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DIVISION 32 - EXTERIOR IMPROVEMENTS  
SECTION 32 17 23  
PAVEMENT MARKINGS  
08/16

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SECTION 32 17 23

PAVEMENT MARKINGS

08/16

**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 the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS  
(AASHTO)

- |              |   |
|--------------|---|
| AASHTO M 247 | (2013) Standard Specification for Glass Beads Used in Pavement Markings   |
| AASHTO M 248 | (1991; R 2012) Standard Specification for Ready-Mixed White and Yellow Traffic Paints                             |
| AASHTO M 249 | (2012; R2016) Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form) |

ASTM INTERNATIONAL (ASTM)

- |                 |  |
|-----------------|--|
| ASTM D471       | (2016a) Standard Test Method for Rubber Property - Effect of Liquids   |
| ASTM D476       | (2015) Dry Pigmentary Titanium Dioxide Pigments  |
| ASTM D522/D522M | (2017) Mandrel Bend Test of Attached Organic Coatings  |
| ASTM D638       | (2014) Standard Test Method for Tensile Properties of Plastics   |
| ASTM D695       | (2010) Standard Test Method for Compressive Properties of Rigid Plastics   |
| ASTM D711       | (2010; R 2015) No-Pick-Up Time of Traffic Paint  |
| ASTM D823       | (2018) Standard Practices for Producing Films of Uniform Thickness of Paint, Coatings, and Related Products on Test Panels                   |
| ASTM D1652      | (2011; E 2012) Standard Test Method for Epoxy Content of Epoxy Resins  |
| ASTM D2074      | (2007; R2013) Standard Test Methods for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method |

ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2621	(1987; R 2016) Standard Test Method for Infrared Identification of Vehicle Solids from Solvent-Reducible Paints
ASTM D2697	(2003; R 2014) Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM D3335	(1985a; R 2020) Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
ASTM D3718	(1985a; R 2015) Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
ASTM D3924	(2016) Standard Specification for Environment for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials
ASTM D3960	(2005; R 2013) Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
ASTM D4060	(2019) Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4061	(2013) Standard Test Method for Retroreflectance of Horizontal Coatings
ASTM D4280	(2012) Extended Life Type, Nonplowable, Raised, Retroreflective Pavement Markers
ASTM D4383	(2012) Standard Specification for Plowable, Raised Retroreflective Pavement Markers
ASTM D4505	(2012; R 2017) Standard Specification for Preformed Retroreflective Pavement Marking Tape for Extended Service Life
ASTM D4541	(2017) Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
ASTM D6628	(2003; R 2015) Standard Specification for Color of Pavement Marking Materials
ASTM D7234	(2012) Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers
ASTM E1347	(2006; R 2020) Standard Test Method for Color and Color Difference Measurement by Tristimulus (Filter) Colorimetry
ASTM E1710	(2011) Standard Test Method for Measurement of Retroreflective Pavement

Marking Materials with CEN-Prescribed  
Geometry Using a Portable  
Retroreflectometer

ASTM E2177 (2011) Standard Test Method for Measuring  
the Coefficient of Retroreflected  
Luminance (RL) of Pavement Markings in a  
Standard Condition of Wetness

ASTM E2302 (2003; R 2016) Standard Test Method for  
Measurement of the Luminance Coefficient  
Under Diffuse Illumination of Pavement  
Marking Materials Using a Portable  
Reflectometer

ASTM G154 (2016) Standard Practice for Operating  
Fluorescent Light Apparatus for UV  
Exposure of Nonmetallic Materials

INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

ICRI 03732 (1997) Selecting and Specifying Concrete  
Surface Preparation for Sealers, Coatings,  
and Polymer Overlays

MASTER PAINTERS INSTITUTE (MPI)

MPI 32 (2012) Traffic Marking Paint, S.B.

MPI 97 (2012) Traffic Marking Paint, Latex

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE AMS-STD-595A (2017) Colors used in Government  
Procurement

U.S. FEDERAL AVIATION ADMINISTRATION (FAA)

FAA AC 150/5370-10 (2018; Rev H; Errata 1 2019) Standard  
Specifications for Construction of Airports

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

MUTCD (2015) Manual on Uniform Traffic Control  
Devices

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS TT-B-1325 (Rev D; Notice 1; Notice 2 2017) Beads  
(Glass Spheres) Retro-Reflective (Metric)

FS TT-P-1952 (2015; Rev F; Notice 1) Paint, Traffic and  
Airfield Markings, Waterborne

1.2 SUBMITTALS.

Government approval is required for submittals with a "G" designation;  
submittals not having a "G" designation are for information only. When  
used, a designation following the "G" designation identifies the government  
officer that will review the submittal for the Government.

SD-03 Product Data

Surface Preparation Equipment List; G, COR

Application Equipment List; G, COR

Exterior Surface Preparation

Safety Data Sheets; G, COR

Reflective media for airfields; G, COR

Reflective media for roads; G, COR

Waterborne Paint; G, COR

Solventborne Paint; G, COR

Thermoplastic compound; G, COR

Raised Pavement Markers Primers and Adhesives; G, COR

SD-06 Test Reports

Reflective Media for Airfields; G, COR

Reflective Media for Roads; G, COR

Waterborne Paint; G, COR

Solventborne Paint; G, COR

Thermoplastic Compound; G, COR

Raised Pavement Markers Primers and Adhesives; G, COR

Test Reports

SD-07 Certificates

Qualifications; G, COR

Reflective Media for Airfields

Reflective Media for Roads

Waterborne Paint

Solventborne Paint

Volatile Organic Compound, (VOC); G, COR

Thermoplastic Compound

SD-08 Manufacturer's Instructions

Waterborne Paint; G, COR

Solventborne Paint; G, COR

Thermoplastic Compound; G, COR

1.3 QUALITY ASSURANCE.

1.3.1 Regulatory Requirements

Submit certificate stating that the proposed pavement marking paint meets the Volatile Organic Compound, (VOC) regulations of the local Air Pollution Control District having jurisdiction over the geographical area in which the project is located. Submit Safety Data Sheets for each product.

1.3.2 Qualifications

Submit documentation certifying that pertinent personnel are qualified for equipment operation and handling of applicable chemicals. The documentation should include experience on five projects of similar size and scope with references for all personnel.

1.3.3 Qualifications For Airfield Marking Personnel

Submit documentation of qualifications in resume format a minimum of 14 days before pavement marking work is to be performed showing personnel who will be performing the work have experience working on airfields, operating mobile self-powered marking, cleaning, and paint removal equipment and performing these tasks. Include with resume a list of references complete with points of contact and telephone numbers.

1.4 DELIVERY AND STORAGE.

Deliver paint materials, thermoplastic compound materials, and reflective media in original sealed containers that plainly show the designated name, specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer.

Provide storage facilities at the job site, only in areas approved by the Contracting Officer, for maintaining materials at temperatures recommended by the manufacturer.

1.5 PROJECT/SITE CONDITIONS.

1.5.1 Environmental Requirements

1.5.1.1 Weather Limitations for Application

Apply pavement markings to clean, dry surfaces, and unless otherwise approved, only when the air and pavement surface temperature is at least 5 degrees F above the dew point and the air and pavement temperatures are within the limits recommended by the pavement marking manufacturer. Allow pavement surfaces to dry after water has been used for cleaning or rainfall has occurred prior to striping or marking. Test the pavement surface for moisture before beginning work each day and after cleaning. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer. Employ the "plastic wrap method" to test the pavement for moisture as specified in paragraph TESTING FOR MOISTURE.

1.5.1.2 Weather Limitations for Removal of Pavement Markings on Roads and Automotive Parking Areas

Pavement surface must be free of snow, ice, or slush; with a surface

temperature of at least 40 degrees F and rising at the beginning of operations, except those involving shot or sand blasting or grinding. Cease operation during thunderstorms, or during rainfall, except for waterblasting and removal of previously applied chemicals. Cease waterblasting where surface water accumulation alters the effectiveness of material removal.

#### 1.5.2 Traffic Controls

Place warning signs conforming to MUTCD near the beginning of the worksite and well ahead of the worksite for alerting approaching traffic from both directions. Place small markers 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. Mark painting equipment with large warning signs indicating slow-moving painting equipment in operation.

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

#### 1.5.3 Airfield Traffic Control

Coordinate performance of all work in the controlled zones of the airfield with the Contracting Officer and with the Flight Operations Officer or Airfield Manager. Neither equipment nor personnel can use any portion of the airfield without permission of these officers unless the runway is closed. Runways will be closed as shown in scope of work.

#### 1.5.4 Airfield Radio Communication

No personnel or equipment will be allowed in the controlled zones of the airfield until radio contact has been made with the control tower and permission is granted by the control tower. Maintain contact with the control tower at all times during work in vicinity of the airfield. Notify the control tower when work is completed and all personnel, equipment and materials have been removed from all aircraft operating surfaces.

#### 1.5.5 Airfield Emergency Landing and Takeoff

Emergencies take precedence over all operations. Upon notification from the control tower of an emergency landing or imminent takeoff, stop all operations immediately and evacuate all personnel and equipment to an area not utilized for aircraft traffic which is at least 250 feet measured perpendicular to and away from the near edge of the runway unless otherwise authorized by the Contracting Officer. Equipment and chemicals or detergents as well as excess water must be able to be removed from the work area within 3 minutes.

#### 1.5.6 Lighting

When night operations are necessary, provide all necessary lighting and equipment. Direct or shade lighting to prevent interference with aircraft, the air traffic control tower, and other base operations. Provide lighting and related equipment capable of being removed from the runway within 15 minutes of notification of an emergency. Night work must be coordinated with the Flight Operations Manager or Airfield Manager and approved in advance by the Contracting Officer. The Government reserves the right to accept or reject night work on the day following night activities by the Contractor.

## **PART 2 PRODUCTS.**

### 2.1 EQUIPMENT.

#### 2.1.1 Surface Preparation and Paint Removal

##### 2.1.1.1 Surface Preparation and Paint Removal Equipment for Airfield Pavements

Prepare all airfield surfaces and remove paint from airfield surfaces..

##### 2.1.1.2 Surface Preparation Equipment for Roads and Automotive Parking Areas

Submit a surface preparation equipment list by serial number, type, model, and manufacturer. Include descriptive data indicating area of coverage per pass, pressure adjustment range, tank and flow capacities, and safety precautions required for the equipment operation. Mobile equipment must allow for removal of markings without damaging the pavement surface or joint sealant. Maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition.

###### 2.1.1.2.1 Sandblasting Equipment

Use mobile sandblasting equipment capable of producing a pressurized stream of sand and air that effectively removes paint from the surface without filling voids with debris in asphalt or tar pavements or removing joint sealants in Portland cement concrete pavements. Include with the equipment and air compressor, hoses, and nozzles of adequate size and capacity for removing paint. Equip the compressor with traps and coalescing filters that maintain the compressed air free of oil and water.

###### 2.1.1.2.2 Waterblasting Equipment

Use mobile waterblasting equipment capable of producing a pressurized stream of water that effectively removes paint from the pavement surface without significantly damaging the pavement. Provide equipment, tools, and machinery which are safe and in good working order at all times.

###### 2.1.1.2.3 Shotblasting Equipment

Use mobile self propelled shotblasting equipment capable of producing an adjustable depth of paint removal and of propelling abrasive particles at high velocities on the paint for effective removal. Ensure each unit is self cleaning and self contained. Use equipment able to confine the abrasive, any dust that is produced, and removed paint and is capable of recycling the abrasive for reuse.

###### 2.1.1.2.4 Grinding or Scarifying Equipment

Use equipment capable of removing surface contaminants, paint build-up, or extraneous markings from the pavement surface without leaving any residue. Clean the surface by hydro blast to remove surface contaminants and ash after a weed torch is used to remove paint.

###### 2.1.1.2.5 Chemical Removal Equipment

Use chemical equipment capable of applying and removing chemicals and paint from the pavement surface, leaving only non-toxic biodegradable



residue without scarring or other damage to the pavement or joints and joint seals.

## 2.1.2 Application Equipment

Submit application equipment list appropriate for the material(s) to be used. Include manufacturer's descriptive data and certification for the planned use that indicates area of coverage per pass, pressure adjustment range, tank and flow capacities, and all safety precautions required for operating and maintaining the equipment. Provide and maintain machines, tools, and equipment used in the performance of the work in satisfactory operating condition, or remove them from the work site. Provide mobile and maneuverable application equipment to the extent that straight lines can be followed and normal curves can be made in a true arc.

### 2.1.2.1 Paint Application Equipment

#### 2.1.2.1.1 Hand-Operated, Push-Type Machines

Provide hand-operated push-type applicator machine of a type commonly used for application of water based paint or two-component, chemically curing paint, thermoplastic, or preformed tape, to pavement surfaces for small marking projects, such as legends and cross-walks, automotive parking areas, or surface painted signs. Provide applicator machine equipped with the necessary tanks and spraying nozzles capable of applying paint uniformly at coverage specified. Hand operated spray guns may be used in areas where push-type machines cannot be used.

#### 2.1.2.1.2 Self-Propelled or Mobile-Drawn Spraying Machines

Provide self-propelled or mobile-drawn spraying machine with suitable arrangements of atomizing nozzles and controls to obtain the specified results. Provide machine having a speed during application capable of applying the stripe widths indicated at the paint coverage rate specified herein and of even uniform thickness with clear-cut edges.

##### 2.1.2.1.2.1 Road Marking

Provide equipment used for marking roads capable of placing the prescribed number of lines at a single pass as solid lines, intermittent lines, or a combination of solid and intermittent lines using a maximum of three different colors of paint as specified.

##### 2.1.2.1.2.2 Airfield Marking

Provide self-propelled or mobile-drawn spraying machine for applying the paint for airfield pavements with an arrangement of atomizing nozzles capable of applying the specified line width in a single pass. Provide paint applicator with paint reservoirs or tanks of sufficient capacity and suitable gages to apply paint in accordance with requirements specified. Equip tanks with suitable mechanical agitators. Equip spray mechanism with quick-action valves conveniently located, and include necessary pressure regulators and gages in full view and reach of the operator. Install paint strainers in paint supply lines to ensure freedom from residue and foreign matter that may cause malfunction of the spray guns. The paint applicator must be readily adaptable for attachment of a dispenser for the reflective media approved for use.

##### 2.1.2.1.2.3 Hand Application

Provide spray guns for hand application of paint in areas where the mobile

paint applicator cannot be used.

#### 2.1.2.2 Thermoplastic Application Equipment

##### 2.1.2.2.1 Thermoplastic Material

Apply thermoplastic material with equipment that is capable of providing continuous uniformity in the dimensions and reflectorization of the marking.

##### 2.1.2.2.2 Application Equipment

- a. Provide application equipment capable of continuous mixing and agitation of the material, with conveying parts which prevent accumulation and clogging between the main material reservoir and the extrusion shoe or spray gun. All parts of the equipment which come into contact with the material must be easily accessible and exposed for cleaning and maintenance.  
All mixing and conveying parts up to and including the extrusion shoes and spray guns must maintain the material at the required temperature with heat-transfer oil or electrical-element-controlled heat.
- b. Provide application equipment constructed to ensure continuous uniformity in the dimensions of the stripe. Provide an applicator with a means for cleanly cutting off stripe ends squarely and providing a method of applying "skiplines." Provide equipment capable of applying varying widths of traffic markings.
- c. Provide mobile and maneuverable application equipment allowing straight lines to be followed and normal curves to be made in a true arc. Provide equipment used for the placement of thermoplastic pavement markings of two general types: mobile applicator and portable applicator.
- d. Equip the applicator with a pressurized or drop-on type bead dispenser capable of uniformly dispensing reflective glass spheres at controlled rates of flow. The bead dispenser must operate automatically to begin flow prior to the flow of binder to assure that the strip is fully reflectorized.

##### 2.1.2.2.3 Mobile Application Equipment

Provide a truck-mounted, self-contained pavement marking machine that is capable of hot applying thermoplastic by either the extrusion or spray method.

- a. Equip the unit to apply the thermoplastic marking material at temperatures according to the manufacturer's instructions, at widths varying from 3 to 12 inches, with an automatic pressurized or drop-on bead dispensing system, capable of operating continuously, and of installing a minimum of 20,000 lineal feet of longitudinal markings in an 8-hour day.
- b. Equip the mobile unit with a melting kettle which holds a minimum of 6000 pounds of molten thermoplastic material; capable of heating the thermoplastic composition to temperatures as recommended by the manufacturer. Use a thermostatically controlled heat transfer liquid. Heating of the composition by direct flame is not allowed. Oil and material temperature gauges must be visible at both ends of the kettle.

- c. Equip mobile units for application of extruded markings with a minimum of two extrusion shoes; located one on each side of the truck, capable of marking simultaneous edge line and centerline stripes; each being a closed, oil-jacketed unit; holding the molten thermoplastic at a temperature as recommended by the manufacturer; and capable of extruding a line of 3 to 8 inches in width; and at a thickness of not less than 0.120 inch nor more than 0.190 inch, of generally uniform cross section.
- d. Equip mobile units for application of spray markings with a spray gun system capable of marking simultaneous edgeline and centerline stripes. Surround (jacket) the spray system with heating oil to maintain the molten thermoplastic at a temperature of 375 to 425 degrees F, capable of spraying a stripe of 3 to 12 inches in width, and in thicknesses varying from 0.060 inch to 0.098 inch, of generally uniform cross section.
- e. Equip the mobile unit with an electronic programmable line pattern control system, 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, equip the mobile unit with an automatic counting mechanism capable of recording the number of lineal feet of thermoplastic markings applied to the pavement surface with an accuracy of 0.5 percent.

#### 2.1.2.2.4 Portable Application Equipment

Provide portable hand-operated equipment, specifically designed for placing special markings such as crosswalks, stop bars, legends, arrows, and short lengths of lane, edge and centerlines; and capable of applying thermoplastic pavement markings by the extrusion method. Equip the portable applicator with all the necessary components, including a materials storage reservoir, bead dispenser, extrusion shoe, and heating accessories, capable of holding the molten thermoplastic at the temperature recommended by the manufacturer, and of extruding a line of 3 to 12 inches in width, and in thickness of not less than 0.120 inch nor more than 0.190 inch and of generally uniform cross section.

#### 2.1.2.3 Reflective Media Dispenser

Attach the dispenser for applying the reflective media to the thermoplastic dispenser and designed to operate automatically and simultaneously with the applicator through the same control mechanism. The bead applicator must 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.

#### 2.1.2.4 Preformed Tape Application Equipment

Provide and use mechanical application equipment for the placement of preformed marking tape which is a mobile pavement marking machine specifically designed for use in applying pressure-sensitive pavement marking tape of varying widths. Equip the applicator with rollers, or other suitable compaction device to provide initial adhesion of the material with the pavement surface. Use additional tools and devices as needed to properly seat the applied material as recommended by the manufacturer.

## 2.2 MATERIALS.

Use waterborne or methacrylate paint for airfield markings. Use thermoplastic for roads. Use non-reflectorized waterborne or solventborne paint for automotive parking areas. The maximum allowable VOC content of pavement markings is 150 grams per liter. Color of markings are indicated on the drawings and must conform to ASTM D6628 for roads and automotive parking areas and SAE AMS-STD-595A for airfields. Provide materials conforming to the requirements specified herein.

#### 2.2.1 Waterborne Paint

FS TT-P-1952, Type I or II.

#### 2.2.2 Solventborne Paint

AASHTO M 248.

#### 2.2.3 Methacrylate Paint

Formulate methacrylate paint to meet the requirements of FAA AC 150/5370-10, Item P-620.2, Methacrylate.

#### 2.2.4 Thermoplastic Compound

##### 2.2.4.1 Composition Requirements

Thermoplastic compound must conform to AASHTO M 249. Formulate the binder component as an alkyd resin.

##### 2.2.4.2 Primer

- a. Asphalt concrete primer: A primer is not required for thermoplastic placed on new asphalt pavement. Provide thermosetting adhesive primer with a solids content of pigment reinforced synthetic rubber and synthetic plastic resin dissolved or dispersed in a volatile organic solvent for asphaltic concrete pavements. The solids content must not be less than 10 percent by weight at 70 degrees F and 60 percent relative humidity. A wet film thickness of 0.005 inch, plus or minus 0.001 inch, must dry to a tack-free condition in less than 5 minutes.
- b. Portland cement concrete primer: A primer is not required for thermoplastic placed on new asphalt pavement. Provide an epoxy resin primer for Portland cement concrete pavements, of the type recommended by the manufacturer of the thermoplastic composition.

#### 2.2.5 Preformed Tape

Provide adherent reflectorized strip preformed tape in accordance with ASTM D4505 Retroreflectivity Level II, Class 1, 2 or 3, Skid Resistance Level B.

#### 2.2.6 Raised Pavement Markers Primers and Adhesives

Use either metallic or nonmetallic markers of the button or prismatic

reflector type. Provide permanent color markers as specified for pavement marking, which retain the color and brightness under the action of traffic. Provide button markers with a diameter of not less than 4 inches, spaced not more than 40 feet apart on solid longitudinal lines. Provide button markers with rounded surfaces presenting a smooth contour to traffic and not projecting more than 19 mm 3/4 inch above level of pavement. Provide plowable pavement markers and adhesive epoxy conforming to ASTM D4280 or ASTM D4383.

#### 2.2.7 Reflective Media

##### 2.2.7.1 Reflective Media for Airfields

Reflective Media for Airfields. FS TT-B-1325, Type I, Gradation A.

##### 2.2.7.2 Reflective Media for Roads

Reflective Media for Roads. FS TT-B-1325 Type I, Gradation A or AASHTO M 247 Type 1.

### **PART 3 EXECUTION.**

#### 3.1 EXAMINATION.

##### 3.1.1 Testing for Moisture

Test the pavement surface for moisture before beginning pavement marking after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point. Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Contracting Officer or authorized representative. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 12 inch by 12 inch section of clear plastic wrap and seal the edges with tape. After 15 minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap. Re-test surfaces when work has been stopped due to rain.

##### 3.1.2 Test Stripe Demonstration

Prior to paint application, demonstrate test stripe application within the work area using the proposed materials and equipment. Apply separate test stripes in each of the line widths and configurations required herein using the proposed equipment. Make the test stripes long enough to determine the proper speed and operating pressures for the vehicle(s) and machinery, but not less than 50 feet long.

##### 3.1.3 Application Rate Demonstration

During the Test Stripe Demonstration, demonstrate compliance with the application rates specified herein. Document the equipment speed and operating pressures required to meet the specified rates in each configuration of the equipment and provide a copy of the documentation to the Contracting Officer prior to proceeding with the work.

##### 3.1.4 Retroreflective Value Demonstration

After the test stripes have cured to a "no-track" condition, demonstrate

compliance with the average retroreflective values specified herein. Take a minimum of ten readings on each test stripe with a Retroreflectometer with a direct readout in millicandelas per square meter per lux (mcd/m<sup>2</sup>/lx). Perform testing in accordance with ASTM D4061, ASTM E1710, ASTM E2177, and ASTM E2302.

### 3.1.5 Level of Performance Demonstration

The Contracting Officer will be present at the application demonstrations to observe the results obtained and to validate the operating parameters of the vehicle(s) and equipment. If accepted by the Contracting Officer, the test stripe is the measure of performance required for this project. Do not proceed with the work until the demonstration results are satisfactory to the Contracting Officer.

## 3.2 EXTERIOR SURFACE PREPARATION.

Allow new pavement surfaces to cure for a period of not less than 30 days before application of marking materials. Thoroughly clean surfaces to be marked before application of the paint. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods as required. Remove residual curing compounds and other coatings adhering to the pavement.

- a. For Portland Cement Concrete pavement, grinding, light shot blasting, or light scarification, to a resulting profile equal to ICRI 03732 CSP 2, CSP 3, and CSP 4, respectively, can be used in addition to water blasting on most pavements, to either remove existing coatings, or for surface preparation.
- b. Do not use shot blasting on airfield pavements due to the potential of Foreign Object Damage (FOD) to aircraft. Scrub affected areas, where oil or grease is present on old pavements to be marked, with several applications of trisodium phosphate solution or other approved detergent or degreaser and rinse thoroughly after each application. After cleaning oil-soaked areas, seal with shellac or primer recommended by the manufacturer to prevent bleeding through the new paint. Do not commence painting in any area until pavement surfaces are dry and clean.

### 3.2.1 Early Painting of Rigid Pavements

Pretreat rigid pavements that require early painting with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride. Apply the solution to the areas to be marked.

### 3.2.2 Early Painting of Asphalt Pavements

For asphalt pavement systems requiring painting application at less than 30 days, apply the paint and beads at half the normal application rate, followed by a second application at the normal rate after 30 days.

## 3.3 APPLICATION.

Apply pavement markings to dry pavements only.

### 3.3.1 Paint

Apply paint with approved equipment at rate of coverage specified herein. Provide guidelines and templates as necessary to control paint

application. Take special precautions in marking numbers, letters, and symbols. Manually paint numbers, letters, and symbols. Sharply outline all edges of markings. 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 deficiency in drying of the markings, painting operations must cease until the cause of the slow drying is determined and corrected.

### 3.3.1.1 Waterborne Paint

#### 3.3.1.1.1 Airfields

For non-reflectorized markings, apply paint conforming to FS TT-P-1952 Type I or II at a rate of 3.0 plus or minus 0.15 square meter per liter 121 plus or minus 6 square feet per gallon.

For reflectorized markings, apply FS TT-B-1325 beads at a rate of 834 plus or minus 60 grams of glass spheres per liter 7 plus or minus 0.5 pounds of glass spheres per gallon.

#### 3.3.1.1.2 Roads

Apply paint at a rate of 105 plus or minus 5 square feet per gallon. Apply FS TT-B-1325 Type I (Gradation A) beads at a rate of 7 plus or minus 0.5 pounds of glass spheres per gallon.

### 3.3.1.2 Solventborne Paint

Apply paint at a minimum wet film thickness of 15 mils. Apply FS TT-B-1325 Type I (Gradation A) beads at a minimum rate of 6 pounds of glass spheres per gallon.

### 3.3.1.3 Methacrylate Paint

Apply paint evenly to the pavement surface at a maximum rate of 45 square feet per gallon. Apply glass spheres conforming to FS TT-B-1325 uniformly to the wet paint on airfield pavement. Use either Type I (Gradation A), Type III, or Type IV (Gradation A or B) beads. Apply Type I (Gradation A) beads at a minimum rate of 15 pounds of glass spheres per gallon. Apply Type III beads at a minimum rate of 20 pounds of glass spheres per gallon. Apply Type IV (Gradation A or B) beads at a minimum rate of 16 pounds of glass spheres per gallon.

### 3.3.2 Thermoplastic Compound

Place thermoplastic pavement markings, free from dirt or tint, upon dry pavement. The temperature must be a minimum of 40 degrees F and rising at the time of installation. Apply all centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator. Place all special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable applicator, using the extrusion method.

#### 3.3.2.1 Primer

After surface preparation has been completed, prime the asphalt or concrete pavement surface with spray equipment. Allow primer materials to "set-up" prior to applying the thermoplastic composition. Allow the Portland cement concrete primer to dry in accordance with the thermoplastic manufacturer recommendations. After the primer has "set-up", apply the thermoplastic at temperatures no lower than 375 degrees F nor higher than 425 degrees F at the point of deposition. Apply all extruded thermoplastic markings at the specified width and at a thickness of not less than 0.125 inch nor more than 0.190 inch. Apply all sprayed thermoplastic markings at the specified width and the thickness designated in the contract plans. If the plans do not specify a thickness, apply centerline markings at a wet thickness of 0.090 inch, plus or minus 0.005 inch, and edgeline markings at a wet thickness of 0.060 inch, plus or minus 0.005 inch.

#### 3.3.2.2 Reflective Media

Immediately after installation of the thermoplastic material, mechanically apply drop-on reflective glass spheres conforming to FS TT-B-1325 Type I (Gradation A) or AASHTO M 247 Type 1 at the rate of one pound per 20 square feet such that the spheres are held by and imbedded in the surface of the molten material. Accomplish drop-on application of the glass spheres to ensure even distribution at the specified rate of coverage. If there is a malfunction of either thermoplastic applicator or reflective media dispenser, discontinue operations until deficiency is corrected.

#### 3.3.3 Raised Pavement Markers

Align prefabricated markers carefully at the spacing indicated on the drawings and permanently fix in place by means of epoxy adhesives. To ensure good bond prior to applying adhesive, thoroughly clean all areas where markers are to be set by water blasting and use of compressed air.

#### 3.3.4 Preformed Tape

The pavement surface and ambient air temperature must be a minimum of 60 degrees F and rising. Place the preformed markings in accordance with the manufacturer's written instructions.

#### 3.3.5 Cleanup and Waste Disposal

Keep the worksite clean and free of debris and waste from the removal and application operations. Immediately cleanup following removal operations in areas subject to aircraft traffic. Dispose of debris at approved sites.

### 3.4 FIELD QUALITY CONTROL.

#### 3.4.1 Material Inspection

Examine material at the job site to determine that it is the material referenced in the report of test results or certificate of compliance. Provide test results substantiating conformance to the specified requirements with each certificate of compliance.

#### 3.4.2 Dimensional Tolerances

Apply all markings in the standard dimensions provide in the drawings. New markings may deviate a maximum of 10 percent larger than the standard dimension. The maximum deviation allowed when painting over an old marking is up to 20 percent larger than the standard dimensions.



#### 3.4.3 Bond Failure Verification

Inspect newly applied markings for signs of bond failure based on visual inspection and comparison to results from Test Stripe Demonstration paragraph.

#### 3.4.4 Reflective Media and Coating Application Verification

Use a wet film thickness gauge to measure the application of wet paint. Use a microscope or magnifying glass to evaluate the embedment of glass beads in the paint. Verify the glass bead embedment with approximately 50 percent of the individual bead spheres embedded and 50 percent of the individual bead spheres exposed.

#### 3.4.5 Retroreflective Markings

Collect and record readings for white and yellow retroreflective markings at the rate of one reading per 1000 linear feet. The minimum acceptable average for white markings is 200 millicandelas per square meter per lux (mcd/m<sup>2</sup>/lx) (measured with Retroreflectometer). The minimum acceptable average for yellow markings is 175 millicandelas per square meter per lux (mcd/m<sup>2</sup>/lx). Compute readings by averaging a minimum of 10 readings taken within the area at random locations. Re-mark areas not meeting the retroreflective requirements stated above.

#### 3.4.6 Material Bond Verification and Operations Area Cleanup for Airfields

Vacuum sweep the aircraft operating area before it is opened for aircraft operations to preclude potential foreign object damaged to aircraft engines. Visually inspect the pavement markings and the material captured by the vacuum. Verify that no significant loss of reflective media has occurred to the pavement marking due to the vacuum cleaning.

-- End of Section --