors from the material.

### 3.1.6 Joints

Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond between the patch and existing concrete at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other adjacent joints, and sealed as specified elsewhere.

### 3.1.7 Steel Encountered In Cavity

If reinforcing bars or tie bars are encountered at the required depth of removal and not more than one-half of the circumference of the wire or bar is exposed, the bar or fabric shall be left in place, any loose rust blasted off, and the cavity repaired. If more than one-half of the circumference is exposed, the removal shall continue to a depth of 3/4 inch below and around bars and to 1/2 inch below fabric, any loose rust blasted off, and the cavity repaired. If more than 1/10 of the circumference of a dowel is exposed, the entire repair shall be made full depth of the pavement, and the dowel cut off and replaced by drilling and grouting as previously specified. If any of these is severely rusted so as to reduce the diameter by 20 percent or more at any point, it shall be cut off and replaced with similar new material, lapped or connected as approved.

### 3.1.8 Curing Portland Cement Concrete and Mortar

Curing shall be by moist curing for at least 7 days, followed by application of white-pigmented membrane-forming curing compound, performed as follows:

a. Commence immediately after finishing is complete for each repair (patch).

b. Apply two layers of completely presaturated clean burlap conforming to AASHTO M182.

c. Resaturate (oversaturate) the burlap after placing and immediately cover with clear or white polyethylene sheeting at least 4 mils in thickness.

d. Cover with plywood at least 1/2 inch thick or wood form material and

weight down sufficiently to prevent displacement by wind.

e. All covering materials, burlap, plastic, and wood, shall extend at least 150 mm (6 inches) beyond every edge of the patch.

f. At least once every 24 hours, the plywood and plastic shall be removed, the burlap resaturated, and the plastic and plywood immediately replaced.

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g. When moist curing operations are complete, remove the plastic sheet and the plywood between 20:00 and 24:00 hours in the evening. Between 3 and 7 hours later, remove the burlap and immediately apply a uniform coat of white-pigmented curing compound to the repair area. Curing compound shall conform to CRD-C300, and shall be applied at a coverage rate of 200 sq. ft. per gallon.

h. Patches shall be protected from traffic for at least the following 7 days.

#### 3.1.9 Testing During Construction

At least once for 1.0 cu. yd. of portland cement concrete or mortar, the Contractor shall perform slump and air content tests, and at double that interval shall fabricate, cure, protect and test 6 inch by 12 inch test cylinders. One cylinder shall be tested at 7 days and the other at 14-day age. The cylinders shall be fabricated and cured in accordance with ASTM C31 and tested in accordance with C39. Slump tests shall be made in accordance with ASTM C143, and air content tests in accordance with C231.

#### 3.1.10 Final Acceptance

After 14 days and before final acceptance, each patch shall be tested by the Contractor in the presence of a Government representative. Patches shall be tested by sounding with a carpenter's hammer, at least 20 oz., or similar equipment. Any patches found to be drummy shall be removed and replaced at no additional cost to the Government.

-- End of Section --

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SECTION 02593

COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS  
09/93

**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 this text by basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2628 (1991) Preformed Polychloroprene  
Elastomeric Joint Seals for Concrete  
Pavements

ASTM D 2835 (1989; R 1993) Lubricant for Installation  
of Preformed Compression Seals in Concrete  
Pavements

CORPS OF ENGINEERS (COE)

COE CRD-C 548 (1988) Jet-Fuel and Heat Resistant  
Preformed Polychloroprene Elastomeric  
Joint Seals for Rigid Pavements

1.2 MEASUREMENT

The quantity of each sealing item to be paid for shall be determined by actual measurement of the number of linear metersfeet of in-place material that has been approved by the Contracting Officer.

1.3 PAYMENT

Payment shall be made at the contract unit bid prices per linear meter foot for the sealing items scheduled, including approved trail joint installation. The unit bid prices shall include the cost of all labor, materials, the use of all equipment, and tools required to complete the work.

1.2 SAFETY

Compression joint seals shall not be placed within 7.5 meters 25 feet of liquid oxygen (LOX) equipment, LOX storage, or LOX piping.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

## SD-01 DATA

Test Results; GA.

Certified copies of test results shall be provided 15 days prior to use of material on the project.

Equipment List; GA.

List of proposed equipment to be used in the performance of construction work, including descriptive data shall be provided 15 days prior to use on the project.

Manufacturer's Instructions; GA.

Where installation procedures are required in accordance with the manufacturer's recommendations, printed copies of manufacturers' instructions, 15 days prior to use on the project.

## SD-14, Samples

Compression Seals; GA.

Regardless of testing responsibility, 1.2 meter 4-foot long samples of the materials shall be submitted for approval 15 days prior to use on the project. Printed directions from the manufacturer on recommended installation criteria shall be furnished with the samples plus the manufacturer's certification that the selected seal is recommended for the installation on this project.

### 1.4 TEST REQUIREMENTS

Each lot of compression joint seal and lubricant/adhesive shall be sampled, identified, and tested for conformance with the applicable material specification. A lot of compression seal shall consist of 1 day's production or 6,000 meters 20,000 linear feet for each cross section, whichever is less. A lot of lubricant/adhesive shall consist of 1 day's production. Testing of the compression joint seal and lubricant/adhesive material shall be the responsibility of the Contractor and shall be performed in an approved independent laboratory, and certified copies of the test reports shall be submitted for approval 15 days prior to the use of the materials at the jobsite. Samples of each lot of material shall also be submitted and will be retained by the Government for possible future testing should the materials appear defective during or after application. The Contractor shall furnish additional samples of materials, in sufficient quantity to be tested, upon request. Final acceptance will be based on conformance to the specified test requirements and the performance of the in-place materials.

### 1.5 EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

#### 1.5.1 Joint Cleaning Equipment

#### 1.5.1.1 Concrete Saw

A self-propelled power saw with water-cooled diamond saw blades shall be provided for cutting joints to the depths and widths specified and for removing filler, existing old joint seal, or other material embedded in the joints or adhered to the joint faces.

#### 1.5.1.2 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hose, and a long-wearing venturi-type nozzle of proper size, shape, and opening. The maximum nozzle opening should not exceed 6.35 mm 1/4 inch. The air compressor shall be portable and shall be capable of furnishing not less than 4200 liters 150 cubic feet per minute and maintaining a line pressure of not less than 620 kPa 90 psi at the nozzle while in use. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint about 25 mm 1 inch above the pavement surface and will direct the blast to clean the joint walls. The height, angle of inclination, and the size of the nozzle shall be adjusted as necessary to ensure satisfactory results.

#### 1.5.2 Sealing Equipment

Equipment used to install the compression seal shall place the compression seal to the prescribed depths within the specified tolerances without cutting, nicking, twisting, or otherwise damaging the seal. The equipment shall be capable of placing the seal with not more than two percent longitudinal stretch or compression of the seal during installation. The machine shall be an automatic self-propelled joint seal application equipment and engine powered. The machine shall include a reservoir for the lubricant/adhesive, a device for conveying the lubricant/adhesive in the proper quantities to the sides of the compression seal or the sidewalls of the joints, a reel capable of holding one full spool of compression seal, and a power-driven apparatus for feeding the joint seal through a compression device and inserting the seal into the joint. The equipment shall also include a guide to maintain the proper course along the joint being sealed. The machine shall at all times be operated by an experienced operator.

#### 1.6 TRIAL JOINT SEAL AND LUBRICANT/ADHESIVE INSTALLATION

Prior to the cleaning and sealing of the joints for the entire project, a test section at least 69 meters 200 feet long shall be prepared at a designated location in the project pavement using the specified materials and the approved equipment, so as to demonstrate the proposed joint preparation and sealing of all types of joints in the project. Following the completion of the trial length and before any other joint is sealed, the trial joints will be inspected by the Government to determine that the materials and installation meet the requirements specified. If materials or installation do not meet requirements, the materials shall be removed, and the joints shall be recleaned and resealed at no cost to the Government. No other joints shall be sealed until the test installation has been approved. If the trial section is approved, it may be incorporated into the permanent work. Other joints shall be sealed in the manner approved for sealing the trial joint.

#### 1.7 DELIVERY AND STORAGE

Materials delivered to the jobsite shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall protect materials from weather and shall maintain materials at temperatures recommended by the manufacturer.

#### 1.8 ENVIRONMENTAL CONDITIONS

The ambient temperature and the pavement temperature within the joint wall shall be at least of 16 degrees C 35 degrees F and rising at the time of installation of the materials. Sealant installation will not be allowed if moisture or foreign material is observed in the joint.

### **PART 2 PRODUCTS**

#### 2.1 COMPRESSION SEALS

Compression joint seal materials shall be a vulcanized elastomeric compound using polychloroprene as the only base polymer. The material and manufactured seal shall conform to ASTM D 2628 and COE CRD-C 548 where jet fuel and/or heat blast resistance is required. The joint seal shall be a labyrinth type seal. The uncompressed depth of the face of the compression seal (that is to be bonded to the joint wall) shall be greater than the uncompressed width of the seal, except that for seals 25 mm 1 inch or greater in width, the depth need be only 1 inch or greater. The actual width of the uncompressed seal shall be 20.6 mm or 25.4 mm with a tolerance of plus 3.2 mm or minus 1.6 mm 13/16 inch or 1 inch with a tolerance of plus 1/8 inch and minus 1/16 inch.

#### 2.2 LUBRICANT/ADHESIVE

Lubricant/adhesive used for the compression elastomeric joint seal shall be a one-component compound conforming to ASTM D 2835.

### **PART 3 EXECUTION**

#### 3.1 PREPARATION OF JOINTS

Immediately before installation of the compression joint seal, the joints shall be thoroughly cleaned to remove laitance, filler, existing sealer, foreign material and protrusions of hardened concrete from the sides and upper edges of the joint space to be sealed. Cleaning shall be by sandblasting or waterblasting and shall extend along pavement surfaces at least 12 mm 1/2 inch on either side of the joint. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water. The Contractor shall demonstrate that the selected cleaning operation meets the cleanliness requirements. Any irregularity in the joint face which would prevent uniform contact between the joint seal and the joint face shall be corrected prior to the installation of the joint seal.

##### 3.1.1 Sawing

Joints shall be cleaned and to opened to the specified width and depth by sawing. Immediately following the sawing operation, the joint faces and opening shall be thoroughly cleaned using a water jet to remove saw

cuttings or debris remaining on the faces or in the joint opening. Compression seal shall be installed within 3 calendar days of the time the joint cavity is sawed. Depth of the joint cavity will be as recommended by the seal manufacturer. The saw cut for the joint seal cavity shall be centered over the joint line. The nominal width of the sawed joint seal cavity shall be as follows; the actual width shall be within a tolerance of plus or minus 1.6 mm/16 inch.

### 3.1.2 Sandblast Cleaning

A multiple pass sandblasting technique shall be used until the surfaces are free of dust, dirt, curing compound, or any residue that might prevent ready insertion or uniform contact of the seal and bonding of the lubricant/adhesive to the concrete.

### 3.1.4 Rate of Progress

Sandblasting of joint faces shall be limited to the length of joint that can be sealed during the same workday.

## 3.2 INSTALLATION OF THE COMPRESSION SEAL

### 3.2.1 Time of Installation

Joints shall be sealed immediately within 3 calendar days of sawing the joint seal cavity and following concrete cure and the final cleaning of the joint walls. Open joints ready for sealing that cannot be sealed under the specified conditions shall be provided with an approved temporary seal to prevent infiltration of foreign material. When rain interrupts the sealing operations, the joints shall be washed, air pressure cleaned, and allowed to dry prior to installing the lubricant/adhesive and compression seal.

### 3.2.2 Sequence of Installation

Longitudinal joints shall be sealed first, followed by transverse joints. Seals in longitudinal joints shall be installed so that all transverse joint seals will be intact from edge to edge of the pavement. Intersections shall be made monolithic by use of joint seal adhesive and care in fitting the intersection parts together. Extender pieces of seal shall not be used at intersections. Any seal falling short at the intersection shall be removed and replaced with new seal at no additional cost to the Government. Seals that are required to change direction by more than 20 degrees, may require a poured sealant at the intersection. Poured sealant shall be as recommended by the compression seal manufacturer.

## 3.3 SEALING OF JOINTS

The sides of the joint seal or the sides of the joint shall be covered with a coating of lubricant/adhesive and the seal installed in such a manner as to conform to all requirements specified. Butt joints and seal intersections shall be coated with liberal applications of lubricant/adhesive. Lubricant/adhesive spilled on the pavement shall be removed immediately to prevent setting on the pavement. The in-place joint seal shall be in an upright position and free from twisting, distortion, and cuts. Adjustments shall be made to the installation equipment and procedure, if the stretch or compression exceeds 2 percent. Any seal exceeding 2 percent stretch or compression shall be removed and replaced.

The joint seal shall be placed at a uniform depth within the tolerances specified. In-place joint seal which fails to meet the specified requirements shall be removed and replaced with new joint seal at no cost to the Government. The compression joint seal shall be placed to a depth of 6.4 mm 1/4 inch, plus or minus 3.2 mm 1/8 inch, below the pavement surface except when the joint is beveled or has a radius at the surface, or unless otherwise directed. For beveled joints or joints with a radius at the surface, the compression joint seal shall be installed at a depth of 3.2 mm 1/8 inch, plus or minus 1/8 inch, below the bottom of the edge of the bevel or radius. No part of the seal shall be allowed to project above the surface of the pavement or above the edge of the bevel or radius. The seal shall be installed in the longest practicable lengths in longitudinal joints and shall be cut at the joint intersections to provide continuous installation of the seal in the transverse joints. The lubricant/adhesive in the longitudinal joints shall be allowed to set for 1 hour prior to cutting at the joint intersections to reduce the possibility of shrinkage. For all transverse joints, the minimum length of the compression joint seal shall be the pavement width from edge to edge.

### 3.4 CLEAN-UP

Upon completion of the project, all unused materials shall be removed from the site, any lubricant/adhesive on the pavement surface shall be removed, and the pavement shall be left in clean condition.

### 3.5 QUALITY CONTROL PROVISIONS

#### 3.5.1 Equipment

The application equipment shall be inspected to assure uniform application of lubricant/adhesive to the sides of the compression joint seal or the walls of the joint. If any equipment causes cutting, twisting, nicking, excessive stretching or compressing of the seal, or improper application of the lubricant/adhesive, the operation will be suspended until causes of the deficiencies are determined and corrected.

#### 3.5.2 Procedures

##### 3.5.2.1 Quality Control Inspection

Quality control provisions shall be provided during the joint cleaning process to prevent or correct improper equipment and cleaning techniques that damage the concrete in any manner. Cleaned joints shall be approved by the Government prior to installation of the lubricant/adhesive and compression joint seal.

##### 3.5.2.2 Conformance to Stretching and compression Limitations

Conformance to stretching and compression limitations shall be determined. The top surface of the compression seal shall be marked at 1 foot intervals in a manner clear and durable to enable length determinations of the seal. After installation, the distance between the marks shall be measured on the seal. If the stretching or compression exceeds 2 percent, the seal shall be removed and replaced with new joint at no additional cost to the Government. The seal shall be removed up to the last correct measurement. The seal shall be inspected a minimum of once per 30 meters100 feet of seal for compliance to the shrinkage or compression requirements. Measurements shall also be made at the same interval to determine

conformance with depth and width of installation requirements. Compression seal that is not in conformance with specification requirements shall be removed and replaced with new joint seal at no additional cost to the Government.

#### 3.5.2.3 Pavement Temperature

The pavement temperature shall be determined by placing a thermometer in the initial saw cut for the joint and the reading shall be recorded. The thermometer shall remain in the joint for an adequate time to provide a control reading.

#### 3.5.3 Product

The joint sealing system (compression seal and lubricant/adhesive) shall be inspected for proper rate of cure and bonding to the concrete, cuts, twists, nicks and other deficiencies. Seals exhibiting any defects, at any time prior to final acceptance of the project, shall be removed from the joint, wasted, and replaced in a satisfactory manner.

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SECTION 02630

STORM-DRAINAGE SYSTEM  
09/98

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.

ACI INTERNATIONAL (ACI)

ACI 346/346R (1990) Standard Specification for Cast-in-Place Nonreinforced Concrete Pipe and Recommendations

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO HB-16 (1996) Standard Specifications for Highway Bridges

AASHTO M 167 (1994) Corrugated Steel Structural Plate, Zinc Coated, for Field Bolted Pipe

AASHTO M 190 (1988) Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches

AASHTO M 198 (1994) Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

AASHTO M 219 (1992) Aluminum Alloy Structural Plate for Field Bolted Conduits

AASHTO M 243 (1994) Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches

AASHTO M 294 (1994) Corrugated Polyethylene Pipe, 305- to 915- mm (12-to 36 in.) Diameter

AASHTO MP6 (1995) Corrugated Polyethylene Pipe 1050 and 1200 mm Diameter

AMERICAN RAILWAY ENGINEERING ASSOCIATION (AREA)

AREA-01 (1997) 1997-1998 Manual for Railway Engineering 4 Vol., Volume 1

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48	(1994a) Gray Iron Castings
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 536	(1984; R 1993) Ductile Iron Castings
ASTM A 716	(1995) Ductile Iron Culvert Pipe
ASTM A 742/A 742M	(1995) Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
ASTM A 760/A 760M	(1997) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A 762/A 762M	(1997) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A 798/A 798M	(1997) Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
ASTM A 807	(1996) Installing Corrugated Steel Structural Plate Pipe for Sewers and Other Applications
ASTM A 849	(1996) Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM A 929/A 929M	(1996) Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
ASTM B 26/B 26M	(1997) Aluminum-Alloy Sand Castings
ASTM B 745/B 745M	(1995) Corrugated Aluminum Pipe for Sewers and Drains
ASTM C 12	(1995) Installing Vitrified Clay Pipe Lines
ASTM C 14	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 14M	(1995) Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 32	(1993) Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 55	(1997) Concrete Building Brick
ASTM C 62	(1997) Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 76	(1997) Reinforced Concrete Culvert, Storm

Drain, and Sewer Pipe

ASTM C 76M	(1997) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 139	(1997) Concrete Masonry Units for Construction of Catch Basins and Manholes
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 270	(1997a) Mortar for Unit Masonry
ASTM C 425	(1997) Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C 443	(1994) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C 478	(1997) Precast Reinforced Concrete Manhole Sections
ASTM C 478M	(1997) Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C 506	(1995a) Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C 506M	(1995a) Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 507	(1995a) Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C 507M	(1995a) Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 655	(1995a) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 700	(1997) Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
ASTM C 789	(1995a) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C 828	(1990; R 1996) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C 850	(1995a) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 ft of Cover Subjected to Highway Loadings
ASTM C 877	(1994) External Sealing Bands for

Noncircular Concrete Sewer, Storm Drain,  
and Culvert Pipe

ASTM C 924	(1989; R 1997) Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C 1103	(1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C 1103M	(1994) Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM D 1056	(1991) Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D 1171	(1994) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D 1557	(1991) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu.m.))
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D 1784	(1997) Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2321	(1989; R 1995) Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D 3017	(1988; R 1993) Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3034	(1994) Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3212	(1996a) Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D 3350	(1996) Polyethylene Plastics Pipe and Fittings Materials

ASTM F 477	(1995) Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 679	(1995) Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F 714	(1994) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F 794	(1995a) Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F 894	(1995) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F 949	(1994) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F 1417	(1992) Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

### SD-06 Instructions

Placing Pipe; FIO.

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

### SD-13 Certificates

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

Certified copies of test reports demonstrating conformance to applicable pipe specifications, before pipe is installed. Certification on the ability of frame and cover or gratings to carry the imposed live load.

### SD-14 Samples

Pipe for Culverts and Storm Drains; FIO.

Samples of the following materials, before work is started.

## 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. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall 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 ASTM A 760.

### 2.2 DRAINAGE STRUCTURES

#### 2.2.1 Flared End Sections

Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A 929/A 929M.

## 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 02300 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 610 mm 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. Contractor shall not overexcavate. 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 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 in his performance of shoring and sheeting, 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 Corrugated Metal Pipe

Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A 798/A 798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, the Contractor shall either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A 807.

### 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 (%)
Corrugated Steel	5
Concrete-Lined Corrugated Steel	3

Not less than 30 days after the completion of backfilling, the Government may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced at no cost to the Government.

#### 3.3.1 Concrete 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.

### 3.3.2 Corrugated Metal Pipe and Pipe Arch

Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M 190 or AASHTO M 243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During installation, pipe or pipe arch shall be handled with care to preclude damage to the bituminous coating or paving. Prior to placing backfill, damaged areas of coupling bands and pipe shall be given a coating of bituminous material, as specified in AASHTO M 190 or AASHTO M 243. Pipe on which bituminous coating has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.

### 3.3.3 Jacking Pipe Through Fills

Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREA-01.

## 3.4 BACKFILLING

### 3.4.1 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 150 mm 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 300 mm 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 4 m, 12 feet, whichever is less. After the backfill has reached at least 300 mm 12 inches above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 150 mm. 6 inches.

### 3.4.2 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.

### 3.4.3 Compaction

#### 3.4.3.1 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.

#### 3.4.3.2 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 airfield and heliport pavements, paved roads, streets, 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.

#### 3.4.4 Determination of Density

Testing shall be 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 D 1557 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 D 2167. Test results shall be furnished the Contracting Officer's Representative.

-- End of Section --

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SECTION 02754  
CONCRETE PAVEMENTS FOR SMALL PROJECTS  
03/97

**PART 1 GENERAL**

1.1 SCOPE OF WORK

This specification shall be used for the full depth repairs of existing concrete pavement and new heavy duty concrete pavement.

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.

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(1996) Standard Specification for Structural Concrete
ACI 305R	(1991) Hot Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 184	(1990) Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 615	(1996) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 31	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1993) Concrete Aggregates
ASTM C 39	(1996) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	(1996) Ready-Mixed Concrete
ASTM C 123	(1994) Lightweight Pieces in Aggregate
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1996) Portland Cement
ASTM C 192	(1990a) Making and Curing Concrete Test

## Specimens in the Laboratory

ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1995) Air-Entraining Admixtures for Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 618	(1996a) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 1077	(1995a) Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 1752	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

### ARMY CORPS OF ENGINEERS (COE)

COE CRD-C 130	(1989) Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete

### NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1990) Concrete Plant Standards
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## 1.2 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of concrete (rigid) pavement. However, where the construction covered herein interfaces with other sections, the construction at each interface shall conform to the requirements of both this section and the other section, including tolerances for both.

## 1.3 MEASUREMENT AND PAYMENT

### 1.3.1 Measurement

The quantity of concrete to be paid for will be the volume of concrete in cubic meters yards including monolithic curb, where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line dimensions shown in the plan and cross section. No deductions will be made for rounded edges or the space occupied by embedded items or voids.

### 1.3.2 Payment

Payment will be made at the contract price per cubic meter yard for the scheduled item. Payment will constitute full compensation for furnishing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement. No separate payment will be made for any cementitious materials, admixtures, steel reinforcement, dowels or tie bars, or for any joint materials.

### 1.4 ACCEPTABILITY OF WORK

The pavement will be accepted on the basis of tests made by the Government and by the Contractor or its suppliers, as specified herein. The Government may, at its discretion, make check tests to validate the results of the Contractor's testing. Concrete samples shall be taken by the Contractor at the placement to determine the slump, air content, and strength of the concrete. Test cylinders shall be made for determining conformance with the strength requirements of these specifications and, when required, for determining the time at which pavements may be placed into service. All air content measurements shall be determined in accordance with ASTM C 231. All slump tests shall be made in accordance with ASTM C 143. All test cylinders shall be 150 by 300 mm 6 by 12 inch cylinders and shall be fabricated in accordance with ASTM C 192, using only steel molds, cured in accordance with ASTM C 31, and tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. The Contractor shall furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory.

#### 1.4.1 Evaluation Sampling

Sampling, testing, and mixture proportioning shall be performed by a commercial Testing Laboratory, conforming with ASTM C 1077. The individuals who sample and test concrete and concrete constituents shall be certified as American Concrete Institute (ACI) Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete shall be certified as ACI Concrete Construction Inspector, Level II. All mix design, weekly quality control reports, smoothness reports, and project certification reports shall be signed by a Registered Engineer.

#### 1.4.2 Surface Testing

Surface testing for surface smoothness, edge slump and plan grade shall be performed as indicated below by the Testing Laboratory. The measurements shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the Government within 24 hours after measurement is made. A final report of surface testing, signed by a Registered Engineer, containing all surface measurements and a description of all actions taken to correct deficiencies, shall be provided to the Government upon conclusion of surface testing.

##### 1.4.2.1 Surface Smoothness Requirements

The finished surfaces of the pavements shall have no abrupt change of 3 mm 1/8 inch or more, and all pavements shall be within the tolerances specified in Table 1 when checked with the straightedge. The finished surface in the longitudinal direction or the transverse direction can be

tested using a California Profilograph. Measurements taken with the California Profilograph shall have a Profile Index no greater than 9 inches per mile for helipad and aprons.

TABLE 1  
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

<u>Pavement Category</u> -----	<u>Direction of Testing</u> -----	<u>Tolerances</u> mm -----
Tank Hardstands, Parking Areas, Open Storage Areas	Longitudinal Transverse	6.5 6.5

TABLE 1  
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

<u>Pavement Category</u>	<u>Direction of Testing</u>	<u>Tolerances</u> inches
Runways and Taxiways	Longitudinal Transverse	1/8 1/4
Calibration Hardstands & Compass Swinging Bases	Longitudinal Transverse	1/8 1/8
All Other Airfield and Helicopter Paved Areas	Longitudinal Transverse	1/4 1/4
Tank Hardstands, Parking Areas, Open Storage Areas	Longitudinal Transverse	1/4 1/4

#### 1.4.2.2 Surface Smoothness Testing Method

The surface of the pavement shall be tested with the straightedge to identify all surface irregularities exceeding the tolerances specified above. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines approximately 4.5 m/15 feet apart. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the 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.

#### 1.4.2.3 Profilograph Equipment and Testing

Profilograph testing shall be performed using approved equipment and procedures described in State of California, Department of Transportation, Division of Construction, California Test 526 "Operation of California Profilograph and Evaluation of Profiles". The equipment shall utilize electronic recording and automatic computerized reduction of data to indicate "must-grind" bumps and the Profile Index for the pavement. The profilograph shall be operated by an approved, factory-trained operator on the alignments specified. A copy of the reduced tapes shall be furnished

to the Government at the end of each day's operation. The California profilograph shall be calibrated prior to usage to the Contracting Officer's satisfaction. When the California Profilograph is utilized for smoothness determination, it shall be typically performed in runs exceeding 200 feet. 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 such requirements. Acceptable criteria for acceptance shall be the average of all runs in a single direction done on a feature, that is less than the specified Profile Index indicated in paragraph "1.4.2.1 Surface Smoothness Requirements". If any run has a Profile Index greater than the Profile Index, the Contractor shall stop the operation and make additional measurements to define the problem and perform corrective actions to get it back into the specifications. No single run shall exceed the specified Profile Index by more than 4.0 inches per mile without requiring complete removal and replacement at no cost to the government. Submittal of results shall be signed by a Registered Engineer.

#### 1.4.4 Plan Grade Testing and Conformance

The finished surface of the pavements shall conform, within the tolerances shown in Table 1, to the lines, grades, and cross sections shown. The finished surface of new abutting pavements shall coincide at their juncture. The finished surface of airfield runway, taxiway, and apron pavements shall vary not more than 12 mm0.04 foot above or below the plan grade line or elevation indicated. The surfaces of other pavements shall vary not more than 18 mm0.06 foot above or below the plan grade line or elevation indicated. Each pavement category shall be checked by the Contractor for conformance with plan grade requirements by running lines of levels at intervals to determine the elevation at each joint intersection.

#### 1.5 PRECONSTRUCTION TESTING OF MATERIALS

The Contractor shall not be entitled to any additional payment or extension of time because of delays caused by sampling and testing additional sources, or samples, necessitated by failure of any samples. Aggregates shall be sampled and tested by the Test Laboratory and shall be representative of the materials to be used for the project. The Contractor shall indicate the Aggregate source and its location. Test results, signed by a Registered Engineer, shall be submitted 60 days before commencing paving. No aggregate shall be used unless test results show that it meets all requirements of these specifications, including compliance with ASTM C 33 and deleterious materials limitations.

#### 1.6 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment; GA.

Manufacturer's literature on the concrete plant; mixing equipment; hauling equipment; placing and finishing, and curing equipment; at least 60 days prior to start of paving.

## SD-07 Schedules

Paving; GA.

Paving Schedules at least 14 days prior to start of paving.

## SD-08 Statements

Mixture Proportions; GA.

The report of the Contractor's mixture proportioning studies, signed by a Registered Engineer, included all test breaks showing the proportions of all ingredients and supporting information on aggregate and other materials that will be used in the manufacture of concrete, at least 60 days prior to commencing concrete placing operations.

Placement Inspections; FIO.

Inspection certification by a Registered Engineer shall be submitted prior to each day's paving.

Smoothness & CQC Reports; FIO.

Smoothness and CQC Reports shall be submitted and certified by a Registered Engineer and provided prior to each day's paving.

## 1.7 EQUIPMENT

### 1.7.1 Batching and Mixing

The batching plant shall conform to NRMCA CPMB 100, the equipment requirements in ASTM C 94, and as specified. Water shall not be weighed or measured cumulatively with another ingredient. All concrete materials batching shall meet ASTM C 94 requirements. Mixers shall be stationary mixers or truck mixers. Batching, mixers, mixing time, permitted reduction of mixing time, and concrete uniformity shall meet the requirements of ASTM C 94, and shall be documented in the initial weekly QC Report.

### 1.7.2 Transporting Equipment

Transporting equipment shall be in conformance with ASTM C 94 and as specified herein. Concrete shall be transported to the paving site in rear-dump trucks, in truck mixers designed with extra large blading and rear opening specifically for low slump concrete, or in agitators. Bottom-dump trucks shall not be used for delivery of concrete.

### 1.7.3 Delivery Equipment

When concrete transport equipment cannot operate on the paving lane, side-delivery transport equipment consisting of self-propelled moving conveyors shall be used to deliver concrete from the transport equipment and discharge it in front of the paver. Front-end loaders, dozers, or similar equipment shall not be used to distribute the concrete.

### 1.7.4 Paver-Finisher

The paver-finisher shall be a heavy-duty, self-propelled machine designed

specifically for paving and finishing high quality pavement. The paver-finisher shall weigh at least 3280 kg per m<sup>2</sup>2200 lb./foot of lane width, and shall be powered by an engine having at least 15000 W per meter 6.0 horsepower per foot of lane width. The paver-finisher shall spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The paver-finisher shall be equipped with a full width "knock-down" auger, capable of operating in both directions, which will evenly spread the fresh concrete in front of the screed or extrusion plate. Immersion vibrators shall be gang mounted at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete. The vibrators shall be automatically controlled so that they will be immediately stopped as forward motion of the paver ceases. The spacing of the immersion vibrators across the paving lane shall be as necessary to properly consolidate the concrete, but the clear distance between vibrators shall not exceed 750 mm,30 inches, and the outside vibrators shall not exceed 300 mm12 inches from the edge of the lane. The paver-finisher shall be equipped with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface.

#### 1.7.4.1 Paver-Finisher with Fixed Forms

The paver-finisher shall be equipped with wheels designed to ride the forms, keep it aligned with the forms, and to spread the preventing deformation of the forms.

#### 1.7.4.2 Slipform Paver-Finisher

The slipform paver-finisher shall be automatically controlled and crawler mounted with padded tracks. Horizontal alignment shall be electronically referenced to a taut wire guideline. Vertical alignment shall be electronically referenced on both sides of the paver to a taut wire guideline, to an approved laser control system, or to a ski operating on a completed lane. Control from a slope-adjustment control or control operating from the underlying material shall not be used.

#### 1.7.4.3 Other Types of Finishing Equipment

Bridge deck finishers shall be used for pavements 250 mm10 inches or less in thickness, where longitudinal and transverse surface smoothness tolerances are 6.5 mm1/4 inch or greater. Clary screeds or other rotating tube floats will not be allowed on the project.

#### 1.7.5 Curing Equipment

Equipment for curing is specified in paragraph CURING.

#### 1.7.6 Texturing Equipment

Texturing equipment shall be as specified below.

##### 1.7.6.1 Fabric Drag

A fabric drag shall consist of a piece of fabric material as wide as the lane width securely attached to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. The material shall be wide enough to provide 300 to 450 mm12 to 18 inches

dragging flat on the pavement surface. The fabric material shall be clean, reasonably new burlap, kept clean and saturated during use.

#### 1.7.7 Sawing Equipment

Equipment for sawing joints and for other similar sawing of concrete shall be standard diamond-tip-bladed concrete saws mounted on a wheeled chassis.

#### 1.7.8 Straightedge

The Contractor shall furnish and maintain at the job site one 4 m12 foot straightedge for testing concrete surface smoothness. The straightedge shall be constructed of aluminum or magnesium alloy and shall have blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Straightedges shall have handles for operation on the pavement.

## **PART 2 PRODUCTS**

### 2.1 CEMENTITIOUS MATERIALS

Cementitious materials shall be portland cement and pozzolan and shall conform to appropriate specifications listed below.

#### 2.1.1 Portland Cement

Portland cement shall conform to ASTM C 150 Type II, low-alkali.

#### 2.1.2 High-Early-Strength Portland Cement

ASTM C 150, Type III with tricalcium aluminate limited to 5 percent, low alkali. Type III cement shall be used only in isolated instances and only when approved in writing.

#### 2.1.2 Pozzolan (Fly Ash)

Fly ash shall conform to ASTM C 618 Class F, including all the supplementary optional physical requirements.

### 2.2 AGGREGATES

Aggregates shall consist of clean, hard, uncoated particles meeting the requirements of ASTM C 33, including deleterious materials, abrasion loss and soundness requirements of ASTM C 33, and other requirements specified herein.

#### 2.2.1 Coarse Aggregate

Coarse aggregate shall consist of crushed and/or uncrushed gravel crushed stone, or a combination thereof. The nominal maximum size of the coarse aggregate shall be 25.0 mm. 1 1/2 inches. When the nominal maximum size is greater than 25.0 mm, 1 inch, the aggregates shall be furnished in two ASTM C 33 size groups, No. 67 and No. 4. The amount of deleterious material in each size of coarse aggregate shall not exceed the limits shown in ASTM C 33 Class 1N, 4M or 4S, depending on the weathering region, and the following limits:

- a. Lightweight particles 1.0 max. percent by mass (ASTM C 123).
- b. Other soft particles 2.0 max. percent by mass (COE CRD-C 130).
- c. Total of all deleterious 5.0 max. percent by mass (substances listed in ASTM C 33 and above, exclusive of material finer than 0.075 mm No. 200 sieve).
- d. The separation medium for lightweight particles shall have a density of 2.0 Mg/cubic meters. Sp. Gr. of 2.0.

#### 2.2.2 Fine Aggregate

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two, and shall be composed of clean, hard, durable particles. All fine aggregate shall be composed of clean, hard, durable particles meeting the requirements of ASTM C 33 and the requirements herein. The amount of deleterious material in the fine aggregate shall not exceed the limits in ASTM C 33 and shall not exceed the following limits:

- a. Lightweight particles (ASTM C 123) 1.0 percent max. by mass using a medium with a density of 2.0 Mg/cubic meter. Sp. Gr. of 2.0.
- b. The total of all deleterious material types, listed in ASTM C 33 and above, shall not exceed 3.0 percent of the mass of the fine aggregate.

#### 2.3 CHEMICAL ADMIXTURES

Air-entraining admixture shall conform to ASTM C 260. An accelerator shall be used only when specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES and shall not be used to reduce the amount of cementitious material used. Accelerator shall conform to ASTM C 494 Type C. Calcium chloride and admixtures containing calcium chloride shall not be used. A water-reducing or retarding admixture shall meet the requirements of ASTM C 494. Type G or H admixtures are not allowed.

#### 2.4 CURING MATERIALS

Membrane forming curing compound shall be a white pigmented compound conforming to COE CRD-C 300. Burlap shall be new or shall be clean material never used for anything other than curing concrete.

#### 2.5 WATER

Water for mixing and curing shall be clean, potable, and free of injurious amounts of oil, acid, salt, or alkali.

#### 2.6 JOINT MATERIALS

##### 2.6.1 Expansion Joint Material

Expansion joint filler shall be a preformed material conforming to ASTM D 1752. Expansion joint filler shall be 20 mm 3/4 inch thick.

##### 2.6.2 Slip Joint Material

Slip joint material shall be 6 mm 1/4 inch thick expansion joint filler conforming to ASTM D 1752.

## 2.7 REINFORCING

### 2.7.1 General

Reinforcing bars shall conform to ASTM A 615 Grade 60. Bar mats shall conform to ASTM A 184. Reinforcement shall be free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete.

## 2.8 DOWELS

Dowels shall be single piece, plain (non-deformed) steel bars conforming to ASTM A 615 Grade 60 or higher. Dowels shall be free of loose, flaky rust and loose scale and shall be clean and straight.

## 2.9 EPOXY RESIN

All epoxy-resin materials shall be two-component materials conforming to ASTM C 881, Class as appropriate for each application temperature to be encountered; except, that in addition, the materials shall meet the following requirements:

- a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.
- b. Material for use as patching for complete filling of spalls, wide cracks, and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.
- c. Material for injecting cracks shall be Type IV, Grade 1.
- d. Material for bonding freshly mixed portland cement concrete, mortar, or freshly mixed epoxy resin concrete to hardened concrete shall be Type V, Grade as approved.

## 2.10 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

The compressive strength (f'c) for the heavy duty airfield pavement and other heavy duty concrete work shall be 28 MPa (4,000 psi) 4000 psi at 28 days. Minor concrete work (non-structural) shall have compressive strength of 21 MPa (3,000 psi) 3,000 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio is based on absolute volume equivalency, where the ratio is determined using the weight of cement for a cement only mix, or using the total volume of cement plus pozzolan converted to an equivalent weight of cement by the absolute volume equivalency method described in ACI 211.1. For this project the use of fly ash for all concrete paving shall be mandatory. The concrete shall be air-entrained with a total air content of 4 plus or minus 1 percent. The maximum allowable slump of the concrete shall be 75 mm 3 inches for pavement constructed with fixed forms. The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 3.5 MPa. 500 psi. Additional

analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

## 2.11 MIXTURE PROPORTIONS

### 2.11.1 Composition Concrete

Composition concrete shall be composed of cementitious material, water, fine and coarse aggregates, and admixtures. Fly ash shall be used only at a rate between 15 and 35 percent by mass of the total cementitious material. Admixtures shall consist of air entraining admixture and may also include water-reducing admixture. High range water-reducing admixtures and admixtures to produce flowable concrete shall not be used. No substitutions shall be made in the materials used in the mixture proportions without additional tests to show that the quality of the concrete is satisfactory.

### 2.11.2 Concrete Mixture Proportioning Studies

Trial design batches, mixture proportioning studies, and testing shall be the responsibility of the Contractor, and shall be performed by the Test Laboratory and signed by a Registered Engineer. No concrete pavement shall be placed until the Contracting Officer has approved the Contractor's mixture proportions. All materials used in mixture proportioning studies shall be representative of those proposed for use on the project. If there is a change in materials, additional mixture design studies shall be made using the new materials. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in ACI 211.1. At least three different water-cementitious ratios, separated by a minimum of 0.05 which will produce a range of strength encompassing that required on the project, shall be used. Laboratory trial mixtures shall be proportioned for maximum permitted slump and air content. Maximum sand content shall be 40 percent of the total aggregate SSD weight. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

### 2.11.3 Mixture Proportioning Procedure

The Contractor shall perform the following:

- a. Fabricate, cure and test 6 test cylinders per age for each mixture at 7 and 28 days.
- b. Using the average strength for each  $w/(c+p)$ , plot the results from each of the three mixtures on separate graphs for  $w/(c+p)$  versus 28-day strength.
- c. From the graphs select a  $w/(c+p)$  which will produce a mixture giving a 28-day strength equal to the required strength determined in accordance with the following paragraph.

### 2.11.4 Average Strength Required for Mixtures

In order to ensure meeting, during production, the strength requirements specified, the mixture proportions selected shall produce a required average strength,  $f'_{cr}$ , exceeding the specified strength,  $f'_c$ , in

accordance with procedures in Chapter 3 of ACI 301, "Proportioning."

### **PART 3 EXECUTION**

#### 3.1 CONDITIONING OF UNDERLYING MATERIAL

Underlying material, base course or subgrade, upon which concrete is to be placed shall be clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. If any paving or other Construction equipment causes any disturbance to the underlying materials, the Contractor shall get the equipment off.

#### 3.2 WEATHER LIMITATIONS

##### 3.2.1 Hot Weather Paving

The temperature of concrete shall not exceed 32 degrees C. 90 degrees F. Steel forms, dowels and reinforcing shall be cooled prior to concrete placement when steel temperatures are greater than 49 degrees C. 120 degrees F.

##### 3.2.2 Cold Weather Paving

The ambient temperature of the air at the placing site and the temperature of surfaces to receive concrete shall be not less 5 degrees C. 40 degrees F. The temperature of the concrete when placed shall be not less than 10 degrees C. 50 degrees F. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. Upon written approval, chemical admixture conforming to ASTM C 494 Type C or E may be used provided it contains no calcium chloride. Calcium chloride shall not be used at any time. Covering and other means shall be provided for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing, and at a temperature above freezing for the remainder of the curing period. Pavement damaged by freezing shall be completely removed and replaced at the Contractor's expense as specified in paragraph, REPAIR, REMOVAL, AND REPLACEMENT OF SLABS.

#### 3.3 CONCRETE PRODUCTION

##### 3.3.1 General Requirements

Concrete shall be deposited in front of the paver within 45 minutes from the time cement has been charged into the mixing drum, except that if the ambient temperature is above 32 degrees C, 90 degrees F, the time shall be reduced to 30 minutes. Every load of concrete delivered to the paving site shall be accompanied by a batch ticket from the operator of the batching plant. Tickets shall show at least the mass, or volume, of all ingredients in each batch delivered, and the time of day. Tickets shall be delivered to the placing foreman who shall keep them on file and deliver them to the Government daily.

##### 3.3.2 Transporting and Transfer-Spreading Operations

Non-agitating equipment shall be used only on smooth roads and for haul

time less than 15 minutes. Equipment shall be allowed to operate on the underlying material only if no damage is done to the underlying material and its degree of compaction. Any disturbance to the underlying material that does occur shall be corrected before the paver-finisher reaches the location of the disturbance and the equipment shall be replaced or procedures changed to prevent any future damage. Additional water may be added to truck mixers to bring the slump within the specified range provided the mixture water-cement ratio is not exceeded.

### 3.4 PAVING

Pavement shall be constructed with paving and finishing equipment utilizing fixed forms.

#### 3.4.1 Consolidation

The paver vibrators shall be inserted into the concrete not closer to the underlying material than 50 mm. 2 inches. The vibrators or any tamping units in front of the paver shall be automatically controlled so that they shall be stopped immediately as forward motion ceases. Excessive vibration shall not be permitted. Concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment shall be vibrated with a hand-operated immersion vibrator. Vibrators shall not be used to transport or spread the concrete.

#### 3.4.2 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions shall be made to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of any debris, and placing rubber mats beneath the paver tracks. Transversely oscillating screeds and extrusion plates shall overlap the existing pavement the minimum possible, but in no case more than 200 mm. 8 inches.

#### 3.4.3 Required Results

The paver-finisher shall be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. It shall produce only a very minimum of paste at the surface. Multiple passes of the paver-finisher shall not be permitted. The equipment and its operation shall produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. No water, other than true fog sprays (mist), shall be applied to the concrete surface during paving and finishing.

#### 3.4.4 Fixed Form Paving

Forms shall be steel, except that wood forms may be used for curves having a radius of 45 m 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form shall be not less than eight-tenths of the vertical height of the form, except that forms 200 mm 8 inches or less in vertical height shall have a base width not less than the vertical height of the form. Wood forms for curves and fillets shall be adequate in strength and rigidly braced. Forms shall be set on

firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms shall not be set on blocks or on built-up spots of underlying material. Forms shall remain in place at least 12 hours after the concrete has been placed. Forms shall be removed without injuring the concrete.

#### 3.4.5 Slipform Paving

The slipform paver shall shape the concrete to the specified and indicated cross section in one pass, and shall finish the surface and edges so that only a very minimum amount of hand finishing is required. Dowels shall not be installed by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete.

#### 3.4.6 Placing Reinforcing Steel

Reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement, or may be placed on an initial layer of consolidated concrete, with the subsequent layer placed within 30 minutes of the first layer placement.

#### 3.4.7 Placing Dowels

Dowels shall be installed with alignment not greater than 1 mm per 100 mm. 1/8 inch per ft. Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 15 mm 5/8 inch and a vertical tolerance of plus or minus 5 mm 3/16 inch. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement. Dowels in joints shall be omitted when the center of the dowel is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness.

##### 3.4.7.2 Construction Joints-Fixed Form Paving

Installation of dowels shall be by the bonded-in-place method, supported by means of devices fastened to the forms. Installation by removing and replacing in preformed holes will not be permitted.

##### 3.4.7.3 Dowels Installed in Hardened Concrete

Installation shall be by bonding the dowels into holes drilled into the hardened concrete. Holes approximately 3 mm 1/8 inch greater in diameter than the dowels shall be drilled into the hardened concrete. Dowels shall be bonded in the drilled holes using epoxy resin injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel.

##### 3.4.7.4 Expansion Joints

Dowels in expansion joints shall be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

### 3.5 FINISHING

Clary screeds, "bridge deck" finishers, or other rotating pipe or tube type equipment shall not be permitted. The sequence of machine operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Hand finishing shall be used only infrequently and only on isolated areas of odd slab shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Equipment to be used for supplemental hand finishing shall primarily be 3 to 4 m10 to 12 feet cutting straightedges; only very sparing use of bull floats shall be allowed. At no time shall water be added to the surface of the slab in any way, except for fog (mist) sprays to prevent plastic shrinkage cracking.

#### 3.5.1 Machine Finishing With Fixed Forms

The machine shall be designed to ride the forms. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

#### 3.5.3 Surface Correction

While the concrete is still plastic, irregularities and marks in the pavement surface shall be eliminated by means of cutting straightedges, 3 to 4 m 10 to 12 feet in length. Depressions shall be filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. Long-handled, flat "bull floats" shall be used sparingly and only as necessary to correct minor, scattered surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Joints and edges shall not be overfinished.

#### 3.5.4 Hand Finishing

Hand finishing operations shall be used only for those unusual slabs as specified previously. Grate tampers (jitterbugs) shall not be used. As soon as placed and vibrated, the concrete shall be struck off and screeded. The surface shall be tamped with a strike-off and tamping screed, or vibratory screed. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally. Long-handled, flat bull floats shall be used sparingly and only as necessary to correct surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Joints and edges shall not be overfinished. No water shall be added to the pavement during finishing operations.

#### 3.5.5 Texturing

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein.

After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. The concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement shall be finished to provide a surface of the same texture as the surrounding area.

#### 3.5.5.1 Fabric-Drag Surface Finish

Surface texture shall be applied by dragging the surface of the pavement, in the direction of the concrete placement, with a moist fabric drag. The dragging shall produce a uniform finished surface having a fine sandy texture without disfiguring marks.

#### 3.5.6 Edging

After texturing has been completed, the edge of the slabs along the forms shall be carefully finished with an edging tool to form a smooth rounded surface of 3 mm/8 inch radius. No water shall be added to the surface during edging.

### 3.6 CURING

Concrete shall be continuously protected against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Unhardened concrete shall be protected from rain and flowing water. During hot weather with low humidity and/or wind, the Contractor shall institute measures to prevent plastic shrinkage cracks from developing. ACI 305R contains means of predicting plastic shrinkage cracking and preventative measures. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry. Curing shall be accomplished by one of the following methods.

#### 3.6.1 Membrane Curing

A uniform coating of white-pigmented membrane-forming curing compound shall be applied to the entire exposed surface of the concrete including pavement edges as soon as the free water has disappeared from the surface after finishing. If evaporation is high and no moisture is present on the surface even though bleeding has not stopped, fog sprays shall be used to keep the surface moist until setting of the cement occurs. Curing compound shall then be immediately applied. Curing compound shall be applied to the finished surfaces by means of a self-propelled automatic spraying machine, equipped with multiple spraying nozzles with wind shields, spanning the newly paved lane. The curing compound shall be applied at a maximum application rate of 5 square meters per L. 200 square feet per gallon. The application of curing compound by hand-operated, mechanical powered pressure sprayers will be permitted only on odd widths or shapes of slabs where indicated and on concrete surfaces exposed by the removal of forms. The compound shall form a uniform, continuous, cohesive film that will not check, crack, or peel and that will be free from pinholes and other discontinuities. Areas where the curing compound develops the above defects or is damaged by heavy rainfall, sawing or other construction operations within the curing period, shall be immediately resprayed.

#### 3.6.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the

entire curing period, commencing immediately after finishing. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Impervious sheet curing shall not be used.

### 3.7 JOINTS

No deviation from the jointing pattern shown on the drawings shall be made without written approval of the Design District Pavement or Geotechnical Engineer. All joints shall be straight, perpendicular to the finished grade of the pavement, and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 13 mm. 1/2 inch.

#### 3.7.1 Longitudinal Construction Joints

Dowels shall be installed in the longitudinal construction joints, or the edges shall be thickened as indicated.

#### 3.7.2 Transverse Construction Joints

Transverse construction joints shall be installed at a planned transverse joint, at the end of each day's placing operations and when concrete placement is interrupted. Transverse construction joints shall be constructed either by utilizing headers and hand placement and finishing techniques, or by placing concrete beyond the transverse construction joint location and then saw cutting full depth and removing concrete back to the transverse construction joint location. For the latter case, dowels shall be installed using methods for dowels installed in hardened concrete described above. All transverse construction joints shall be dowelled.

#### 3.7.3 Expansion Joints

Expansion joints shall be formed where indicated, and about any structures and features that project through or into the pavement, using preformed joint filler of the type, thickness, and width indicated, and shall extend the full slab depth. Edges of the concrete at the joint face shall be edged. The joint filler strips shall be installed to form a recess at the pavement surface to be filled with joint sealant. Expansion joints shall be constructed with thickened edges for load transfer.

#### 3.7.4 Slip Joints

Slip joints shall be installed the full depth of the slab using expansion joint preformed joint filler material attached to the face of the original concrete placement. A reservoir for joint sealant shall be constructed at the top of the joint. Edges of the joint face shall be edged.

#### 3.7.5 Contraction Joints

Transverse and longitudinal contraction joints shall be of the weakened-plane or dummy type. Longitudinal contraction joints shall be constructed by sawing a groove in the hardened concrete with a power-driven saw. Transverse contraction joints shall be constructed in conformance with requirements for sawed joints.

##### 3.7.5.1 Sawed Joints

Sawed contraction joints shall be constructed by sawing a groove in the concrete with a 3 mm 1/8 inch blade to the indicated depth. The time of initial sawing shall vary depending on existing and anticipated weather conditions and shall be such as to prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. The joints shall be sawed at the required spacing consecutively in the sequence of the concrete placement. Sawing at a given joint location shall be discontinued when a crack develops ahead of the saw cut. Immediately after the joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint. The surface shall be resprayed with curing compound as soon as free water disappears. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed with cord or backer rod before the concrete in the region of the joint is resprayed with curing compound.

#### 3.7.6 Thickened Edge Joints

Underlying material in the transition area shall meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

### 3.8 REPAIR, REMOVAL, AND REPLACEMENT OF SLABS

New pavement slabs that contain full-depth cracks shall be removed and replaced, as specified herein at no cost to the Government. Removal and replacement shall be full depth, shall be full width of the paving lane, and the limit of removal shall be from each original transverse joint. The Contracting Officer will determine whether cracks extend full depth of the pavement and may require minimum 150 mm 6 inch diameter cores to be drilled on the crack to determine depth of cracking. Cores shall be drilled and the hole later filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin. Drilling of cores and refilling holes shall be at no expense to the Government. Cracks that do not extend full depth of slab shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1. The Contractor shall ensure that the crack is not widened during epoxy resin injection. Where a full depth crack intersects the original transverse joint, the slab(s) containing the crack shall be removed and replaced, with dowels installed, as required below. Spalls along joints shall be repaired as specified.

#### 3.8.1 Removal and Replacement of Full Slabs

Unless there are keys or dowels present, all edges of the slab shall be sawcut full depth. If dowels, or tie bars are present along any edges, these edges shall be sawed full depth 150 mm 6 inches from the edge just beyond the end of dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 25 mm 1 inch of the depth of the dowel. The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. The narrow strips along keyed or doweled edges shall be carefully broken up and removed. Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. Protruding portions of dowels shall be painted and lightly oiled. The joint face below dowels shall be suitably trimmed so that there is no abrupt offset. If underbreak occurs at any point along any edge, the area shall be

hand-filled with concrete, producing an even joint face from top to bottom, before replacing the removed slab. If underbreak over 100 mm 4 inches deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels, tie bars, on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete. Original damaged dowels or tie bars shall be cut off flush with the joint face. All four edges of the new slab shall thus contain dowels or original tie bars. Prior to placement of new concrete, the underlying material shall be graded and recompact, and the surfaces of all four joint faces shall be cleaned of all loose material and contaminants, and coated with a double application of membrane forming curing compound as bond breaker. Placement of concrete shall be as specified for original construction. The resulting joints around the new slab shall be prepared and sealed as specified.

### 3.8.2 Repairing Spalls Along Joints

Spalls along joints and cracks shall be repaired by first making a vertical saw cut at least 25 mm 1 inch outside the spalled area and to a depth of at least 50 mm. 2 inches. Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete. The cavity shall be thoroughly cleaned with high pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Prime coat for portland cement repairs shall be a neat cement grout and for epoxy resin repairs shall be epoxy resin, Type III, Grade 1. The cavity shall be filled with low slump portland cement concrete or mortar, or with epoxy resin concrete or mortar. Portland cement concrete shall be used for larger spalls, those more than 0.009 cubic meter 1/3 cu. ft. in size after removal operations; portland cement mortar shall be used for spalls between 0.00085 and 0.009 cubic meter; 0.03 and 1/3 cu. ft; and epoxy resin mortar or Type III, Grade 3 epoxy resin for those spalls less than 0.00085 cubic meter 0.03 cu. ft. in size after removal operations. Portland cement concretes and mortars shall be very low slump mixtures, proportioned, mixed, placed, tamped, and cured. If the materials and procedures are approved in writing, latex modified concrete mixtures may be used for repairing spalls less than 0.009 cubic meter 1/3 cu.ft. in size. Epoxy resin mortars shall be made with Type III, Grade 1, epoxy resin, using proportions, mixing, placing, tamping and curing procedures as recommended by the manufacturer. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints. In lieu of sawing, spalls not adjacent to joints, and popouts, both less than 150 mm 6 inches in maximum dimension, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. The core hole shall be repaired as specified above for other spalls.

### 3.8.3 Areas Defective in Plan Grade or Smoothness

In areas not meeting the specified limits for surface smoothness and plan

grade, high areas shall be reduced to attain the required smoothness and grade, except as depth is limited below. High areas shall be reduced by grinding the hardened concrete with a surface grinding machine after the concrete is 14 days or more old. The depth of grinding shall not exceed 6 mm. 1/4 inch. All pavement areas requiring plan grade or surface smoothness corrections in excess of the specified limits, shall be removed and replaced. In pavement areas given a wire comb or tined texture, areas exceeding 2 square meters 25 square feet that have been corrected by rubbing or grinding shall be retextured by grooving machine sawn grooves meeting the requirements for the wire comb or tined texture. All areas in which grinding has been performed will be subject to the thickness tolerances specified in paragraph Thickness. Any grinding performed on individual slabs with excessive deficiencies shall be performed at the Contractor's own decision without entitlement to additional compensation if eventual removal of the slab is required.

### 3.9 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

Existing concrete pavement shall be removed as indicated and as specified in Section 02050 DEMOLITION modified, and expanded as specified herein. Removal, repair and replacement shall be made as indicated and as specified in paragraph REPAIR, REMOVAL, AND REPLACEMENT OR SLABS.

### 3.10 PAVEMENT PROTECTION

The Contractor shall protect the pavement against all damage prior to final acceptance of the work. Traffic shall be excluded from the new pavement. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling equipment will be permitted on the new pavement after the pavement has been cured for 7 days and the joints have been sealed or otherwise protected. All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean. Special cleaning and care shall be used where Contractor's traffic uses or crosses active airfield pavement.

### 3.11 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL (CQC)

Paragraph ACCEPTABILITY OF WORK contains additional CQC requirements. The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and submit reports as specified. When, in the opinion of the Contracting Officer, the paving operation is out of control, concrete placement shall cease.

#### 3.11.1 Batch Plant Control

A daily report shall be prepared indicating checks made for scale accuracy with test weights, checks of batching accuracy, and corrective action taken prior to and during placement for weighing or batching, type and source of cement used, type and source of pozzolan, amount and source of admixtures used, aggregate source, the required aggregate and water masses per cubic meter, yd, amount of water as free moisture, aggregate gradation in each size of aggregate, and the batch aggregate and water masses per cubic meter yd. for each class of concrete batched during each day's plant operation.

#### 3.11.2 Concrete Mixture

- a. Air Content Testing. Air content tests shall be made on randomly

selected batches of concrete for each 250 cubic yards, or fraction thereof, of concrete placed during each 8-hour shift. Whenever air content reaches specified limits, an immediate confirmatory test shall be made. If the second test also shows air content at or exceeding specified limits, an adjustment shall immediately be made in the amount of air-entraining admixture batched to bring air content within specified limits. If the next adjusted batch of concrete is not within specified limits, concrete placement shall be halted until concrete air content is within specified limits.

- b. Slump Testing. Slump tests shall be made on randomly selected batches of concrete for each 250 cubic yards, or fraction thereof, of concrete placed during each 8-hour shift. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Whenever slump approaches the maximum limit, an adjustment shall immediately be made in the batch masses of water and fine aggregate, without exceeding the maximum  $w/(c+p)$ . When a slump result exceeds the specification limit, no further concrete shall be delivered to the paving site until adjustments have been made and slump is again within the limit.
- c. Temperature. The temperature of the concrete shall be measured every 250 cubic yards, or fraction thereof, of concrete placed during an 8-hour shift.
- d. Concrete Strength Testing. Four (4) cylinders from the same batch shall be fabricated, cured and tested for compressive strength, testing two cylinders at 7-day, and two cylinders at 28-day age. The four cylinders shall be made for each 500 cubic yards or fraction thereof, of concrete placed during an 8-hour shift. Control charts for strength, showing the 7-day and 28-day CQC compressive strengths, and the 28-day required compressive strength, shall be maintained and submitted with the weekly CQC Reports.

### 3.11.3 Inspection Before Placing

Underlying materials, joint locations and types, construction joint faces, forms, reinforcing, dowels, and embedded items shall be inspected by a Registered Engineer in sufficient time prior to each paving operation in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing, and the certification signed by the Registered Engineer, prior to each days' paving.

### 3.11.4 Paving Operations

The placing foreman shall supervise all placing and paving operations, shall determine that the correct quality of concrete is placed in each location as shown, shall insure that the concrete is consolidated full depth and that finishing is performed as specified. The placing foreman shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume of concrete placed, and method of paving and any problems encountered.

### 3.11.5 Curing Inspection

- a. Moist Curing Inspections. Each day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded. When any inspection finds an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for the area shall be extended by 1 day.
- b. Membrane Curing Inspection. At the end of each day's placement, the CQC Representative shall determine the quantity of compound used by measurement of the container; shall determine the area of concrete surface covered; shall then compute the rate of coverage in square meters per square feet per gallon and shall also note whether or not coverage is uniform. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

### 3.11.6 Cold-Weather Protection

At least once per day, an inspection shall be made of all areas subject to cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

### 3.11.7 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report, signed by a registered engineer, shall be prepared for the updating of control charts and test data, and all CQC inspections and actions covering the entire period from the start of the construction through the current week. Reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all CQC records. A copy of weekly reports shall be faxed to the Design District Pavement or Geotechnical Engineer. At the completion of concrete placement, a certification report shall be prepared containing mix designs, all updated control charts and concrete test data, quality control reports, smoothness reports, and other pertinent data on the concrete, with a certification by a registered engineer that the concrete placed meets all specification requirements. A copy of the certification report shall be mailed to the Design District pavement or Geotechnical Engineer.

-- End of Section --

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SECTION 02760

FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS  
03/97

**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 this text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM D 789	(1994) Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)
ASTM D 3405	(1994) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements
ASTM D 3569	(1985; R 1991) Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant-Type for Portland Cement Concrete Pavements
ASTM D 5893	(1996) Cold Applied, Single Component Chemically Curing Silicon Joint Sealant for Portland Cement Concrete Pavement

CORPS OF ENGINEERS (COE)

COE CRD-C 525	(1989) Corps of Engineers Test Method for Evaluation of Hot-Applied Joint Sealants for Bubbling Due to Heating
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FEDERAL SPECIFICATIONS (FS)

FS SS-S-200	(Rev E; Am 2) Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement
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1.2 UNIT PRICES

1.2.1 Measurement

The quantity of each sealing item to be paid for shall be determined by actual measurement of the number of linear meters feet of in-place material that has been approved by the Contracting Officer.

### 1.2.2 Payment

Payment shall be made at the contract unit bid prices per linear meter foot for the sealing items scheduled. The unit bid prices shall include the cost of all labor, materials, and the use of all equipment and tools required to complete the work.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-06 Instructions

Manufacturer's Recommendations; GA.

Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of these recommendations, 14 days prior to use on the project. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

#### SD-07 Schedules

Construction Equipment List; FIO.

List of proposed equipment to be used in performance of construction work including descriptive data, 14 days prior to use on the project.

#### SD-14 Samples

Materials; GA.

Samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing and approval 14 days prior to the beginning of work. No material will be allowed to be used until it has been approved.

### 1.4 SAFETY

Joint sealant shall not be placed within 8 meters 25 feet of any liquid oxygen (LOX) equipment, LOX storage, or LOX piping. Joints in this area shall be thoroughly cleaned and left unsealed.

### 1.5 TEST REQUIREMENTS

The joint sealant and backup or separating material shall be tested for conformance with the referenced applicable material specification. Testing of the materials shall be performed in an approved independent laboratory and certified copies of the test reports shall be submitted and approved 14 days prior to the use of the materials at the job site. Samples will be retained by the Government for possible future testing should the materials appear defective during or after application. Conformance with the requirements of the laboratory tests specified will not constitute final

acceptance of the materials. Final acceptance will be based on the performance of the in-place materials.

## 1.6 EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

### 1.6.1 Joint Cleaning Equipment

#### 1.6.1.1 Tractor-Mounted Routing Tool

The routing tool used for removing old sealant from the joints shall be of such shape and dimensions and so mounted on the tractor that it will not damage the sides of the joints. The tool shall be designed so that it can be adjusted to remove the old material to varying depths as required. The use of V-shaped tools or rotary impact routing devices will not be permitted. Hand-operated spindle routing devices may be used to clean and enlarge random cracks.

#### 1.6.1.2 Concrete Saw

A self-propelled power saw with water-cooled diamond or abrasive saw blades will be provided for cutting joints to the depths and widths specified or for refacing joints or cleaning sawed joints where sandblasting does not provide a clean joint.

#### 1.6.1.3 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening should not exceed 6.4 mm (1/4 inch). The air compressor shall be portable and shall be capable of furnishing not less than 71 liters per second (150 cubic feet per minute) 150 cubic feet per minute and maintaining a line pressure of not less than 621 kPa (90 psi) 90 psi at the nozzle while in use. Compressor capability under job conditions must be demonstrated before approval. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately 1 inch above the pavement surface. The height, angle of inclination and the size of the nozzle shall be adjusted as necessary to secure satisfactory results.

#### 1.6.1.4 Waterblasting Equipment

Waterblasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary resupply equipment shall be of sufficient capacity to permit continuous operations. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately 1 inch above the pavement surface. The height, angle of inclination and the size of the nozzle shall be adjustable as necessary to obtain satisfactory results. A pressure gauge mounted at the pump shall show at all times the pressure in pounds per square inch at which the equipment is operating.

#### 1.6.1.5 Hand Tools

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

#### 1.6.2 Sealing Equipment

##### 1.6.2.1 Hot-Poured Sealing Equipment

The unit applicators used for heating and installing ASTM D 3405 or ASTM D 3569 joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

##### 1.6.2.2 Two-Component, Cold-Applied, Machine Mix Sealing Equipment

The equipment used for proportioning, mixing, and installing FS SS-S-200 Type M joint sealants shall be designed to deliver two semifluid components through hoses to a portable mixer at a preset ratio of 1 to 1 by volume using pumps with an accuracy of plus or minus 5 percent for the quantity of each component. The reservoir for each component shall be equipped with mechanical agitation devices that will maintain the components in a uniform condition without entrapping air. Provisions shall be incorporated to permit thermostatically controlled indirect heating of the components, when required. However, immediately prior to proportioning and mixing, the temperature of either component shall not exceed 32.2 degrees C (90 degrees F). 90 degrees F. Screens shall be provided near the top of each reservoir to remove any foreign particles or partially polymerized material that could clog fluid lines or otherwise cause misproportioning or improper mixing of the two components. The equipment shall be capable of thoroughly mixing the two components through a range of application rates of 37.8 to 189 liters (10 to 60 gallons) 10 to 60 gallons per hour and through a range of application pressures from 345 kPa to 10.3 MPa (50 to 1500 psi) 50 to 1500 psi as required by material, climatic, or operating conditions. The mixer shall be designed for the easy removal of the supply lines for cleaning and proportioning of the components. The mixing head shall accommodate nozzles of different types and sizes as may be required by various operations. The dimensions of the nozzle shall be such that the nozzle tip will extend into the joint to allow sealing from the bottom of the joint to the top. The initially approved equipment shall be maintained in good working condition, serviced in accordance with the supplier's instructions, and shall not be altered in any way without obtaining prior approval.

##### 1.6.2.3 Two-Component, Cold-Applied, Hand-Mix Sealing Equipment

Mixing equipment for FS SS-S-200 Type H sealants shall consist of a slow-speed electric drill or air-driven mixer with a stirrer in accordance with the manufacturer's recommendations.

##### 1.6.2.4 Cold-Applied, Single-Component Sealing Equipment

The equipment for installing ASTM D 5893 single component joint sealants shall consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. The initially approved equipment shall be maintained in good working condition, serviced in accordance with the supplier's instructions, and shall not be altered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

#### 1.7 TRIAL JOINT SEALANT INSTALLATION

Prior to the cleaning and sealing of the joints for the entire project, a test section of at least 60 m 200 feet long shall be prepared using the specified materials and approved equipment, so as to demonstrate the proposed joint preparation and sealing of all types of joints in the project. Following the completion of the test section and before any other joint is sealed, the test section shall be inspected to determine that the materials and installation meet the requirements specified. If it is determined that the materials or installation do not meet the requirements, the materials shall be removed, and the joints shall be recleaned and resealed at no cost to the Government. When the test section meets the requirements, it may be incorporated into the permanent work and paid for at the contract unit price per linear foot for sealing items scheduled. All other joints shall be prepared and sealed in the manner approved for sealing the test section.

#### 1.8 DELIVERY AND STORAGE

Materials delivered to the job site shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall be provided by the Contractor at the job site for maintaining materials at the temperatures and conditions recommended by the manufacturer.

#### 1.9 ENVIRONMENTAL CONDITIONS

The ambient air temperature and the pavement temperature within the joint wall shall be a minimum of 10 degrees C 50 degrees F and rising at the time of application of the materials. Sealant shall not be applied if moisture is observed in the joint.

### PART 2 PRODUCTS

#### 2.1 SEALANTS

Materials for sealing cracks in the various paved areas indicated on the drawings shall be as follows:

<u>Area</u>	<u>Sealing Material</u>
Joint between new AC and PCC Paving	ASTM D 3405 and COE CRD-C 525
Joint in the area subject	ASTM D 3569 and COE CRD-C 525

<u>Area</u>	<u>Sealing Material</u>
to Jet-Fuel-Resistant	
Joint in the area subject to Jet-Blast_Resistant	FS SS-S-200 Type M FS SS-S-200 Type H
Joint in any area	ASTM D 5893

## 2.2 PRIMERS

Primers, when their use is recommended by the manufacturer of the sealant, shall be as recommended by the manufacturer of the sealant.

## 2.3 BACKUP MATERIALS

The backup material shall be a compressible, nonshrinking, nonstaining, nonabsorbing material and shall be nonreactive with the joint sealant. The material shall have a melting point at least 3 degrees C 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D 789. The material shall have a water absorption of not more than 5 percent of the sample weight when tested in accordance with ASTM C 509. The backup material shall be 25 plus or minus 5 percent larger in diameter than the nominal width of the crack.

## 2.4 BOND BREAKING TAPES

The bond breaking tape or separating material shall be a flexible, nonshrinkable, nonabsorbing, nonstaining, and nonreacting adhesive-backed tape. The material shall have a melting point at least 3 degrees C 5 degrees F greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D 789. The bond breaker tape shall be approximately 3 mm 1/8 inch wider than the nominal width of the joint and shall not bond to the joint sealant.

# PART 3 EXECUTION

## 3.1 PREPARATION OF JOINTS

Immediately before the installation of the sealant, the joints shall be thoroughly cleaned to remove all laitance, curing compound, filler, protrusions of hardened concrete, and old sealant from the sides and upper edges of the joint space to be sealed.

### 3.1.1 Existing Sealant Removal

The in-place sealant shall be cut loose from both joint faces and to the depth shown on the drawings, using the tractor-mounted routing equipment as specified in paragraph EQUIPMENT. Depth shall be sufficient to accommodate any separating or backup material that is required to maintain the depth of new sealant to be installed. Prior to further cleaning operations, all loose old sealant remaining in the joint opening shall be removed by blowing with compressed air. Hand tools may be required to remove sealant from random cracks. Chipping, spalling, or otherwise damaging the concrete will not be allowed.

### 3.1.2 Sawing

#### 3.1.2.1 Refacing of Joints

Refacing of joints shall be accomplished using a concrete saw as specified in paragraph EQUIPMENT to remove all residual old sealant and a minimum of concrete from the joint face to provide exposure of newly cleaned concrete, and, if required, to enlarge the joint opening to the width and depth shown on the drawings. The blade shall be stiffened with a sufficient number of suitable dummy (used) blades or washers. Immediately following the sawing operation, the joint opening shall be thoroughly cleaned using a water jet to remove all saw cuttings and debris.

#### 3.1.2.2 Refacing of Random Cracks

Sawing of the cracks shall be accomplished using a power-driven concrete saw as specified in paragraph EQUIPMENT. The saw blade shall be 152 mm (6 inch) 6 inches or less in diameter to enable the saw to follow the trace of the crack. The blade shall be stiffened as necessary with suitable dummy (or used) blades or washers. Immediately following the sawing operation, the crack opening shall be thoroughly cleaned using a water jet to remove all saw cuttings and debris.

### 3.1.3 Sandblasting

The newly exposed concrete joint faces and the pavement surfaces extending a minimum of 13 mm 1/2 inch from the joint edges shall be sandblasted clean. A multiple-pass technique shall be used until the surfaces are free of dust, dirt, curing compound, filler, old sealant residue, or any foreign debris that might prevent the bonding of the sealant to the concrete. After final cleaning and immediately prior to sealing, the joints shall be blown out with compressed air and left completely free of debris and water.

### 3.1.4 Back-Up Material

When the joint opening is of a greater depth than indicated for the sealant depth, the lower portion of the joint opening shall be plugged or sealed off using a back-up material to prevent the entrance of the sealant below the specified depth. Care shall be taken to ensure that the backup material is placed at the specified depth and is not stretched or twisted during installation.

### 3.1.5 Bond Breaking Tape

Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, a bond breaker separating tape will be inserted to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. The tape shall be securely bonded to the bottom of the joint opening so it will not float up into the new sealant.

### 3.1.6 Rate of Progress of Joint Preparation

The stages of joint preparation which include sandblasting, air pressure cleaning and placing of the back-up material shall be limited to only that lineal footage that can be sealed during the same day.

### 3.2 PREPARATION OF SEALANT

#### 3.2.1 Hot-Poured Sealants

Sealants conforming to ASTM D 3405 or ASTM D 3569 shall not be heated in excess of the safe heating temperature recommended by the manufacturer as shown on the sealant containers. Sealant that has been overheated or subjected to application temperatures for over 4 hours or that has remained in the applicator at the end of the day's operation shall be withdrawn and wasted.

#### 3.2.2 Type M Sealants

The FS SS-S-200 Type M sealant components and containers shall be inspected prior to use. Any materials that contain water, hard caking of any separated constituents, nonreversible jell, or materials that are otherwise unsatisfactory shall be rejected. Settlement of constituents in a soft mass that can be readily and uniformly remixed in the field with simple tools shall not be cause for rejection. Prior to transfer of the components from the shipping containers to the appropriate reservoir of the application equipment, the materials shall be thoroughly mixed to ensure homogeneity of the components and incorporation of all constituents at the time of transfer. When necessary for remixing prior to transfer to the application equipment reservoirs, the components shall be warmed to a temperature not to exceed 32 degrees C 90 degrees F by placing the components in heated storage or by other approved methods but in no case shall the components be heated by direct flame, or in a single walled kettle, or a kettle without an oil bath.

#### 3.2.3 Type H Sealants

The FS SS-S-200 Type H sealant components shall be mixed either in the container furnished by the manufacturer or a cylindrical metal container of volume approximately 50 percent greater than the package volume. The base material shall be thoroughly mixed in accordance with the manufacturer's instructions. The cure component shall then be slowly added during continued mixing until a uniform consistency is obtained.

#### 3.2.4 Single-Component, Cold-Applied Sealants

The ASTM D 5893 sealant and containers shall be inspected prior to use. Any materials that contain water, hard caking of any separated constituents, nonreversible jell, or materials that are otherwise unsatisfactory shall be rejected. Settlement of constituents in a soft mass that can be readily and uniformly remixed in the field with simple tools will not be cause for rejection.

### 3.3 INSTALLATION OF SEALANT

#### 3.3.1 Time of Application

Joints shall be sealed immediately following final cleaning of the joint walls and following the placement of the separating or backup material. Open joints that cannot be sealed under the conditions specified, or when rain interrupts sealing operations shall be recleaned and allowed to dry prior to installing the sealant.

### 3.3.2 Sealing Joints

Immediately preceding, but not more than 15 m50 feet ahead of the joint sealing operations, a final cleaning with compressed air shall be performed. The joints shall be filled from the bottom up to 6 mm1/4 inch plus or minus 1.5 mm1/16 inch below the pavement surface. Excess or spilled sealant shall be removed from the pavement by approved methods and shall be discarded. The sealant shall be installed in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Contracting Officer. When a primer is recommended by the manufacturer, it shall be applied evenly to the joint faces in accordance with the manufacturer's instructions. Joints shall be checked frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

### 3.4 INSPECTION

#### 3.4.1 Joint Cleaning

Joints shall be inspected during the cleaning process to correct improper equipment and cleaning techniques that damage the concrete pavement in any manner. Cleaned joints shall be approved prior to installation of the separating or back-up material and joint sealant.

#### 3.4.2 Joint Sealant Application Equipment

The application equipment shall be inspected to ensure conformance to temperature requirements, proper proportioning and mixing (if two-component sealant) and proper installation. Evidences of bubbling, improper installation, failure to cure or set shall be cause to suspend operations until causes of the deficiencies are determined and corrected.

#### 3.4.3 Joint Sealant

The joint sealant shall be inspected for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified herein at no additional cost to the Government.

### 3.5 CLEAN-UP

Upon completion of the project, all unused materials shall be removed from the site and the pavement shall be left in a clean condition.

-- End of Section --

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SECTION 02763

PAVEMENT MARKINGS  
09/98

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 M 247 (1981) Glass Beads Used in Traffic Paint

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 792 (1991) Density and Specific Gravity  
(Relative Density) of Plastics by  
Displacement

ASTM D 4280 (1996) Extended Life Type, Nonplowable,  
Prismatic, Raised, Retroreflective  
Pavement Markers

ASTM D 4505 (1996) Preformed Plastic Pavement Marking  
Tape for Extended Service Life

ASTM E 28 (1997) Softening Point of Resins by Ring  
and Ball Apparatus

FEDERAL SPECIFICATIONS (FS)

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

FS TT-P-1952 (Rev D) Paint, Traffic and Airfield  
Marking, Waterborne (Metric)

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Equipment Lists; GA.

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.

#### SD-06 Instructions

Mixing, Thinning and Application; FIO.

Manufacturer's current printed product description and Material Safety Data Sheets (MSDS) for each type paint/color proposed for use.

#### SD-08 Statements

Qualifications; FIO.

Document certifying that personnel are qualified for equipment operation and handling of chemicals.

#### SD-09 Reports

Material Tests; FIO.

Certified copies of the test reports, prior to the use of the materials at the jobsite. Testing shall be performed in an approved independent laboratory.

#### SD-13 Certificates

Volatile Organic Compound (VOC) Content; FIO.

Certificate stating that the proposed pavement marking paint meets the VOC regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located.

### 1.3 DELIVERY AND STORAGE

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.

### 1.4 EQUIPMENT

All machines, tools and equipment used in the performance of the work shall be approved and maintained in satisfactory operating condition. Equipment operating on roads and runways shall display low speed traffic markings and traffic warning lights.

#### 1.4.1 Paint Application Equipment

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 8 kilometers per hour (5 mph), 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. The equipment used to apply the paint binder to airfield pavements shall be a self-propelled or mobile-drawn pneumatic spraying machine with an arrangement of atomizing nozzles capable of applying a line width at any one time in multiples of 150 mm (6 inches), 6 inches, from 150 mm (6 inches) 6 inches to 900 mm (36 inches) 36 inches. 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.

#### 1.4.2 Thermoplastic Application Equipment

##### 1.4.2.1 Thermoplastic Material

Thermoplastic material shall be applied to the primed pavement surface by spray techniques or by the extrusion method, wherein one side of the shaping die is the pavement and the other three sides are contained by, or are part of, suitable equipment for heating and controlling the flow of material. By either method, the markings shall be applied with equipment that is capable of providing continuous uniformity in the dimensions of the stripe.

##### 1.4.2.2 Application Equipment

a. Application equipment shall provide continuous mixing and agitation of the material. Conveying parts of the equipment between the main material reservoir and the extrusion shoe or spray gun shall prevent accumulation and clogging. All parts of the equipment which come into contact with the material shall be easily accessible and exposable for cleaning and maintenance. All mixing and conveying parts up to and including the extrusion shoes and spray guns shall maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.

b. The application equipment shall be constructed to ensure continuous uniformity in the dimensions of the stripe. The applicator shall provide a means for cleanly cutting off stripe ends squarely and shall provide a method of applying "skiplines". The equipment shall be capable of applying varying widths of traffic markings.

c. The applicator shall be equipped with a drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser shall be automatically operated and shall begin flow prior to the flow of composition to assure that the strip is fully reflectorized.

##### 1.4.2.3 Mobile and Maneuverable

Application equipment shall be mobile and maneuverable to the extent that

straight lines can be followed and normal curves can be made in a true arc. The equipment used for the placement of thermoplastic pavement markings shall be of two general types: mobile applicator and portable applicator.

a. Mobile Application Equipment: The mobile applicator shall be defined as a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method. The unit shall be equipped to apply the thermoplastic marking material at temperatures exceeding 190 degrees C (375 degrees F), 375 degrees F, at widths varying from 75 to 300 mm (3 to 12 inches) 3 to 12 inches and in thicknesses varying from 1.0 to 5.0 mm (0.020 to 0.190 inch) 0.020 to 0.190 inch and shall have an automatic drop-on bead system. The mobile unit shall be capable of operating continuously and of installing a minimum of 6 kilometers (20,000 lineal feet) 20,000 lineal feet of longitudinal markings in an 8-hour day.

(1) The mobile unit shall be equipped with a melting kettle which holds a minimum of 2.7 metric tons (6000 pounds) 6000 pounds of molten thermoplastic material. The kettle shall be capable of heating the thermoplastic composition to temperatures of 195 to 220 degrees C (375 to 425 degrees F). 375 to 425 degrees F. A thermostatically controlled heat transfer liquid shall be used. Heating of the composition by direct flame will not be allowed. Oil and material temperature gauges shall be visible at both ends of the kettle. The mobile unit shall be equipped with a spray gun system. The spray system shall consist of a minimum of four spray guns, located two on each side of the truck, and shall be capable of marking simultaneous edgeline and centerline stripes. The spray system shall be surrounded (jacketed) with heating oil to maintain the molten thermoplastic at a temperature of 195 to 220 degrees C (375 to 425 degrees F); 375 to 425 degrees F; and shall be capable of spraying a stripe of 75 to 300 mm (3 to 12 inches) 3 to 12 inches in width, and in thicknesses varying from 1.5 mm (0.055 inch) 0.055 inch to 2.5 mm (0.095 inch), 0.095 inch, and of generally uniform cross section.

(2) The mobile unit shall be equipped with an electronic programmable line pattern control system. The control system shall be capable of applying skip or solid lines in any sequence, through any and all of the extrusion shoes, or the spray guns, and in programmable cycle lengths. In addition, the mobile unit shall be equipped with an automatic counting mechanism capable of recording the number of lineal meters (feet) feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

b. Portable Application Equipment: The portable applicator shall be defined as hand-operated equipment, specifically designed for placing special markings such as crosswalks, stopbars, legends, arrows, and short lengths of lane, edge and centerlines. The portable applicator shall be capable of applying thermoplastic pavement markings by the extrusion method. The portable applicator shall be loaded with hot thermoplastic composition from the melting kettles on the mobile applicator. The portable applicator shall be equipped with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, so as to be capable of holding the molten thermoplastic at a temperature of 195 to 220 degrees C (375 to 425 degrees F), 375 to 425 degrees F, of extruding a line of 75 to 300 mm (3 to 12 inches) 3 to 12 inches in width, and in thicknesses of not less than 3.0 mm (0.125 inch) 0.125 inch nor more than 5.0 mm (0.190 inch) 0.190 inch and of

generally uniform cross section.

#### 1.4.3 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.

#### 1.4.4 Preformed Tape Application Equipment

Mechanical application equipment shall be used for the placement of preformed marking tape. Mechanical application equipment shall be defined as a mobile pavement marking machine specifically designed for use in applying precoated, pressure-sensitive pavement marking tape of varying widths, up to 300 mm (12 inches). 12 inches. The applicator shall be equipped with rollers, or other suitable compactive device, to provide initial adhesion of the preformed, pressure-sensitive marking tape with the pavement surface. Additional hand-operated rollers shall be used as required to properly seat the thermoplastic tape.

#### 1.4.5 Surface Preparation Equipment

##### 1.4.5.1 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 70.8 liters per sec (150 cfm) 150 cfm of air at a pressure of not less than 620 kPa (90 psi) 90 psi at each nozzle used, and shall be equipped with traps that will maintain the compressed air free of oil and water.

##### 1.4.5.2 Waterblast Equipment

The water pressure shall be specified at 17.9 MPa (2600 psi) 2600 psi at 60 degrees C (140 degrees F) 140 degrees F in order to adequately clean the surfaces to be marked.

#### 1.4.6 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.

##### 1.4.6.1 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.

#### 1.4.6.2 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.

#### 1.4.7 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.

#### 1.5 HAND-OPERATED, PUSH-TYPE MACHINES

All machines, tools, and equipment used in performance of the work shall be approved and maintained in satisfactory operating condition. Hand-operated push-type machines of a type commonly used for application of paint to pavement surfaces will be acceptable for marking small streets and parking areas. Applicator machine shall be equipped with the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Sandblasting equipment shall be provided as required for cleaning surfaces to be painted. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

#### 1.6 WEATHER LIMITATIONS FOR REMOVAL

Pavement surface shall be free of snow, ice, or slush. Surface temperature shall be at least 5 degrees C 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 airfields, roads, and streets shall conform to FS TT-P-1952, color as shown in the Task Order. 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. Paint for California shall conform to CALTRANS Specification 8010-20B dated MAR 88.

#### 2.2 THERMOPLASTIC COMPOUNDS

The thermoplastic reflectorized pavement marking compound shall be extruded or sprayed in a molten state onto a primed pavement surface. Following a surface application of glass beads and upon cooling to normal pavement

temperatures, the marking shall be an adherent reflectorized strip of the specified thickness and width that is capable of resisting deformation by traffic.

2.2.1 Composition Requirements

The binder component shall be formulated as a hydrocarbon resin. The pigment, beads and filler shall be uniformly dispersed in the binder resin. The thermoplastic composition shall be free from all skins, dirt, and foreign objects and shall comply with the following requirements:

Component	Percent by Weight	
	White	Yellow
Binder	17 min.	17 min.
Titanium dioxide	10 min.	-
Glass beads,	20 min.	20 min.
Calcium carbonate & inert fillers	49 max.	*
Yellow pigments	-	*

\*Amount and type of yellow pigment, calcium carbonate and inert fillers shall be at the option of the manufacturer, providing the other composition requirements of this specification are met.

2.2.2 Physical Properties

2.2.2.1 Color

The color shall be as indicated.

2.2.2.2 Drying Time

When installed at 20 degrees C) 70 degrees F and in thicknesses between 3 and 5 mm, 1/8 and 3/16 inch, the composition shall be completely solid and shall show no damaging effect from traffic after curing 15 minutes.

2.2.2.3 Softening Point

The composition shall have a softening point of not less than 90 degrees C (194 degrees F) 194 degrees F when tested in accordance with ASTM E 28.

2.2.2.4 Specific Gravity

The specific gravity of the composition shall be between 1.9 and 2.2 as determined in accordance with ASTM D 792.

2.2.3 Asphalt Concrete Primer

The primer for asphalt concrete pavements shall be a thermosetting adhesive

with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved and/or dispersed in a volatile organic solvent. The solids content shall not be less than 10 percent by weight at 20 degrees C 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.10 mm 0.005 inch plus or minus 0.025 mm, 0.001 inch, shall dry to a tack-free condition in less than 5 minutes.

#### 2.2.4 Portland Cement Concrete Primer

The primer for Portland cement concrete pavements shall be an epoxy resin primer. The primer shall be of the type recommended by the manufacturer of the thermoplastic composition. Epoxy primers recommended by the manufacturer shall be approved by the Contracting Officer prior to use. Requests for approval shall be accompanied with technical data, instructions for use, and a 1 liter 1 quart sample of the primer material.

#### 2.3 PREFORMED TAPE

The preformed tape shall be an adherent reflectorized strip in accordance with ASTM D 4505 Type I or IV, Class optional.

#### 2.4 RAISED REFLECTIVE MARKERS

Either metallic or nonmetallic markers of the button or prismatic reflector type may be used. Markers shall be of permanent colors, as specified for pavement marking, and shall retain the color and brightness under the action of traffic. Button markers shall have a diameter of not less than 100 mm (4 inches), 4 inches, and shall be spaced not more than 12 meters 40 feet apart on solid longitudinal lines. Broken centerline marker spacings shall be as required by the Task Order. Markers shall have rounded surfaces presenting a smooth contour to traffic and shall not project more than 19 mm 3/4 inch above level of pavement. Pavement markers and adhesive epoxy shall conform to ASTM D 4280.

#### 2.5 REFLECTIVE MEDIA

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

#### 2.6 SAMPLING AND TESTING

Materials proposed for use shall be stored on the project site in sealed and labeled containers, or segregated at source of supply, sufficiently in advance of needs to allow 60 days for testing. Upon notification by the Contractor that the material is at the site or source of supply, a sample shall be taken by random selection from sealed containers by the Contractor in the presence of a representative of the Contracting Officer. Samples shall be clearly identified by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quantity involved. Testing shall be performed in an approved independent laboratory. If materials are approved based on reports furnished by the Contractor, samples will be retained by the Government for possible future testing should the material appear defective during or after application.

### PART 3 EXECUTION

### 3.1 SURFACE PREPARATION

Surfaces to be marked shall be thoroughly cleaned 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 recleaned, when work has been stopped due to rain.

#### 3.1.1 Pretreatment for Early Painting

Where early painting is required on rigid pavements, a pretreatment with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride shall be applied to prepared pavement areas prior to painting.

#### 3.1.2 Cleaning Existing Pavement Markings

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

#### 3.1.3 Cleaning Concrete Curing Compounds

On new Portland cement concrete pavements, cleaning operations shall not begin until a minimum of 30 days after the placement of concrete. All new concrete pavements shall be cleaned by either sandblasting or water blasting. When water blasting is performed, thermoplastic and preformed markings shall be applied no sooner than 24 hours after the blasting has been completed. The extent of the blasting work shall be to clean and prepare the concrete surface as follows:

- a. There is no visible evidence of curing compound on the peaks of the textured concrete surface.
- b. There are no heavy puddled deposits of curing compound in the valleys of the textured concrete surface.
- c. All remaining curing compound is intact; all loose and flaking material is removed.

d. The peaks of the textured pavement surface are rounded in profile and free of sharp edges and irregularities.

e. The surface to be marked is dry.

### 3.2 APPLICATION

All pavement markings and patterns shall be placed as shown on the plans. Newly laid AC shall be allowed to cure for 30 days prior to striping

#### 3.2.1 Paint

Paint shall be applied to clean, dry surfaces, and only when air and pavement temperatures are above 5 degrees C 40 degrees F and less than 35 degrees C. 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. The Contractor shall 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 2.9 plus or minus 0.5 square meter per liter. 105 plus or minus 5 square feet per gallon. Glass spheres shall be applied uniformly to the wet paint on airfield pavement at a rate of 1.0 kg. 8 lbs. and on road and street pavement at a rate of 0.7 kg. 6 lbs. plus or minus 0.06 kilograms 0.5 pounds of glass spheres per liter gallon of paint.

b. Nonreflective Markings: Paint shall be applied evenly to the pavement surface to be coated at a rate of 2.9 plus or minus 0.5 square meter per liter. 105 plus or minus 5 square feet per gallon.

##### 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 Thermoplastic Compounds

Thermoplastic pavement markings shall be placed upon dry pavement; surface dry only will not be considered an acceptable condition. At the time of installation, the pavement surface temperature shall be a minimum of 5 degrees C 40 degrees F and rising. Thermoplastics, as placed, shall be free from dirt or tint.

##### 3.2.2.1 Longitudinal Markings

All centerline, skipline, edgeline, and other longitudinal type markings shall be applied with a mobile applicator. All special markings,

crosswalks, stop bars, legends, arrows, and similar patterns shall be placed with a portable applicator, using the extrusion method.

#### 3.2.2.2 Primer

After surface preparation has been completed the asphalt and/or concrete pavement surface shall be primed. The primer shall be applied with spray equipment. Primer materials shall be allowed to "set-up" prior to applying the thermoplastic composition. The asphalt concrete primer shall be allowed to dry to a tack-free condition, usually occurring in less than 10 minutes. The Portland cement concrete primer shall be allowed to dry in accordance with the thermoplastic manufacturer's recommendations. To shorten the curing time of the epoxy resins an infrared heating device may be used on the concrete primer.

a. Asphalt Concrete Primer: Primer shall be applied to all asphalt concrete pavements at a wet film thickness of 0.10 mm (0.005 inch), 0.005 inch, plus or minus 0.025 mm (0.001 inch) 0.001 inch 25-40 square meters per liter. (265-400 square feet per gallon).

b. Portland Cement Concrete Primer: Primer shall be applied to all concrete pavements (including concrete bridge decks) at a wet film thickness of between 1.0 to 1.3 mm 0.04 to 0.05 inch 30-40 square meters per liter. (320-400 square feet per gallon).

#### 3.2.2.3 Markings

After the primer has "set-up", the thermoplastic shall be applied at temperatures no lower than 190 degrees C 375 degrees F nor higher than 220 degrees C 425 degrees F at the point of deposition. Immediately after installation of the marking, drop-on glass spheres shall be mechanically applied so that the spheres are held by and imbedded in the surface of the molten material.

a. Extruded Markings: All extruded thermoplastic markings shall be applied at the specified width and at a thickness of not less than 3.0 mm (0.125 inch) 0.125 inch nor more than 5.0 mm (0.190 inch). 0.190 inch.

b. Sprayed Markings: All sprayed thermoplastic markings shall be applied at the specified width and the thicknesses designated in the contract plans. If the plans do not specify a thickness, centerline markings shall be applied at a wet thickness of 2.0 mm (0.090 inch), 0.090 inch, plus or minus 0.10 mm (0.005 inch, 0.005 inch, and edgeline markings at a wet thickness of 1.5 mm (0.60 inch), 0.060 inch, plus or minus 0.10 mm (0.005 inch). 0.005 inch.

c. Reflective Glass Spheres: Immediately following application, reflective glass spheres shall be dropped onto the molten thermoplastic marking at the rate of 1 kilogram per 2 square meters 1 pound per 20 square feet of compound.

#### 3.2.3 Preformed Tape

The pavement surface temperature shall be a minimum of 15 degrees C 60 degrees F and the ambient temperature shall be a minimum of 15 degrees C 60 degrees F and rising. The preformed markings shall be placed in accordance with the manufacturer's written instructions.

#### 3.2.4 Raised Reflective Markers

Prefabricated markers shall be aligned carefully at the required spacing and permanently fixed in place by means of epoxy resin adhesives. To insure good bond, pavement in areas where markers will be set shall be thoroughly cleaned by sandblasting and use of compressed air prior to applying adhesive.

#### 3.2.5 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. Contractor shall 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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II

SECTION 02770

CONCRETE SIDEWALKS AND CURBS AND GUTTERS

03/98

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)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM A 616/A 616M	(1996) Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 617/A 617M	(1996a) Axle-Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM C 31/C 31M	(1996) Making and Curing Concrete Test Specimens in the Field
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 171	(1997) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 309	(1997) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D 1751	(1983; R 1991) Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(1984; R 1996) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

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SD-09 Reports

Field Quality Control; FIO.

Copies of all test reports within 24 hours of completion of the test.

SD-18 Records

Concrete; GA.

Copies of certified delivery tickets for all concrete used in the construction.

1.3 WEATHER LIMITATIONS

1.3.1 Placing During Cold Weather

Concrete placement shall be discontinued when the air temperature reaches 40 degrees F and is falling. Placement may begin when the air temperature reaches 35 degrees F and is rising. Provisions shall be made 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 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 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.

#### 1.3.2 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.

### 1.4 PLANT, EQUIPMENT, MACHINES, AND TOOLS

#### 1.4.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be 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.

#### 1.4.2 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,

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crawler mounted, and capable of spreading, consolidating, and shaping the plastic concrete to the desired cross section in 1 pass.

## PART 2 PRODUCTS

### 2.1 CONCRETE

Concrete shall conform to the applicable requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE except as otherwise specified. Concrete shall have a minimum compressive strength of 21 MPa 3000 psi at 28 days. Maximum size of aggregate shall be 1 inch.

#### 2.1.1 Air Content

Mixtures may have air content by volume of concrete of 3 to 5 percent, based on measurements made immediately after discharge from the mixer.

#### 2.1.2 Slump

The concrete slump shall be 3 inches plus or minus 1 inch where determined in accordance with ASTM C 143.

### 2.2 CONCRETE CURING MATERIALS

#### 2.2.1 Impervious Sheet Materials

Impervious sheet materials shall conform to ASTM C 171, 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 C 309, Type 2.

## 2.3 JOINT FILLER STRIPS

2.3.1 Contraction Joint Filler for Curb and Gutter Contraction joint filler for curb and gutter shall consist of hard-pressed fiberboard.

### 2.3.2 Expansion Joint Filler, Premolded

Expansion joint filler, premolded, shall conform to ASTM D 1751 or ASTM D 1752, 3/8 inch thick, unless otherwise indicated

## 2.4 FORM WORK

Form work shall be designed and constructed 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

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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 2 welded stake pockets per form. Stake pins shall be solid steel rods with chamfered heads and pointed tips designed for use with steel forms.

### 2.4.1 Sidewalk Forms

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

### 2.4.2 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 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.

## 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 to a

minimum of 95 percent of the laboratory maximum density to a depth of 6 inches or the full depth of fill, whichever is greater.

#### 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.

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#### 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

Forms shall be set to the indicated alignment, grade and dimensions. Forms shall be held 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

Forms for sidewalks shall be set 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 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

Concrete shall be placed 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 with an approved vibrator, and the surface shall be finished to grade with a wood float, bull float, or darby, edged and broom finished.

#### 3.3.2 Concrete Finishing

After straightedging, when most of the water sheen has disappeared, and just before the concrete hardens, the surface shall be finished 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.

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#### 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 3 mm. 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 7.9 mm (5/16 inch) 5/16 inch from the testing edge of a 3.05 m (10-foot) 10-foot straightedge. Permissible deficiency in section thickness will be up to 6.4 mm (1/4 inch). 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.

#### 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 3/8 inch joint filler strips. Joint filler shall be placed with top edge 1/4 inch below the surface and 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 joint sealer. [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.

### 3.6 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. Contraction joints 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.

### 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 9.5 mm 3/8 inch in width shall be provided at intervals not exceeding 15 meters. 50 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 sealer. 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 10 degrees C 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

Concrete shall be protected against loss of moisture and rapid temperature changes for at least 7 days from the beginning of the curing operation. Unhardened concrete shall be protected 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 Mat Method

The entire exposed surface shall be covered with 2 or more layers of burlap. Mats shall overlap each other at least 6 inches. The mat shall be thoroughly wetted with water prior to placing on concrete surface and shall be kept continuously in a saturated condition and in intimate contact with concrete for not less than 7 days.

#### 3.7.1.2 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.

#### 3.7.1.3 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 per gallon for 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

#### 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. The Contractor shall 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.

##### 3.7.4.1 Application

Curing and backfilling operation shall be completed prior to applying protective coating. Concrete shall be surface dry and clean before each application. Coverage shall be not more than 50 square yards per gallon for first application and not more than 70 square yards per gallon for second

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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 temperatures lower than 50 degrees F.

### 3.8 FIELD QUALITY CONTROL

#### 3.8.1 General Requirements

The Contractor shall 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, the Contractor shall 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

The Contractor shall 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 C 172. Cylinders for acceptance shall be molded in conformance with ASTM C 31/C 31M 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 4 MPa.500 psi.

##### 3.8.2.2 Air Content

Air content shall be determined in accordance with ASTM C 173 or ASTM C 231. ASTM C 231 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.

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##### 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 02800

ADDITIONAL WORK

1. LABOR POOL - A pool of labor hours has been set aside to accomplish work not covered in the contract line items listed on Schedule B. The Contractor is required to include direct labor rate, related labor costs, mix of trades, overhead, General and Administrative expense and profit in the development of a composite labor rate. The justification for and dollar amount will be negotiated for each task order.

2. EQUIPMENT POOL - This pool is established to accomplish work not covered in the contract line items listed on Schedule B. The Contractor is required to provide copies of invoices for rental of equipment and/or provide rate schedule in support of these costs. This is equipment required to implement a task order. The justification for and dollar amount will be negotiated for each task order, as needed, and will not be included in the price proposal.

3. MATERIAL POOL - This pool is established to accomplish work not covered in the contract line items listed on Schedule B. The Contractor is required to provide copies of purchase orders and/or invoices for material required and expended to implement a task order. The justification for and dollar amount will be negotiated and specified in each task order, as needed, and will not be included in the price proposal.

-----End of Section-----

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SECTION 02821

FENCING  
09/98

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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 116	(1995) Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric
ASTM A 121	(1992a) Zinc-Coated (Galvanized) Steel Barbed Wire
ASTM A 153/A 153M	(1995) Zinc-Coated (Hot Dip) on Iron and Steel Hardware
ASTM A 176	(1996) Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
ASTM A 392	(1996) Zinc-Coated Steel Chain-Link Fence Fabric
ASTM A 478	(1995a) Chromium-Nickel Stainless and Heat-Resisting Steel Weaving and Knitting Wire
ASTM A 491	(1996) Aluminum-Coated Steel Chain-Link Fence Fabric
ASTM A 585	(1992) Aluminum-Coated Steel Barbed Wire
ASTM A 666	(1996b) Austenitic Stainless Steel Sheet; Annealed or Cold-Worked
ASTM A 702	(1989; R 1994) Steel Fence Posts and Assemblies, Hot Wrought
ASTM A 780	(1993a) Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings
ASTM A 824	(1995) Metallic-Coated Steel Marcellled Tension Wire for Use With Chain Link Fence
ASTM C 94	(1997) Ready-Mixed Concrete

ASTM D 4541	(1995) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM F 626	(1996) Fence Fittings
ASTM F 668	(1996) Poly(Vinyl Chloride) (PVC)-Coated Steel Chain-Link Fence Fabric
ASTM F 883	(1990) Padlocks
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1995) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures
ASTM F 1184	(1994) Industrial and Commercial Horizontal Slide Gates
ASTM G 23	(1996) Operating Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 26	(1996) Operating Light-Exposure Apparatus (Xenon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials
ASTM G 53	(1996) Operating Light- and Water-Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials

AMERICAN WOOD PRESERVERS ASSOCIATION (AWPA)

AWPA C1	(1995) All Timber products - Preservative Treatment by Pressure Processes
AWPA C4	(1995) Poles - Preservative Treatment by Pressure Processes

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-13 Certificates

Chain Link Fence; FIO.

Statement, signed by an official authorized to certify on behalf of the manufacturer, attesting that the chain link fence and component materials

meet the specified requirements.

## SD-19 Operation and Maintenance Manuals

Electro-Mechanical Locks; GA. Gate Operator; GA.

Six copies of operating and maintenance instructions, a minimum of 2 weeks prior to field training. Operating instructions shall outline the step-by-step procedures required for system startup, operation, and shutdown. The instructions shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance instructions shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The instructions shall include the general gate layout, equipment layout and simplified wiring and control diagrams of the system as installed.

## PART 2 PRODUCTS

### 2.1 FENCE FABRIC

Fence fabric shall conform to the following:

#### 2.1.1 Chain Link Fence Fabric

ASTM A 392, Class 1, zinc-coated steel wire with minimum coating weight of 610 grams 2.0 ounces of zinc per square meter foot of coated surface, or ASTM A 491, Type I, aluminum-coated steel wire. Fabric shall be fabricated of 9 gauge wire woven in 50 mm 2 inch mesh. Fabric height shall be 2.1 m 7 feet. Fabric shall be twisted and barbed on the top selvage and knuckled on the bottom selvage.

### 2.2 GATES

ASTM F 900 and/or ASTM F 1184. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 1-1/2. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 1-1/2. Gate fabric shall be as specified for chain link fabric. Gate leaves more than 2.44 m 8 feet wide shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate leaves less than 2.44 m 8 feet wide shall have truss rods or intermediate braces. Intermediate braces shall be provided on all gate frames with an electro-mechanical lock. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position. For high security applications, each end member of gate frames shall be extended sufficiently above the top member to carry three strands of barbed wire in horizontal alignment with barbed wire strands on the fence.

### 2.3 POSTS

### 2.3.1 Metal Posts for Chain Link Fence

ASTM F 1083, zinc-coated. Group IA, with external coating Type A steel pipe. Group IC steel pipe, zinc-coated with external coating Type A or Type B and Group II, formed steel sections, shall meet the strength and coating requirements of ASTM F 1043. Group III, ASTM F 1043 steel H-section may be used for line posts in lieu of line post shapes specified for the other classes. Sizes shall be as shown on the drawings. Line posts and terminal (corner, gate, and pull) posts selected shall be of the same designation throughout the fence. Gate post shall be for the gate type specified subject to the limitation specified in ASTM F 900 and/or ASTM F 1184.

### 2.4 BRACES AND RAILS

ASTM F 1083, zinc-coated, Group IA, steel pipe, size NPS 1-1/4. Group IC steel pipe, zinc-coated, shall meet the strength and coating requirements of ASTM F 1043. Group II, formed steel sections, size 42 mm (1-21/32 inch), 1-21/32 inch, conforming to ASTM F 1043, may be used as braces and rails if Group II line posts are furnished.

### 2.5 WIRE

#### 2.5.1 Tension Wire

Tension wire shall be Type I or Type II, Class 2 coating, in accordance with ASTM A 824.

### 2.6 ACCESSORIES

ASTM F 626. Ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Truss rods shall be provided with turnbuckles or other equivalent provisions for adjustment. Barbed wire shall be 2 strand, 12-1/2 gauge wire, zinc-coated, Class 3 in accordance with ASTM A 121 or aluminum coated Type I in accordance with ASTM A 585. Barbed wire shall be four-point barbed type steel wire. Barbed wire support arms shall be the single or V arm type and of the design required for the post furnished. Tie wire for attaching fabric to rails, braces, and posts shall be 9 gauge steel wire and match the coating of the fence fabric. Miscellaneous hardware coatings shall conform to ASTM A 153/A 153M unless modified.

### 2.7 BARBED TAPE

Reinforced barbed tape, double coil or single coil, for fence toppings shall be fabricated from 430 series stainless steel with a hardness range of Rockwell (30N) 37-45 conforming to the requirements of ASTM A 176. The stainless steel strip shall be 0.6 mm thick by 25 mm 0.025 inch thick by 1 inch wide before fabrication. Each barb shall be a minimum of 30.5 mm (1.2 inch) 1.2 inch in length, in groups of 4, spaced on 102 mm (4 inch) 4 inch centers. The stainless steel core wire shall have a 2.5 mm (0.098 inch) 0.098 inch diameter with a minimum tensile strength of 9.68 MPa (140 psi) 140 psi and shall be in accordance with ASTM A 478. Sixteen gauge stainless steel twistable wire ties shall be used for attaching the barbed tape to the barbed wire and to the fence for ground application.

### 2.8 CONCRETE

ASTM C 94, using 19 mm 3/4 inch maximum size aggregate, and having minimum compressive strength of 21 MPa 3000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

## 2.9 PADLOCKS

Padlocks shall be as shown in the Task Order. Padlocks shall be keyed alike and each lock shall be furnished with two keys.

## 2.10 GATE OPERATOR

Electric gate operators for sliding gates shall be as follows: Electrical gate operators shall have a right angle gearhead instantly reversing motor with magnetic drum-type brake, friction disc clutch, reversing starter with thermal overload protection, and a chain-driven geared rotary-type automatic limit switch. Gears shall consist of a hardened steel machine cut worm and mating bronze gear. All gears and bearings shall operate in a bath of oil. Gate operators with V-belt pulleys will not be allowed. Gate operators shall be equipped with an emergency release to allow the gate to be operated manually. The emergency release mechanism shall be capable of being locked in the engaged or disengaged position. Positive stops shall be provided on the gate tracks as a backup to the limit switches.

## 2.11 ELECTRO-MECHANICAL LOCKS

Electro-mechanical locking devices for sliding gates and personnel gates shall be solenoid actuated such that the deadbolt retracts when the solenoid is energized and remains electrically retracted until the gate is closed. The solenoid shall be the continuous duty type, rated for 120V ac, 60Hz operation. The locking device shall be unlockable by key and shall be keyed on both sides. Status of the electro-mechanical lock shall be monitored by two limit switches (integral to the locking device) wired in series. One switch shall monitor the deadlock lever and the other switch shall monitor the locking tongue.

## PART 3 EXECUTION

### 3.1 INSTALLATION

Fence shall be installed to the lines and grades indicated. The area on either side of the fence line shall be cleared to the extent indicated. Line posts shall be spaced equidistant at intervals not exceeding 3 m (10 feet). 10 feet. Terminal (corner, gate, and pull) posts shall be set at abrupt changes in vertical and horizontal alignment. Fabric shall be continuous between terminal posts; however, runs between terminal posts shall not exceed 152.4 m (500 feet). 500 feet. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A 780.

### 3.2 EXCAVATION

Post holes shall be cleared of loose material. Waste material shall be spread where directed. The ground surface irregularities along the fence line shall be eliminated to the extent necessary to maintain a 25 mm 1 inch clearance between the bottom of the fabric and finish grade.

### 3.3 POST INSTALLATION

#### 3.3.1 Posts for Chain Link Fence

Posts shall be set plumb and in alignment. Except where solid rock is encountered, posts shall be set in concrete to the depth indicated on the drawings. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 457 mm (18 inches) 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to the minimum depth indicated on the drawing unless a penetration of 457 mm (18 inches) 18 inches in solid rock is achieved before reaching the indicated depth, in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Posts set in concrete shall be set in holes not less than the diameter shown on the drawings. Diameters of holes in solid rock shall be at least 25 mm (1 inch) 1 inch greater than the largest cross section of the post. Concrete and grout shall be thoroughly consolidated around each post, shall be free of voids and finished to form a dome. Concrete and grout shall be allowed to cure for 72 hours prior to attachment of any item to the posts. Group II line posts may be mechanically driven, for temporary fence construction only, if rock is not encountered. Driven posts shall be set to a minimum depth of 914 mm (3 feet) 3 feet and shall be protected with drive caps when being set. For high security fences, fence post rigidity shall be tested by applying a 222.4 newtons (50 pound) 50 pound force on the post, perpendicular to the fabric, at 1.52 m (5 feet) 5 feet above ground; post movement measured at the point where the force is applied shall be less than or equal to 19 mm (3/4 inch) 3/4 inch from the relaxed position; every tenth post shall be tested for rigidity; when a post fails this test, further tests on the next four posts on either side of the failed post shall be made; all failed posts shall be removed, replaced, and retested at the Contractor's expense.

### 3.4 RAILS

#### 3.4.1 Top Rail

Top rail shall be supported at each post to form a continuous brace between terminal posts. Where required, sections of top rail shall be joined using sleeves or couplings that will allow expansion or contraction of the rail. Top rail, if required for high security fence, shall be installed as indicated on the drawings.

#### 3.4.2 Bottom Rail

The bottom rail shall be bolted to double rail ends and double rail ends shall be securely fastened to the posts. Bolts shall be peened to prevent easy removal. Bottom rail shall be installed before chain link fabric.

### 3.5 BRACES AND TRUSS RODS

Braces and truss rods shall be installed as indicated and in conformance with the standard practice for the fence furnished. Horizontal (compression) braces and diagonal truss (tension) rods shall be installed on fences over 1.83 m (6 feet) 6 feet in height. A center brace or 2 diagonal truss rods shall be installed on 3.66 m (12 foot) 12 foot fences. Braces and truss rods shall extend from terminal posts to line posts. Diagonal braces shall form an angle of approximately 40 to 50 degrees with

the horizontal. No bracing is required on fences 1.83 m (6 feet) 6 feet high or less if a top rail is installed.

### 3.6 TENSION WIRES

Tension wires shall be installed along the [top and] [bottom] of the fence line and attached to the terminal posts of each stretch of the fence. Top tension wires shall be installed within the top 102 mm 4 inches of the installed fabric. Bottom tension wire shall be installed within the bottom 152 mm (6 inches) 6 inches of the installed fabric. Tension wire shall be pulled taut and shall be free of sag.

### 3.7 CHAIN LINK FABRIC

Chain link fabric shall be installed on the side of the post indicated. Fabric shall be attached to terminal posts with stretcher bars and tension bands. Bands shall be spaced at approximately 381 mm (15 inch) 15 inch intervals. The fabric shall be installed and pulled taut to provide a smooth and uniform appearance free from sag, without permanently distorting the fabric diamond or reducing the fabric height. Fabric shall be fastened to line posts at approximately 381 mm (15 inch) 15 inch intervals and fastened to all rails and tension wires at approximately 305 mm 12 inch intervals. Fabric shall be cut by untwisting and removing pickets. Splicing shall be accomplished by weaving a single picket into the ends of the rolls to be joined. The bottom of the installed fabric shall be 25 mm plus or minus 13 mm 1 plus or minus 1/2 inch above the ground. For high security fence, after the fabric installation is complete, the fabric shall be exercised by applying a 222 newtons (50 pound) 50 pound push-pull force at the center of the fabric between posts; the use of a 133 newtons (30 pound) 30 pound pull at the center of the panel shall cause fabric deflection of not more than 63.5 mm (2-1/2 inches) 2-1/2 inches when pulling fabric from the post side of the fence; every second fence panel shall meet this requirement; all failed panels shall be resecured and retested at the Contractor's expense.

### 3.8 BARBED WIRE SUPPORTING ARMS AND BARBED WIRE

#### 3.8.1 General Requirements

Barbed wire supporting arms and barbed wire shall be installed as indicated and as recommended by the manufacturer. Supporting arms shall be anchored to the posts in a manner to prevent easy removal with hand tools Supporting arms shall be anchored with 9.5 mm (3/8 inch) 3/8 inch diameter plain pin rivets or, at the Contractor's option, with studs driven by low-velocity explosive-actuated tools for steel, wrought iron, ductile iron, or malleable iron. Studs driven by an explosive-actuated tool shall not be used with gray iron or other material that can be fractured. A minimum of two studs per support arm shall be used. Barbed wire shall be pulled taut and attached to the arms with clips or other means that will prevent easy removal.

### 3.9 GATE INSTALLATION

Gates shall be installed at the locations shown. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required. Gates shall be installed as recommended by the manufacturer. Padlocks shall be attached to gates or gate posts with chains. Hinge pins, and hardware shall be welded or otherwise secured to

prevent removal.

### 3.10 BARBED TAPE INSTALLATION

Stainless steel reinforced barbed tape shall be installed as detailed on the drawings. Barbed tape shall be stretched out to its manufacturer's recommended length, set on top of the barbed wire and "V" shaped support arms, and then secured to the barbed wire. The barbed tape shall be secured to the barbed wire at the two points and at every spiral turn of both coils as shown on the drawings. Stainless steel barbed tape for ground applications shall be installed per manufacturer's recommendations.

### 3.11 GROUNDING

Fences crossed by overhead powerlines in excess of 600 volts shall be grounded. Electrical equipment attached to the fence shall be grounded as specified in Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL or Section 16375 ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND. Fences shall be grounded on each side of all gates, at each corner, at the closest approach to each building located within 15 m 50 feet of the fence, and where the fence alignment changes more than 15 degrees. Grounding locations shall not exceed 198 m 650 feet. Each gate panel shall be bonded with a flexible bond strap to its gate post. Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 45 m 150 feet on each side of crossing. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be 19 mm (3/4 inch) 3/4 inch by 3.05 m (10 foot) 10 foot long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 152 mm (6 inches) 6 inches below the grade. Where driving is impracticable, electrodes shall be buried a minimum of 305 mm 12 inches deep and radially from the fence. The top of the electrode shall be not less than 0.6 m 2 feet or more than 2.4 m 8 feet from the fence. Ground conductor shall be clamped to the fence and electrodes with bronze grounding clamps to create electrical continuity between fence posts, fence fabric, and ground rods. After installation the total resistance of fence to ground shall not be greater than 25 ohms.

-- End of Section --

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SECTION 02930

EXTERIOR PLANTING  
06/98

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 NURSERY AND LANDSCAPE ASSOCIATION (ANLA)

ANLA ANSI/ANLA Z60.1 (1996) American Standard for Nursery Stock

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A300 (1995) Tree Care Operations - Trees, Shrubs and other Woody Plant Maintenance

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 602 (1995a) Agricultural Liming Materials

ASTM D 4972 (1995a) pH of Soils

ASTM D 5034 (1995) Breaking Strength and Elongation of Textile Fabrics (Grab Test)

ASTM D 5035 (1995) Breaking Strength and Elongation of Textile Fabrics (Grab Test)

ASTM D 5268 (1992; R1996) Topsoil Used for Landscaping Purposes

ASTM D 5883 (1996) Standard Guide for Use of Rotary Kiln Produced Expanded Shale, Clay or Slate (ESCS) as a Mineral Amendment in Topsoil Used for Landscaping and Related Purposes

1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Geotextile; FIO. Chemical Treatment Material; FIO.

Manufacturer's literature including physical characteristics, application and installation instructions for geotextile and chemical treatment material.

#### SD-07 Schedules

Equipment; FIO.

A listing of equipment to be used for the planting operation.

#### SD-08 Statements

Delivery; FIO.

Delivery schedule.

Finished Grade, Topsoil and Underground Utilities; GA.

Finished grade status; location of underground utilities and facilities; and availability of topsoil from the stripping and stock piling operation.

#### SD-09 Reports

Soil Test; FIO. Percolation Test; FIO.

Certified reports of inspections and laboratory tests, prepared by an independent testing agency, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

#### SD-13 Certificates

Plant Material; FIO. Topsoil; FIO. pH Adjuster; FIO. Fertilizer; FIO. Organic Material; FIO. Soil Conditioner; FIO. Organic Mulch; FIO. Mycorrhizal Fungi Inoculum; FIO. Pesticide; FIO.

Prior to delivery of materials, certificates of compliance attesting that materials meet the specified requirements. Certified copies of the material certificates shall include the following.

- a. Plant Material: Classification, botanical name, common name, size, quantity by species, and location where grown.
- b. Topsoil: Particle size, pH, organic matter content, textural class, soluble salts, chemical and mechanical analyses.
- c. pH Adjuster: Sieve analysis and calcium carbonate equivalent.
- d. Fertilizer: Chemical analysis and composition percent.
- e. Organic Material: Composition and source.
- f. Soil Conditioner: Composition and source.
- g. Organic Mulch: Composition, source, and treatment against fungi growth.

h. Mycorrhizal Fungi Inoculum: Plant material treated.

i. Pesticide. EPA registration number and registered uses.

#### SD-14 Samples

Delivered Topsoil; FIO.

Samples taken from several locations at the source.

Soil Amendments; FIO.

A 4.5 kilogram 10 pound sample.

Mulch; FIO.

A 4.5 kilogram 10 pound sample.

Geotextile; GA.

A 150 mm 6 inch square sample.

#### SD-18 Records

Plant Establishment Period; FIO.

Calendar time period for the plant establishment period. When there is more than one establishment period, the boundaries of the planted areas covered for each period shall be described.

Maintenance Record; FIO.

Maintenance work performed, quantity of plant losses, and replacements; and diagnosis of unhealthy plant material.

Application of Pesticide; GA.

Pesticide treatment plan with sequence of treatment work with dates and times. The pesticide trade name, EPA registration number, chemical composition, formulation, concentration of original and diluted material, application rate of active ingredients, method of application, area treated, amount applied; and the name and state license number of the state certified applicator shall be included.

#### SD-19 Operation and Maintenance Manuals

Maintenance Instructions; GA.

Instruction for year-round care of installed plant material.

### 1.3 SOURCE INSPECTIONS

The nursery or source of plant material and the source of delivered topsoil shall be subject to inspection.

### 1.4 DELIVERY, INSPECTION, STORAGE, AND HANDLING

#### 1.4.1 Delivery

A delivery schedule shall be provided at least 10 calendar days prior to the first day of delivery.

##### 1.4.1.1 Plant Material Identification

Plant material shall be identified with attached, durable, waterproof labels and weather-resistant ink, stating the correct botanical plant name and size.

##### 1.4.1.2 Protection During Delivery

Plant material shall be protected during delivery to prevent desiccation and damage to the branches, trunk, root system, or earth ball. Branches shall be protected by tying-in. Exposed branches shall be covered during transport.

##### 1.4.1.3 Delivered Topsoil

Prior to the delivery of any topsoil, the availability of topsoil shall be verified in paragraph TOPSOIL. A soil test shall be provided for delivered topsoil.

##### 1.4.1.4 Soil Amendments

Soil amendments shall be delivered to the site in the original, unopened containers bearing the manufacturer's chemical analysis. In lieu of containers, soil amendments may be furnished in bulk. A chemical analysis shall be provided for bulk deliveries.

##### 1.4.1.5 Pesticide Material

Pesticide material shall be delivered to the site in the original, unopened containers bearing legible labels indicating the Environmental Protection Agency (EPA) registration number and the manufacturer's registered uses.

#### 1.4.2 Inspection

Plant material shall be well shaped, vigorous and healthy with a healthy, well branched root system, free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement or abrasion. Plant material shall be checked for unauthorized substitution and to establish nursery grown status. Plant material showing desiccation, abrasion, sun-scald injury, disfigurement, or unauthorized substitution shall be rejected. The plant material shall exhibit typical form of branch to height ratio; and meet the caliper and height measurements specified. Plant material that measures less than specified, or has been poled, topped off or headed back, shall be rejected. Container-grown plant material shall show new fibrous roots and the root mass shall contain its shape when removed from the container. Plant material with broken or cracked balls; or broken containers shall be rejected. Bare-root plant material that is not dormant or is showing roots were pulled from the ground shall be rejected. Other materials shall be inspected for compliance with paragraph PRODUCTS. Open soil amendment containers or wet soil amendments shall be rejected. Topsoil that contains slag, cinders, stones, lumps of soil, sticks, roots, trash or other material larger than 40 mm 1-1/2 inch diameter shall be rejected. Topsoil

that contains viable plant material and plant parts shall be rejected. Unacceptable material shall be removed from the job site.

#### 1.4.3 Storage

##### 1.4.3.1 Plant Material Storage

Plant material not installed on the day of arrival at the site shall be stored and protected in designated areas. Plant material shall not be stored longer than 30 days. Plant material shall be protected from direct exposure to wind and sun. Bare-root plant material shall be heeled-in. All plant material shall be kept in a moist condition by watering with a fine mist spray until installed.

##### 1.4.3.2 Other Material Storage

Storage of other material shall be in designated areas. Soil amendments shall be stored in dry locations and away from contaminants. Chemical treatment material shall be stored according to manufacturer's instructions and not with planting operation material.

#### 1.4.4 Handling

Plant material shall not be injured in handling. Cracking or breaking the earth ball of balled and burlapped plant material shall be avoided. Plant material shall not be handled by the trunk or stems. Materials shall not be dropped from vehicles.

#### 1.4.5 Time Limitation

Except for container-grown plant material, the time limitation from digging to installing plant material shall be a maximum 90 days. The time limitation between installing the plant material and placing the mulch shall be a maximum 24 hours.

### 1.5 WARRANTY

Furnished plant material shall have a warranty for plant growth to be in a vigorous growing condition for a minimum 12 month period. A minimum 12 month calendar time period for the warranty of plant growth shall be provided regardless of the contract time period. When plant material is determined to be unhealthy in accordance with paragraph PLANT ESTABLISHMENT PERIOD, it shall be replaced once under this warranty.

## PART 2 PRODUCTS

### 2.1 PLANT MATERIAL

#### 2.1.1 Plant Material Classification

The plant material shall be nursery grown stock conforming to ANLA ANSI/ANLA Z60.1 and shall be the species specified.

#### 2.1.2 Plant Schedule

The plant schedule shall provide botanical names as included in one or more of the publications listed under "Nomenclature" in ANLA ANSI/ANLA Z60.1.

### 2.1.3 Substitutions

Substitutions will not be permitted without written request and approval from the Contracting Officer.

### 2.1.4 Quality

Well shaped, well grown, vigorous plant material having healthy and well branched root systems in accordance with ANLA ANSI/ANLA Z60.1 shall be provided. Plant material shall be provided free from disease, harmful insects and insect eggs, sun-scald injury, disfigurement and abrasion. Plant material shall be free of shock or damage to branches, trunk, or root systems, which may occur from the digging and preparation for shipment, method of shipment, or shipment. Plant quality is determined by the growing conditions; method of shipment to maintain health of the root system; and growth of the trunk and crown as follows.

### 2.1.5 Growing Conditions

Plant material shall be native to or well-suited to the growing conditions of the project site. Plant material shall be grown under climatic conditions similar to those at the project site.

### 2.1.6 Method of Shipment to Maintain Health of Root System

#### 2.1.6.1 Balled and Burlapped (BB) Plant Material

Ball size and ratio shall be in accordance with ANLA ANSI/ANLA Z60.1. The ball shall be of a diameter and depth to encompass enough fibrous and feeding root system necessary for the full recovery of the plant. The plant stem or trunk shall be centered in the ball. All roots shall be clean cut at the ball surface. Roots shall not be pulled from the ground. Before shipment the root ball shall be dipped in gels containing mycorrhizal fungi inoculum. The root ball shall be completely wrapped with burlap or other suitable material and securely laced with biodegradable twine.

#### 2.1.6.2 Balled and Potted (Pot) Plant Material

Ball size and ratio shall be in accordance with ANLA ANSI/ANLA Z60.1. The ball shall be of a diameter and depth to encompass enough fibrous and feeding root system necessary for the full recovery of the plant. Removal shall be done by hand digging or mechanical devices. The plant stem or trunk shall be centered in the ball. All roots shall be clean cut at the ball surface. Roots shall not be pulled from the ground. Before shipment the root ball shall be dipped in gels containing mycorrhizal fungi inoculum. Container shall be used to retain the ball unbroken. Container shall be rigid to hold ball shape and protect root mass during shipping.

#### 2.1.6.3 Balled and Platform (BP) Plant Material

Ball size and ratio shall be in accordance with ANLA ANSI/ANLA Z60.1. Plants shall be prepared as balled and burlapped plant material and securely fastened to wood platform for shipping.

#### 2.1.6.4 Bare-Root (BR) Plant Material

Minimum root spread shall be in accordance with ANLA ANSI/ANLA Z60.1. A well branched root system characteristic of the species specified shall be provided. Roots shall not be pulled from the ground. Bare-root plant material shall be inoculated with mycorrhizal fungi during germination in the nursery. Before shipment the root system shall be dipped in gels containing mycorrhizal fungi inoculum. Bare-root plant material shall be dormant. The root system shall be protected from drying out.

#### 2.1.6.5 Container-Grown (C) Plant Material

Container size shall be in accordance with ANLA ANSI/ANLA Z60.1. Plant material shall be grown in a container over a duration of time for new fibrous roots to have developed and for the root mass to retain its shape and hold together when removed from the container. Container-grown plant material shall be inoculated with mycorrhizal fungi during germination in the nursery. Before shipment the root system shall be dipped in gels containing mycorrhizal fungi inoculum. The container shall be sufficiently rigid to hold ball shape and protect root mass during shipping.

#### 2.1.7 Growth of Trunk and Crown

##### 2.1.7.1 Deciduous Trees

A height to caliper relationship shall be provided in accordance with ANLA ANSI/ANLA Z60.1. Height of branching shall bear a relationship to the size and species of tree specified and with the crown in good balance with the trunk. The trees shall not be "poled" or the leader removed.

- a. Single stem: The trunk shall be reasonably straight and symmetrical with crown and have a persistent main leader.
- b. Multi-stem: All countable stems, in aggregate, shall average the size specified. To be considered a stem, there shall be no division of the trunk which branches more than 150 mm 6 inches from ground level.
- c. Specimen: The tree provided shall be well branched and pruned naturally according to the species. The form of growth desired, which may not be in accordance with natural growth habit, shall be as indicated.

##### 2.1.7.2 Palms

Palms shall have the specified height as measured from the base of the trunk to the base of the fronds or foliage in accordance with ANLA ANSI/ANLA Z60.1. The palm shall have straight trunk and healthy fronds or foliage as typical for the variety grown in the region of the project. Palms trimmed or pruned for delivery shall retain a minimum of 150 mm 6 inches of foliage at the crown as a means of determining plant health.

##### 2.1.7.3 Deciduous Shrubs

Deciduous shrubs shall have the height and number of primary stems recommended by ANLA ANSI/ANLA Z60.1. Acceptable plant material shall be well shaped, with sufficient well-spaced side branches, and recognized by the trade as typical for the species grown in the region of the project.

#### 2.1.7.4 Coniferous Evergreen Plant Material

Coniferous Evergreen plant material shall have the height-to-spread ratio recommended by ANLA ANSI/ANLA Z60.1. The coniferous evergreen trees shall not be "poled" or the leader removed. Acceptable plant material shall be exceptionally heavy, well shaped and trimmed to form a symmetrical and tightly knit plant. The form of growth desired shall be as indicated.

#### 2.1.7.5 Broadleaf Evergreen Plant Material

Broadleaf evergreen plant material shall have the height-to-spread ratio recommended by ANLA ANSI/ANLA Z60.1. Acceptable plant material shall be well shaped and recognized by the trade as typical for the variety grown in the region of the project.

#### 2.1.7.6 Ground Cover and Vine Plant Material

Ground cover and vine plant material shall have the minimum number of runners and length of runner recommended by ANLA ANSI/ANLA Z60.1. Plant material shall have heavy, well developed and balanced crown with vigorous, well developed root system and shall be furnished in containers.

#### 2.1.8 Plant Material Size

Plant material shall be furnished in sizes indicated. Plant material larger in size than specified may be provided at no additional cost to the Government.

#### 2.1.9 Plant Material Measurement

Plant material measurements shall be in accordance with ANLA ANSI/ANLA Z60.1.

### 2.2 TOPSOIL

Topsoil shall be as defined in ASTM D 5268. When available, the topsoil shall be the existing surface soil stripped and stockpiled onsite in accordance with Section 02300 EARTHWORK. When additional topsoil is required beyond the available topsoil from the stripping operation, topsoil shall be delivered and amended as recommended by the soil test for the plant material specified. Topsoil shall be free from slag, cinders, stones, lumps of soil, sticks, roots, trash or other material over a minimum 40 mm 1-1/2 inch diameter. Topsoil shall be free from viable plants and plant parts.

### 2.3 SOIL AMENDMENTS

Soil amendments shall consist of pH adjuster, fertilizer, organic material and soil conditioners meeting the following requirements. Vermiculite is not recommended.

#### 2.3.1 pH Adjuster

The pH adjuster shall be an agricultural liming material in accordance with ASTM C 602. These materials may be burnt lime, hydrated lime, ground limestone, or shells. The pH adjuster shall be used to create a favorable soil pH for the plant material specified.

#### 2.3.1.1 Limestone

Limestone material shall contain a minimum calcium carbonate equivalent of 80 percent. Gradation: A minimum 95 percent shall pass through a 2.36 mm No. 8 sieve and a minimum 55 percent shall pass through a 0.25 mm No. 60 sieve. To raise soil pH, ground limestone shall be used.

#### 2.3.1.2 Hydrated Lime

Hydrated lime shall contain a minimum calcium carbonate equivalent of 110 percent. Gradation: A minimum 100 percent shall pass through a 2.36 mm No. 8 sieve and a minimum 97 percent shall pass through a 0.25 mm No. 60 sieve.

#### 2.3.1.3 Burnt Lime

Burnt lime shall contain a minimum calcium carbonate equivalent of 140 percent. Gradation: A minimum 95 percent shall pass through a 2.36 mm No. 8 sieve and a minimum 35 percent shall pass through a 0.25 mm No. 60 sieve.

#### 2.3.2 Fertilizer

It shall be as recommended by the soil test. Fertilizer shall be controlled release commercial grade; free flowing, pellet or tablet form; uniform in composition; and consist of a nitrogen-phosphorus-potassium ratio. The fertilizer shall be derived from sulphur coated urea, urea formaldehyde, plastic or polymer coated pills, or isobutylenediurea (IBDU). Fertilizer shall be balanced with the inclusion of trace minerals and micro-nutrients.

#### 2.3.3 Organic Material

Organic material shall consist of either bonemeal, peat, rotted manure, decomposed wood derivatives, recycled compost, or worm castings.

##### 2.3.3.1 Bonemeal

Bonemeal shall be a finely ground, steamed bone product containing from 2 to 4 percent nitrogen and 16 to 40 percent phosphoric acid.

##### 2.3.3.2 Rotted Manure

Rotted manure shall be unleached horse, chicken, or cattle manure containing a maximum 25 percent by volume of straw, sawdust, or other bedding materials. Manure shall contain no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds and shall be free of stones, sticks, and soil.

##### 2.3.3.3 Decomposed Wood Derivatives

Decomposed wood derivatives shall be ground bark, sawdust, or other wood waste material free of stones, sticks, and toxic substances harmful to plants, and stabilized with nitrogen.

##### 2.3.3.4 Recycled Compost

Compost shall be a well decomposed, stable, weed free organic matter

source. It shall be derived from food, agricultural, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated or mixed solid waste. The compost shall possess no objectionable odors and shall not resemble the raw material from which it was derived. The material shall not contain substances toxic to plants. Gradation: The compost material shall pass through a 10 mm 3/8 inch screen, possess a pH of 5.5 to 8.0, and have a moisture content between 35-55 percent by weight. The material shall not contain more than 1 percent or less by weight of man-made foreign matter. Compost shall be cleaned of plastic materials larger than 50 mm 2 inches in length.

#### 2.3.3.5 Worm Castings

Worm castings shall be screened from worms and food source and shall be commercially packaged.

#### 2.3.4 Soil Conditioner

Soil conditioner shall be sand, super absorbent polymers, calcined clay, or gypsum for single use or in combination to meet topsoil requirements for the plant material specified.

##### 2.3.4.1 Sand

Sand shall be clean and free of toxic materials. Gradation: A minimum 95 percent by weight shall pass a 2 mm No. 10 sieve and a minimum 10 percent by weight shall pass a 1.18 mm No. 16 sieve. Greensand shall be balanced with the inclusion of trace minerals and nutrients.

##### 2.3.4.2 Super Absorbent Polymers

To improve water retention in soils, super absorbent polymers shall be sized according to manufacturer's recommendations. Polymers shall be added as a soil amendment and be cross-linked polyacrylamide with an absorption capacity of 250-400 times its weight.

##### 2.3.4.3 Calcined Clay

Granular particles shall be produced from montmorillonite clay calcined to minimum temperature of 650 degrees C. 1200 degrees F. Gradation: A minimum 90 percent passing 2.36 mm No. 8 sieve; a minimum 99 percent shall be retained on 0.25 mm No. 60 sieve; and a maximum 2 percent shall pass a 0.15 mm No. 100 sieve. Bulk density: A maximum 640 kilogram per cubic meter 40 pounds per cubic foot.

##### 2.3.4.4 Gypsum

Gypsum shall be commercially packaged, free flowing, and a minimum 95 percent calcium sulfate by volume.

##### 2.3.4.5 Expanded Shale, Clay, or Slate (ESCS)

Rotary kiln produced ESCS material shall be in conformance with ASTM D 5883.

#### 2.4 MULCH

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

Mulch materials shall be native to the region. Rotted manure is not recommended to be used as a mulch because it would encourage surface rooting of the plant material and weeds.

#### 2.4.1 Inorganic Mulch

When inorganic mulch is required for decorative purposes, it shall be provided in areas designated.

#### 2.4.2 Organic Mulch

Organic mulch materials shall be native to the project site and consist of recycled mulch, shredded bark, wood chips, or ground bark.

##### 2.4.2.1 Recycled Mulch

Recycled mulch may include compost, tree trimmings, or pine needles with a gradation that passes through a 65 x 65 mm 2-1/2 x 2-1/2 inch screen. It shall be cleaned of all sticks a minimum 25 mm 1 inch in diameter and plastic materials a minimum 75 mm 3 inch length. The material shall be treated to retard the growth of mold and fungi. Other recycled mulch may include peanut shells, pecan shells or coco bean shells.

##### 2.4.2.2 Shredded Bark

Locally shredded material shall be treated to retard the growth of mold and fungi.

##### 2.4.2.3 Wood Chips and Ground Bark

Locally chipped or ground material shall be treated to retard the growth of mold and fungi. Gradation: A maximum 50 mm 2 inch wide by 100 mm 4 inch long.

#### 2.5 GEOTEXTILE

Geotextile shall be woven or nonwoven; polypropylene, polyester, or fiberglass, mat in accordance with ASTM D 5034 or ASTM D 5035. It shall be made specifically for use as a fabric around plant material. Nominal weight shall be a minimum 120 grams per square meter 4 ounces per square yard. Permeability rate shall be a minimum 1 mm 0.04 inch per second.

#### 2.6 WOOD STAKING MATERIAL

Wood stakes shall be hardwood or fir; rough sawn; free from knots, rot, cross grain, or other defects that would impair their strength.

##### 2.6.1 Bracing Stake

Wood bracing stakes shall be a minimum 50 x 50 mm 2 x 2 inch square and a minimum 2400 mm 8 feet long with a point at one end. Stake shall be set without damaging rootball.

##### 2.6.2 Wood Ground Stakes

Wood ground stakes shall be a minimum of 50 x 50 mm 2 x 2 inch square and a minimum 900 mm 3 feet long with a point at one end.

### 2.6.3 Deadmen

Wood deadmen shall be a minimum 100 x 100 x 900 mm 4 x 4 x 36 inches long.

## 2.7 METAL STAKING AND GUYING MATERIAL

Metal shall be aluminum or steel consisting of recycled content made for holding plant material in place.

### 2.7.1 Bracing Stakes

Metal bracing stakes shall be a minimum 25 mm 1 inch diameter and a minimum 2400 mm 8 feet long. Stake shall be set without damaging rootball.

### 2.7.2 Metal Ground Stakes

Metal ground stakes shall be a minimum 13 mm 1/2 inch diameter and a minimum 900 mm 3 feet long.

### 2.7.3 Earth Anchor

Metal earth anchors shall be a minimum 13 mm 1/2 inch diameter and a minimum 600 mm 2 feet long.

### 2.7.4 Guying Material

Metal guying material shall be a minimum 12 gauge wire. Multi-strand cable shall be woven wire. Guying material tensile strength shall conform to the size of tree to be held firmly in place.

### 2.7.5 Turnbuckle

Metal turnbuckles shall be galvanized or cadmium-plated steel, and shall be a minimum 75 mm 3 inches long with closed screw eyes on each end. Screw thread tensile strength shall conform to the size of tree to be held firmly in place.

## 2.8 PLASTIC STAKING AND GUYING MATERIAL

Plastic shall consist of recycled plastic product made for holding plant material firmly in place. Plastic shall not be used for deadmen.

### 2.8.1 Plastic Bracing Stake

Plastic bracing stakes shall be a minimum 50 mm 2 inch diameter and a minimum 2400 mm 8 feet long. Stake shall be set without damaging rootball.

### 2.8.2 Plastic Ground Stakes

Plastic ground stakes shall be a minimum 50 mm 1 inch diameter and a minimum 900 mm 3 feet long.

### 2.8.3 Plastic Guying Material

Plastic guying material shall be designed specifically for the purpose of firmly holding plant material in high wind velocities.

#### 2.8.4 Chafing Guard

Plastic chafing guards shall be used to protect tree trunks and branches when metal is used as guying material. The material shall be the same color throughout the project site. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

#### 2.9 RUBBER GUYING MATERIAL

Rubber chafing guards, consisting of recycled material, shall be used to protect tree trunks and branches when metal guying material is applied. The material shall be the same color throughout the project. Length shall be a minimum 1.5 times the circumference of the plant trunk at its base.

#### 2.10 FLAG

Plastic flag material shall be used on guying material. It shall be a minimum 150 mm 6 inches long. Tape color shall be consistent and visually complimentary to the entire project area. The tape color shall meet pedestrian visual safety requirements for day and night.

#### 2.11 TREE ROOT BARRIERS

Tree root barriers shall be metal or plastic consisting of recycled content. Barriers shall utilize vertical stabilizing members to encourage downward tree root growth. Barriers shall limit, by a minimum 90 percent, the occurrence of surface roots. Tree root barriers which are designed to be used as plant pit liners will be rejected.

#### 2.12 MYCORRHIZAL FUNGI INOCULUM

Mycorrhizal fungi inoculum shall be composed of multiple-fungus inoculum as recommended by the manufacturer for the plant material specified.

#### 2.13 WATER

Unless otherwise directed, water shall be the responsibility of the Contractor. Water shall not contain elements toxic to plant life.

#### 2.14 PESTICIDE

Pesticide shall be insecticide, herbicide, fungicide, nematocide, rodenticide or miticide. For the purpose of this specification a soil fumigant shall have the same requirements as a pesticide. The pesticide material shall be EPA registered and approved.

### PART 3 EXECUTION

#### 3.1 INSTALLING PLANT MATERIAL TIME AND CONDITIONS

##### 3.1.1 Deciduous Plant Material Time

Deciduous plant material shall be installed in accordance with instructions from grower.

##### 3.1.2 Evergreen Plant Material Time

Evergreen plant material shall be installed in accordance with instructions from grower.

### 3.1.3 Plant Material Conditions

Planting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted for approval.

### 3.1.4 Tests

#### 3.1.4.1 Percolation Test

Test for percolation shall be done to determine positive drainage of plant pits and beds. A positive percolation shall consist of a minimum 25 mm 1 inch per 3 hours; when a negative percolation test occurs, a shop drawing shall be submitted indicating the corrective measures.

#### 3.1.4.2 Soil Test

Delivered topsoil, excavated plant pit soil, and stockpiled topsoil shall be tested in accordance with ASTM D 5268 and ASTM D 4972 for determining the particle size, pH, organic matter content, textural class, chemical analysis, soluble salts analysis, and mechanical analysis. Sample collection onsite shall be random over the entire site. Sample collection for stockpiled topsoil shall be at different levels in the stockpile. The soil shall be free from debris, noxious weeds, toxic substances, or other materials harmful to plant growth. The test shall determine the quantities and type of soil amendments required to meet local growing conditions for the plant material specified.

## 3.2 SITE PREPARATION

### 3.2.1 Finished Grade, Topsoil and Underground Utilities

The Contractor shall verify that finished grades are as indicated on drawings, and that the placing of topsoil, the smooth grading, and the compaction requirements have been completed in accordance with Section 02300 EARTHWORK, prior to the commencement of the planting operation. The location of underground utilities and facilities in the area of the planting operation shall be verified. Damage to underground utilities and facilities shall be repaired at the Contractor's expense.

### 3.2.2 Layout

Plant material locations and bed outlines shall be staked on the project site before any excavation is made. Plant material locations may be adjusted to meet field conditions.

### 3.2.3 Protecting Existing Vegetation

When there are established lawns in the planting area, the turf shall be covered and/or protected during planting operations. Existing trees, shrubs, and plant beds that are to be preserved shall be barricaded along the dripline to protect them during planting operations.

### 3.3 EXCAVATION

#### 3.3.1 Obstructions Below Ground

When obstructions below ground affect the work, shop drawings showing proposed adjustments to plant material location, type of plant and planting method shall be submitted for approval.

#### 3.3.2 Turf Removal

Where the planting operation occurs in an existing lawn area, the turf shall be removed from the excavation area to a depth that will ensure the removal of the entire root system.

#### 3.3.3 Plant Pits

Plant pits for ball and burlapped or container plant material shall be dug to a depth equal to the height of the root ball as measured from the base of the ball to the base of the plant trunk. Plant pits for bare-root plant material shall be dug to a depth equal to the height of the root system. Plant pits shall be dug a minimum 50 percent wider than the ball or root system to allow for root expansion. The pit shall be constructed with sides sloping towards the base as a cone, to encourage well aerated soil to be available to the root system for favorable root growth. Cylindrical pits with vertical sides shall not be used.

### 3.4 INSTALLATION

#### 3.4.1 Setting Plant Material

Plant material shall be set plumb and held in position until sufficient soil has been firmly placed around root system or ball. In relation to the surrounding grade, the plant material shall be set even with the grade at which it was grown.

##### 3.4.1.1 Bare-Root Plant Material

Bare-root plant material shall be placed in water a minimum 30 minutes prior to setting.

#### 3.4.2 Tree Root Barrier

Tree root barriers shall be installed as recommended by the manufacturer. Tree root barriers shall be used for trees located up to a maximum 1800 mm 6 feet from paved surfaces or structures.

#### 3.4.3 Backfill Soil Mixture

The backfill soil mixture may be a mix of topsoil and soil amendments suitable for the plant material specified. When practical, the excavated soil from the plant pit that is not amended provides the best backfill and shall be used.

#### 3.4.4 Adding Mycorrhizal Fungi Inoculum

Mycorrhizal fungi inoculum shall be added as recommended by the manufacturer for the plant material specified.

### 3.4.5 Backfill Procedure

Prior to backfilling, all metal, wood, synthetic products, or treated burlap devices shall be removed from the ball or root system avoiding damage to the root system. The backfill procedure shall remove air pockets from around the root system. Additional requirements are as follows.

#### 3.4.5.1 Balled and Burlapped, and Balled and Platformed Plant Material

Biodegradable burlap and tying material shall be carefully opened and folded back from the top a minimum 1/3 depth from the top of the root ball. Backfill mixture shall be added to the plant pit in 150 mm 6 inch layers with each layer tamped.

#### 3.4.5.2 Bare-Root Plant Material

The root system shall be spread out and arranged in its natural position. Damaged roots shall be removed with a clean cut. The backfill soil mixture shall be carefully worked in amongst the roots and watered to form a soupy mixture. Air pockets shall be removed from around the root system, and root to soil contact shall be provided.

#### 3.4.5.3 Container-Grown and Balled and Potted Plant Material

The plant material shall be carefully removed from containers that are not biodegradable. Prior to setting the plant in the pit, a maximum 1/4 depth of the root mass, measured from the bottom, shall be spread apart to promote new root growth. For plant material in biodegradable containers the container shall be split prior to setting the plant with container. Backfill mixture shall be added to the plant pit in 150 mm 6 inch layers with each layer tamped.

#### 3.4.5.4 Earth Berm

An earth berm, consisting of backfill soil mixture, shall be formed with a minimum 100 mm 4 inch height around the edge of the plant pit to aid in water retention and to provide soil for settling adjustments.

#### 3.4.6 Plant Bed

Plant material shall be set in plant beds according to the drawings. Backfill soil mixture shall be placed on previously scarified subsoil to completely surround the root balls, and shall be brought to a smooth and even surface, blending to existing areas. Earth berms shall be provided. Polymers shall be spread uniformly over the plant bed and in the planting pit as recommended by the manufacturer and thoroughly incorporated into the soil to a maximum 100 mm 4 inch depth.

#### 3.4.7 Watering

Plant pits and plant beds shall be watered immediately after backfilling, until completely saturated.

#### 3.4.8 Staking and Guying

Staking will be required when trees are unstable or will not remain set due

to their size, shape, or exposure to high wind velocity.

#### 3.4.8.1 One Bracing Stake

Trees 1200 to 1800 mm 4 to 6 feet high shall be firmly anchored in place with one bracing stake. The bracing stake shall be placed on the side of the tree facing the prevailing wind. The bracing stake shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly to the stake with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. A chafing guard shall be used when metal is the guying material.

#### 3.4.8.2 Two Bracing Stakes

Trees from 1800 to 2400 m 6 to 8 feet height shall be firmly anchored in place with 2 bracing stakes placed on opposite sides. Bracing stakes shall be driven vertically into firm ground and shall not injure the ball or root system. The tree shall be held firmly between the stakes with a double strand of guying material. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Chafing guards shall be used when metal is the guying material.

#### 3.4.8.3 Three Ground Stakes

Trees over a minimum 2400 mm 8 feet height and less than a maximum 150 mm 6 inch caliper shall be held firmly in place with 3 bracing or ground stakes spaced equidistantly around the tree. Ground stakes shall be avoided in areas to be mowed. Stakes shall be driven into firm ground outside the earth berm. The guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. For trees over maximum 75 mm 3 inch diameter at breast height, turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used when metal is the guying material.

#### 3.4.9 Deadmen or Earth Anchors

Trees over a minimum 150 mm 6 inch caliper shall be held firmly in place with wood deadmen buried a minimum 900 mm 3 feet in the ground or metal earth anchors. Multi-strand cable guying material shall be firmly anchored at a minimum 1/2 tree height and shall prevent girdling. Turnbuckles shall be used on the guying material for tree straightening purposes. One turnbuckle shall be centered on each guy line. Chafing guards shall be used.

#### 3.4.10 Flags

A flag shall be securely fastened to each guy line equidistant between the tree and the stake, deadmen, or earth anchor. The flag shall be visible to pedestrians.

### 3.5 FINISHING

#### 3.5.1 Plant Material

Prior to placing mulch, the installed area shall be uniformly edged to

provide a clear division line between the planted area and the adjacent turf area, shaped as indicated. The installed area shall be raked and smoothed while maintaining the earth berms.

### 3.5.2 Placing Geotextile

Prior to placing mulch, geotextile shall be placed as indicated in accordance with the manufacturer's recommendations.

### 3.5.3 Placing Mulch

The placement of mulch shall occur a maximum 48 hours after planting. Mulch, used to reduce soil water loss, regulate soil temperature and prevent weed growth, shall be spread to cover the installed area with a minimum 100 mm 4 inch uniform thickness. Mulch shall be kept out of the crowns of shrubs, ground cover, and vines and shall be kept off buildings, sidewalks and other facilities.

### 3.5.4 Pruning

Pruning shall be accomplished by trained and experienced personnel. The pruning of trees and palms shall be in accordance with ANSI A300. Only dead or broken material shall be pruned from installed plants. The typical growth habit of individual plant material shall be retained. Clean cuts shall be made flush with the parent trunk. Improper cuts, stubs, dead and broken branches shall be removed. "Headback" cuts at right angles to the line of growth will not be permitted. Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".

## 3.6 MAINTENANCE DURING PLANTING OPERATION

Installed plant material shall be maintained in a healthy growing condition. Maintenance operations shall begin immediately after each plant is installed to prevent desiccation and shall continue until the plant establishment period commences. Installed areas shall be kept free of weeds, grass, and other undesired vegetation. The maintenance includes maintaining the mulch, watering, and adjusting settling.

## 3.7 APPLICATION OF PESTICIDE

When application of a pesticide becomes necessary to remove a pest or disease, a pesticide treatment plan shall be submitted and coordinated with the installation pest management program.

### 3.7.1 Technical Representative

The certified installation pest management coordinator shall be the technical representative, and shall be present at all meetings concerning treatment measures for pest or disease control. They may be present during treatment application.

### 3.7.2 Application

A state certified applicator shall apply required pesticides in accordance with EPA label restrictions and recommendations. Clothing and personal protective equipment shall be used as specified on the pesticide label. A closed system is recommended as it prevents the pesticide from coming into

contact with the applicator or other persons. Water for formulating shall only come from designated locations. Filling hoses shall be fitted with a backflow preventer meeting local plumbing codes or standards. Overflow shall be prevented during the filling operation. Prior to each day of use, the equipment used for applying pesticide shall be inspected for leaks, clogging, wear, or damage. Any repairs are to be performed immediately.

### 3.8 RESTORATION AND CLEAN UP

#### 3.8.1 Restoration

Turf areas, pavements and facilities that have been damaged from the planting operation shall be restored to original condition at the Contractor's expense.

#### 3.8.2 Clean Up

Excess and waste material shall be removed from the installed area and shall be disposed offsite. Adjacent paved areas shall be cleared.

### 3.9 PLANT ESTABLISHMENT PERIOD

#### 3.9.1 Commencement

Upon completion of the last day of the planting operation, the plant establishment period for maintaining installed plant material in a healthy growing condition shall commence and shall be in effect for the remaining contract time period, not to exceed 12 months. Written calendar time period shall be furnished for the plant establishment period. When there is more than one plant establishment period, the boundaries of the planted area covered for each period shall be described. The plant establishment period shall be coordinated as shown in the Task Order. The plant establishment period shall be modified for inclement weather shut down periods, or for separate completion dates for areas.

#### 3.9.2 Maintenance During Establishment Period

Maintenance of plant material shall include straightening plant material, straightening stakes; tightening guying material; correcting girdling; supplementing mulch; pruning dead or broken branch tips; maintaining plant material labels; watering; eradicating weeds, insects and disease; post-fertilization; and removing and replacing unhealthy plants.

##### 3.9.2.1 Watering Plant Material

The plant material shall be watered as necessary to prevent desiccation and to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is estimated to be the equivalent of 25 mm 1 inch absorbed water per week, delivered in the form of rain or augmented by watering. Run-off, puddling and wilting shall be prevented. Unless otherwise directed, watering trucks shall not be driven over turf areas. Watering of other adjacent areas or existing plant material shall be prevented.

##### 3.9.2.2 Weeding

Grass and weeds in the installed areas shall not be allowed to reach a

maximum 75 mm 3 inches height before being completely removed, including the root system.

#### 3.9.2.3 Pesticide Treatment

Treatment for disease or pest shall be in accordance with paragraph APPLICATION OF PESTICIDE.

#### 3.9.2.4 Post-Fertilization

The plant material shall be topdressed at least once during the period of establishment with controlled release fertilizer, reference paragraph SOIL AMENDMENTS. Apply at the rate of 1 kilogram per 10 square meters 2 pounds per 100 square feet of plant pit or bed area. Dry fertilizer adhering to plants shall be flushed off. The application shall be timed prior to the advent of winter dormancy.

#### 3.9.2.5 Plant Pit Settling

When settling occurs to the backfill soil mixture, additional backfill soil shall be added to the plant pit or plant bed until the backfill level is equal to the surrounding grade. Serious settling that affects the setting of the plant in relation to the maximum depth at which it was grown requires replanting in accordance with paragraph INSTALLATION. The earth berm shall be maintained.

#### 3.9.2.6 Maintenance Record

A record shall be furnished describing the maintenance work performed, the quantity of plant losses, diagnosis of the plant loss, and the quantity of replacements made on each site visit.

#### 3.9.3 Unhealthy Plant Material

A tree shall be considered unhealthy or dead when the main leader has died back, or up to a maximum 25 percent of the crown has died. A shrub shall be considered unhealthy or dead when up to a maximum 25 percent of the plant has died. This condition shall be determined by scraping on a branch an area 2 mm 1/16 inch square, maximum, to determine if there is a green cambium layer below the bark. The Contractor shall determine the cause for unhealthy plant material and shall provide recommendations for replacement. Unhealthy or dead plant material shall be removed immediately and shall be replaced as soon as seasonal conditions permit.

#### 3.9.4 Replacement Plant Material

Unless otherwise directed, plant material shall be provided for replacement in accordance with paragraph PLANT MATERIAL. Replacement plant material shall be installed in accordance with paragraph INSTALLATION, and recommendations in paragraph PLANT ESTABLISHMENT PERIOD. Plant material shall be replaced in accordance with paragraph WARRANTY. An extended plant establishment period shall not be required for replacement plant material.

#### 3.9.5 Maintenance Instructions

Written instructions shall be furnished containing drawings and other necessary information for year-round care of the installed plant material;

including, when and where maintenance should occur, and the procedures for plant material replacement,.

-- End of Section --

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SECTION 02964

COLD MILLING OF BITUMINOUS PAVEMENTS

03/98

PART 1	GENERAL	
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## 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 136 (1996a) Sieve Analysis of Fine and Coarse Aggregates

## 1.2 Measurement and Payment

Measurement and payment will be by the number of square yards completed in the accepted work.

## 1.3 EQUIPMENT, TOOLS, AND MACHINES

Equipment, tools, and machines used in the performance of the work shall be maintained in a satisfactory working condition.

### 1.3.1 Cold-Milling Machine

The cold-milling machine shall be a self-propelled machine capable of milling the pavement to a specified depth and smoothness. Pavement milling machine shall be capable of establishing grade control; shall have means of controlling transverse slope; and shall have effective means of controlling 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.

### 1.3.2 Cleaning Equipment

Cleaning equipment shall be suitable for removing and cleaning loose material from the pavement surface.

### 1.3.3 Straightedge

The Contractor shall 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. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal, and shall have 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.

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## 1.4 WEATHER LIMITATIONS

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

## 1.5 GRADE AND SURFACE-SMOOTHNESS REQUIREMENTS

### 1.5.1 Grade

The finished milled surfaces shall conform to the lines, grades, and cross sections indicated. The finished milled-pavement surfaces shall vary not more than 0.06 foot 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.

### 1.5.2 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.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

### 3.1 PREPARATION OF SURFACE

The pavement surface shall be cleaned of excessive dirt, clay, or other foreign material immediately prior to milling the pavement.

### 3.2 MILLING OPERATION

Sufficient passes shall be made 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. Items damaged during milling, such as manholes, valve boxes, utility lines, pavement that is torn, cracked, gouged, broken, or undercut, shall be repaired or replaced as directed.

### 3.3 GRADE AND SURFACE-SMOOTHNESS TESTING

#### 3.3.1 Grade-Conformance Tests

The finished milled surface of the pavement shall be tested for conformance with the plan-grade requirements and will be tested for acceptance by the Corps QA Field Representative Representative by running lines of levels longitudinally and transversely to determine the elevation of the completed pavement. The Contractor shall 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. The Contractor shall remove and replace the deficient low area. Sufficient material shall be removed to allow at least 1 inch of asphalt concrete to be placed.

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#### 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. Surface irregularities that depart from the testing edge by more than 1/4 inch shall be corrected.

### 3.4 REMOVAL OF MILLED MATERIAL

Material that is removed shall be placed in the disposal area as specified.

-- End of Section --



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SECTION 02975

SEALING OF CRACKS IN BITUMINOUS PAVEMENTS

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SECTION 02975

SEALING OF CRACKS IN BITUMINOUS PAVEMENTS

07/97

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 this text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 509	(1994) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM D 789	(1994) Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)
ASTM D 1190	(1994) Concrete Joint Sealer, Hot-Poured Elastic Type
ASTM D 3405	(1994) Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements

1.2 Measurement and Payment

Measurement and payment will be by the number of linear feet used and completed in the accepted work

1.3 SYSTEM DESCRIPTION

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-06 Instructions

Installation of Sealant; FIO.

Manufacturer's instructions 30 days prior to the use of the material on the project. Installation of the material will not be allowed until the instructions are received.

SD-09 Reports

Test Requirements; GA.

Reports of all tests. Testing of the materials shall be performed in an

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approved independent laboratory and certified copies of the test reports shall be submitted and approved 30 days prior to the use of the materials at the job site. Samples will be retained by the Government for possible future testing should the materials appear defective during or after application.

SD-14 Samples

Materials; GA.

Samples of the materials 60 days prior to their use on the project. No material will be allowed to be used until it has been approved.

1.5 TEST REQUIREMENTS

The crack sealant and backup material, when required, shall be tested for

conformance with the referenced applicable material specification. Samples of materials shall be furnished, in sufficient quantity to be tested, upon request. Conformance with the requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of the in-place materials.

#### 1.6 EQUIPMENT

Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

##### 1.6.1 Crack Cleaning Equipment

###### 1.6.1.1 Routing Equipment

The routing equipment shall be a self-powered machine operating a power driven tool or bit specifically designed for routing bituminous pavements. The bit shall rotate about a vertical axis at sufficient speed to cut a smooth vertical-walled reservoir in the pavement surface and shall maintain accurate cutting without damaging the sides or top edges of the reservoir. The router shall be capable of following the trace of the crack without deviation. The use of rotary impact routing devices may be permitted if vertical-sided carbide tipped bits are used.

###### 1.6.1.2 Concrete Saw

A self-propelled power saw with small diameter 6 inches or less water-cooled diamond or abrasive saw blades shall be provided for cutting cracks to the depths and widths specified and for removing filler that is embedded in the cracks or adhered to the crack faces. The diameter of the saw blade shall be small enough to allow the saw to closely follow the trace of the crack.

###### 1.6.1.3 Sandblasting Equipment

Sandblasting equipment shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening shall not exceed 1/4 inch. The air compressor shall be portable; and shall be capable of furnishing not less than 150 cfm and maintaining a line pressure of not less than 90 psi at the nozzle while in use. Compressor capability under job conditions shall be demonstrated before approval. The

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The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the crack about 1 inch above the pavement surface. The height, angle of inclination and the size of the nozzle shall be adjusted as necessary to secure satisfactory results.

###### 1.6.1.4 Waterblasting Equipment

Waterblasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. The water tank and auxiliary resupply equipment shall be of sufficient capacity to permit continuous operations. The hose, wand, and nozzle shall be capable of cleaning the crack faces and the pavement surface on both sides of the crack for a width of at least 1/2 inch. A pressure gauge mounted at the pump shall show at all times the pressure in kilopascals (psi) pounds per square inch at which the equipment is operating.

###### 1.6.1.5 Hand Tools

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

### 1.6.2 Crack Sealing Equipment

The unit applicators used for heating and installing the hot-poured crack sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the crack to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit design shall allow the sealant to circulate through the delivery hose and return to the inner kettle when not in use.

### 1.7 DELIVERY AND STORAGE

Materials delivered to the job site shall be inspected for defects, unloaded, and stored with a minimum of handling to avoid damage. Storage facilities shall be provided at the job site to protect materials from weather and to maintain them at the temperatures recommended by the manufacturer.

### 1.8 ENVIRONMENTAL CONDITIONS

The ambient air temperature and the pavement temperature within the joint wall shall be a minimum of 50 degrees F and rising at the time of application of the materials. Sealant shall not be applied if moisture is observed in the crack.

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## PART 2 PRODUCTS

### 2.1 SEALANTS

Sealants shall conform to ASTM D 3405 or ASTM D 1190. Usage of sealing materials for sealing cracks in the various paved areas indicated on the drawings shall be as shown in the Task Order.

### 2.2 BACKUP MATERIALS

Backup material shall be a compressible, nonshrinking, nonstaining, nonabsorptive material and shall be nonreactive with the crack sealant. The melting point of the backing material shall be at least 5 degrees F greater than the maximum pouring temperature of the sealant being used, when tested in accordance with ASTM D 789. The material shall have a water absorption of not more than 5 percent by weight when tested in accordance with ASTM C 509. The backup material shall be 25 percent (plus or minus 5 percent) larger in diameter than the nominal width of the crack.

## PART 3 EXECUTION

### 3.1 PREPARATION OF CRACKS

Immediately before the installation of the crack sealant, the cracks shall be thoroughly cleaned to remove oxidized pavement, loose aggregate and foreign debris. The preparation shall be as follows:

#### 3.1.1 Cracks

##### 3.1.1.1 Hairline Cracks

Cracks that are less than 1/8 inch wide do not need to be sealed.

#### 3.1.1.2 Small Cracks

Cracks that are 1/8 to 3/4 inch wide shall be routed to a nominal width 1/8 inch greater than the existing nominal width and to a depth not less than 3/4 inch, waterblasted or wire brushed and cleaned using compressed air.

#### 3.1.1.3 Medium Cracks

Cracks that are 3/4 to 2 inches wide shall be waterblasted or wire brushed and cleaned using compressed air.

#### 3.1.1.4 Large Cracks

Cracks that are greater than 2 inches wide shall be repaired using pothole repair techniques instead of sealing.

#### 3.1.2 Existing Sealant Removal

The in-place sealant shall be cut loose from both crack faces and to a depth shown on the drawings, using a concrete saw or hand tools as specified in paragraph EQUIPMENT. Depth shall be sufficient to accommodate any backup material that is required to maintain the depth of new sealant to be installed. Prior to further cleaning operations, all old loose sealant remaining in the crack opening shall be removed by blowing with compressed air.

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#### 3.1.3 Routing

Routing of the cracks shall be accomplished using a rotary router with a bit that is at least 1/8 inch wider than the nominal width of the crack to remove all residual old sealant (resealing), oxidized pavement and any loose aggregate in the crack wall.

#### 3.1.4 Sawing

Sawing of the cracks shall be accomplished using a power-driving concrete saw as specified in paragraph EQUIPMENT. The blade shall be stiffened as necessary with suitable dummy (or used) blades or washers. Immediately following the sawing operation, the crack opening shall be cleaned using a water jet to remove all saw cuttings and debris.

#### 3.1.5 Sandblasting

The crack faces and the pavement surfaces extending a minimum of 1/2 inch from the crack edges shall be sandblasted clean. A multiple-pass technique shall be used until the surfaces are free of dust, dirt, old sealant residue, or foreign debris that might prevent the sealant material from bonding to the asphalt pavement. After final cleaning and immediately prior to sealing, the cracks shall be blown out with compressed air and left completely free of debris and water. The Contractor shall ensure that sandblasting does not damage the pavement.

#### 3.1.6 Backup Material

Backup material shall be used on all cracks that have a depth greater than 3/4 inch. The backup material shall be inserted into the lower portion of the crack as shown on the drawings. The Contractor shall ensure that the backup material is placed at the specified depth and is not stretched or twisted during installation.

#### 3.1.7 Rate of Progress of Crack Preparation

The stages of crack preparation which include routing, sandblasting of the crack faces, air pressure cleaning and placing of the backup material shall be limited to only that linear footage that can be sealed during the same day.

### 3.2 PREPARATION OF SEALANT

Hot-poured sealants shall not be heated in excess of the safe heating temperature recommended by the manufacturer as shown on the sealant containers. Sealant that has been overheated or subjected to application temperatures for over 4 hours or that has remained in the applicator at the end of the day's operation shall be withdrawn and wasted.

### 3.3 INSTALLATION OF SEALANT

#### 3.3.1 Time of Application

Cracks shall be sealed immediately following final cleaning of the crack walls and following the placement of the backup material (when required). Cracks that cannot be sealed under the conditions specified, or when rain interrupts sealing operations, shall be recleaned and allowed to dry prior to installing the sealant.

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#### 3.3.2 Sealing the Crack

Immediately preceding, but not more than 50 feet ahead of the crack sealing operations, a final cleaning with compressed air shall be performed. The cracks shall be filled from the bottom up to 1/4 inch below the pavement surface. Excess or spilled sealant shall be removed from the pavement by approved methods and shall be discarded. The sealant shall be installed in a manner which prevents the formation of voids and entrapped air. Several passes with the applicator wand may be necessary to obtain the specified sealant depth from the pavement surface. Gravity methods or pouring pots shall not be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Corps QA Field Representative. Cracks shall be checked frequently to ensure that the newly installed sealant is cured to a tack-free condition within 3 hours.

### 3.4 CRACK SEALANT INSTALLATION TEST SECTION

Prior to the cleaning and sealing of the cracks for the entire project, a test section at least 200 feet long shall be prepared using the specified materials and approved equipment, to demonstrate the proposed sealing of all cracks of the project. Following the completion of the test section and before any other crack is sealed, the test section will be inspected to determine that the materials and installation meet the requirements specified. If materials or installation do not meet requirements, the materials shall be removed and the cracks recleaned and resealed at no cost to the Government. When the test section meets the requirements, it may be incorporated into the permanent work and paid for at the contract unit price per linear foot for sealing items scheduled. All other cracks shall be sealed in the manner approved for sealing the test section.

### 3.5 CLEANUP

Upon completion of the project, unused materials shall be removed from the site and the pavement shall be left in a clean condition.

### 3.6 QUALITY CONTROL PROVISIONS

#### 3.6.1 Crack Cleaning

Quality control provisions shall be provided during the crack cleaning process to correct improper equipment and cleaning techniques that damage the bituminous pavement in any manner. Cleaned cracks shall be approved prior to installation of the crack sealant.

#### 3.6.2 Crack Seal Application Equipment

The application equipment shall be inspected to ensure conformance to temperature requirements and proper installation. Evidences of bubbling,

improper installing, and failing to cure or set shall be cause to suspend operations until causes of the deficiencies are determined and corrected.

### 3.6.3 Crack Sealant

The crack sealant shall be inspected for proper cure and set rating, bonding to the bituminous pavement, cohesive separation within the sealant,

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reversion to liquid, and entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the crack, wasted, and replaced as specified herein at no additional cost to the Government.

-- End of Section --

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