

Item P-620 Runway and Taxiway Marking

DESCRIPTION

620-1.1 This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the Resident Project Representative (RPR). The terms “paint” and “marking material” as well as “painting” and “application of markings” are interchangeable throughout this specification.

MATERIALS

620-2.1 Materials acceptance. The Contractor shall furnish manufacturer’s certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer’s surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the Resident Project Representative (RPR) prior to the initial application of markings. The reports can be used for material acceptance or the RPR may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the RPR upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the RPR.

620-2.2 Marking materials.

Table 1. Marking Materials

Paint ¹				Glass Beads ²	
Type	Color	Fed Std. 595 Number	Application Rate Maximum	Type	Application Rate Minimum
*	*	*	*	*	*
*	*	*	*	*	*

¹ See paragraph 620-2.2a

² See paragraph 620-2.2b

Make the appropriate selections for paint type, color, Fed Std 595 number, application rates, and glass bead type and application rates and inserted into Table 1. Asterisks denote insert points.

a. Paint. Paint shall be [waterborne] [epoxy] [methacrylate] [solvent-base] [and] [preformed thermoplastic] in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595. [___]

The Engineer must specify paint type (s), colors and glass beads to be used for the project and populate that information above in Table 1. When more than one paint type is specified, the plans should clearly indicate paint type, paint color and bead type required for each marking.

Select type of paint.

Types: Waterborne, Epoxy, Methacrylate, solvent-base, or preformed Thermoplastic

For waterborne or solvent based paints, specify Type I, II, or III:

- Type I intended for locations where slower tracking is not a problem.
- Type II intended for locations where faster curing is desirable.
- Type III intended for locations that require a thicker, more durable coating.

1. Select paint color(s) from the following Table:

Paint Color	Fed Std. No 595 Color Number
White	37925
Red	31136
Yellow	33538 or 33655
Black	37038
Pink	1 part 31136 to 2 parts 37925
Green	34108

Waterborne or solvent base black paint should be used to outline a border at least 6 inches (150 mm) wide around markings on all light-colored pavements. Preformed thermoplastic markings shall have a non-reflectorized black border integral to the marking.

Select appropriate application rates for type of paint and bead selected:**Application Rates for Paint and Glass Beads for Table 1**

Paint		Glass Beads		
Type	Application Rate Maximum	Type I, Gradation A ¹ Minimum	Type III Minimum	Type IV ¹ Minimum
Waterborne Type I or II	115 ft ² /gal (2.8 m ² /l)	7 lb/gal (0.85 kg/l)	10 lb/gal (1.2 kg/l)	--
Waterborne Type III	90 ft ² /gal (2.2 m ² /l)	7 lb/gal (0.85 kg/l)	8 lb/gal (1.0 kg/l)	
Waterborne Type III	55 ft ² /gal (1.4 m ² /l)		6 lb/gal (.8 kg/l)	5 lb/gal (.7 kg/l)
Solvent Base	115 ft ² /gal (2.8 m ² /l)	7 lb/gal (0.85 kg/l)	10 lb/gal (1.2 kg/l)	--
Solvent Base	55 ft ² /gal (2.2 m ² /l)	--	--	5 lb/gal (.7 kg/l)
Epoxy	90 ft ² /gal (2.2 m ² /l)	15 lb/gal (1.8 kg/l)	20 lb/gal (2.4 kg/l)	16 lb/gal (1.9 kg/l)
Methacrylate	45 ft ² /gal (1.1 m ² /l)	15 lb/gal (1.8 kg/l)	20 lb/gal (2.4 kg/l)	16 lb/gal (1.9 kg/l)
Methacrylate Splatter-Profile	24ft ² /gal. (0.6 m ² /l)	8 lb/gal. (0.1 kg/l)	10 lb/gal. (1.2 kg/l)	10 lb/gal (1.2 kg/l)
Temporary Marking Waterborne Type I or II	230 ft ² /gal (5.6 m ² /l)	No beads	No beads	No beads

¹Glass bead application rate for Red and Pink paint shall be reduced by 2 lb/gal (0.24 kg/l) for Type I and Type IV beads.

The Engineer shall specify the time period in paragraph 620-3.5 in order to allow adequate curing of the pavement surface. The Engineer should contact the paint manufacturer to determine the wait period. A 24- to 30-day waiting period is recommended for all types of paint used for pavement marking. The final application should occur after the waiting period has passed. The final marking application must be at a rate equal to 100% of the full application rate with glass beads.

Markings may be required before paving operations are complete. The Engineer may wish to specify waterborne or solvent-based materials for temporary markings at 30% to 50% of the specified application rates. Glass beads will not adhere well at the low application rates for temporary markings.

CAUTION: Prior to reopening pavements at Part 139 airports verify that all markings comply with Part 139 requirements. Temporary markings not in compliance with AC 150/5340-1 will require a NOTAM regarding any non-standard marking be issued. For example, temporary markings without beads.

When painting Porous Friction Course, the paint should be applied to the pavement in two coats from opposite directions. The first coat should be applied at a rate equal to 50% of the full application rate with no glass beads. The second coat should be applied from the opposite direction at a rate equal to 100% of the full application rate with glass beads.

Preformed thermoplastic pavement markings shall yield at least 225 mcd/m²/lux on white markings at installation and at least 100 mcd/m²/lux on yellow markings at installation.

Retroreflectivity shall be measured by a portable retroreflectometer according to ASTM E1710 and the practices in ASTM D7585 shall be followed for taking retroreflectivity readings with a portable retroreflectometer and computing measurement averages. A vehicle-mounted retroreflectometer may also be used.

[**Waterborne.** Paint shall meet the requirements of Federal Specification TT-P-1952F, [Type I] [Type II] [Type III]. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis. [The acrylic resin used for Type III shall be 100% cross linking acrylic as evidenced by infrared peaks at wavelengths 1568, 1624, and 1672 cm⁻¹ with intensities equal to those produced by an acrylic resin known to be 100% cross linking.]

[**Epoxy.** Paint shall be a two component, minimum 99% solids type system conforming to the following:

(1) **Pigments.** Component A. Percent by weight.

(a) **White:**

- Titanium Dioxide, ASTM D476, type II shall be 18% minimum (16.5% minimum at 100% purity).

(b) **Yellow and Colors:**

- Titanium Dioxide, ASTM D476, type II shall be 14 to 17%.
- Epoxy resin shall be 75 to 79%.
- Organic yellow, other colors, and tinting as required to meet color standard.

(2) **Epoxy content.** Component A. The weight per epoxy equivalent, when tested in accordance with ASTM D1652 shall be the manufacturer's target ±50.

(3) **Amine number.** Component B. When tested in accordance with ASTM D2074 shall be the manufacturer's target ±50.

(4) **Prohibited materials.** The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium,

halogenated solvents, nor any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

(5) Daylight directional reflectance.

(a) White: The daylight directional reflectance of the white paint shall not be less than 75% (relative to magnesium oxide), when tested in accordance with ASTM E2302.

(b) Yellow: The daylight directional reflectance of the yellow paint shall not be less than 55% (relative to magnesium oxide), when tested in accordance with ASTM E2302. The x and y values shall be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:

x	.462	x	.470	x	.479	x	.501
y	.438	y	.455	y	.428	y	.452

(6) Accelerated weathering.

(a) Sample preparation. Apply the paint at a wet film thickness of 0.013-inch (0.33 mm) to four 3 × 6-inch (8 × 15 cm) aluminum panels prepared as described in ASTM E2302. Air dry the sample 48 hours under standard conditions.

(b) Testing conditions. Test in accordance with ASTM G154 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating four (4) hour UV exposure at 140°F (60°C), and four (4) hours condensate exposure at 104°F (40°C).

(c) Evaluation. Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 5 above. Evaluate for conformance with the color requirements.

(7) Volatile organic content. Determine the volatile organic content in accordance with 40 CFR Part 60 Appendix A, Method 24.

(8) Dry opacity. Use ASTM E2302. The wet film thickness shall be 0.015 inch (0.38 mm). The minimum opacity for white and colors shall be 0.92.

(9) Abrasion resistance. Subject the panels prepared in paragraph 620-2.2b(6) to the abrasion test in accordance with ASTM D968, Method A, except that the inside diameter of the metal guide tube shall be from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters (17.5 lb (7.94 kg)) of unused sand shall be used for each test panel. The test shall be run on two test panels Both baked and weathered paint films shall require not less than 150 liters (525 lbs (239 kg)) of sand for the removal of the paint films.

(10) Hardness, shore. Hardness shall be at least 80 when tested in accordance with ASTM D2240.]

[**Methacrylate.** Paint shall be a two component, minimum 99% solids-type system conforming to the following:

(1) Pigments. Component A. Percent by weight.**(a) White:**

- Titanium Dioxide, ASTM D476, type II shall be 10% minimum.
- Methacrylate resin shall be 18% minimum.

(b) Yellow and Colors:

- Titanium Dioxide, ASTM D476, type II shall be 1% minimum. Organic yellow, other colors, and tinting as required to meet color standard.
- Methacrylate resin shall be 18% minimum.

(2) Prohibited materials. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

(3) Daylight directional reflectance:

(a) White: The daylight directional reflectance of the white paint shall not be less than 80% (relative to magnesium oxide), when tested in accordance with ASTM E2302.

(b) Yellow: The daylight directional reflectance of the yellow paint shall not be less than 55% (relative to magnesium oxide), when tested in accordance with ASTM E2302. The x and y values shall be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:

x	.462	x	.470	x	.479	x	.501
y	.438	y	.455	y	.428	y	.452

(4) Accelerated weathering.

(a) Sample preparation. Apply the paint at a wet film thickness of 0.013-inch (0.33 mm) to four 3 × 6-inch (8 × 15 cm) aluminum panels prepared as described in ASTM E2302. Air dry the sample 48 hours under standard conditions.

(b) Testing conditions. Test in accordance with ASTM G154 using both Ultra Violet (UV-B) Light and condensate exposure, 72 hours total, alternating four (4) hour UV exposure at 140°F (60°C), and four (4) hours condensate exposure at 104°F (40°C).

(c) Evaluation. Remove the samples and condition for 24 hours under standard conditions. Determine the directional reflectance and color match using the procedures in paragraph 3 above. Evaluate for conformance with the color requirements.

(5) Volatile organic content. Determine the volatile organic content in accordance with 40 CFR Part 60 Appendix A, Method 24.

(6) Dry opacity. Use ASTM E2302. The wet film thickness shall be 0.015 inch (0.38 mm). The minimum opacity for white and colors shall be 0.92.

(7) Abrasion resistance. Subject the panels prepared in paragraph 620-2.2c(4) to the abrasion test in accordance with ASTM D968, Method A, except that the inside diameter of the metal guide tube shall be from 0.747 to 0.750 inch (18.97 to 19.05 mm). Five liters (17.5 lb (7.94 kg)) of unused sand shall be used for each test panel. The test shall be run on two test panels Both baked and weathered paint films shall require not less than 150 liters (525 lbs (239 kg)) of sand for the removal of the paint films.

(8) Hardness, shore. Hardness shall be at least 60 when tested in accordance with ASTM D2240.

(9) Additional requirements for methacrylate splatter profiled pavement marking. Pavement markings of this type shall comply with all above requirements for methacrylate paint, except as noted below:

(a) The thickness of the marking will be irregular ranging from 0.000 to 0.250 inches (0.00 to 6.4 mm), applied in a splatter pattern which comprises a minimum of 80% of the visible line (when traveling at 5 mph the line appears to be solid.).

(b) The hardness shall be 48 Shore D minimum.]

[**Solvent-Base.** Paint shall meet the requirements of Commercial Item Description [A-A-2886B Type I, Type II, and Type III].]

[**Preformed Thermoplastic Airport Pavement Markings.** Markings must be composed of ester modified resins in conjunction with aggregates, pigments, and binders that have been factory produced as a finished product. The material must be impervious to degradation by aviation fuels, motor fuels, and lubricants.

(1) The markings must be able to be applied in temperatures as low as 35°F without any special storage, preheating, or treatment of the material before application.

(a) The markings must be supplied with an integral, non-reflectorized black border.

(2) Graded glass beads.

(a) The material must contain a minimum of 30% intermixed graded glass beads by weight. The intermixed beads shall conform to Federal Specification TT-B-1325D, Type I, gradation A and Federal Specification TT-B-1325D, Type IV.

(b) The material must have factory applied coated surface beads in addition to the intermixed beads at a rate of one (1) lb (0.45 kg) (±10%) per 10 square feet (1 sq m). These factory-applied coated surface beads shall have a minimum of 90% true spheres, minimum refractive index of 1.50, and meet the following gradation.

Preformed Thermoplastic Bead Gradation

Size Gradation		Retained, %	Passing, %
U.S. Mesh	µm		
12	1700	0 - 2	98 - 100
14	1400	0 - 3.5	96.5 - 100
16	1180	2 - 25	75 - 98
18	1000	28 - 63	37 - 72
20	850	63 - 72	28 - 37
30	600	67 - 77	23 - 33
50	300	89 - 95	5 - 11
80	200	97 - 100	0 - 3

(3) Heating indicators. The material manufacturer shall provide a method to indicate that the material has achieved satisfactory adhesion and proper bead embedment during application and that the installation procedures have been followed.

(4) Pigments. Percent by weight.

(a) White:

- Titanium Dioxide, ASTM D476, type II shall be 10% minimum.

(b) Yellow and Colors:

- Titanium Dioxide, ASTM D476, type II shall be 1% minimum.
- Organic yellow, other colors, and tinting as required to meet color standard.

(5) Prohibited materials. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant federal regulations.

(6) Daylight directional reflectance.

(a) White: The daylight directional reflectance of the white paint shall not be less than 75% (relative to magnesium oxide), when tested in accordance with ASTM E2302.

(b) Yellow: The daylight directional reflectance of the yellow paint shall not be less than 45% (relative to magnesium oxide), when tested in accordance with ASTM E2302. The x and y values shall be consistent with the federal Hegman yellow color standard chart for traffic yellow standard 33538, or shall be consistent with the tolerance listed below:

x	.462	x	.470	x	.479	x	.501
y	.438	y	.455	y	.428	y	.452

(7) **Skid resistance.** The surface, with properly applied and embedded surface beads, must provide a minimum resistance value of 45 BPN when tested according to ASTM E303.

(8) **Thickness.** The material must be supplied at a nominal thickness of 65 mil (1.7 mm).

(9) **Environmental resistance.** The material must be resistant to deterioration due to exposure to sunlight, water, salt, or adverse weather conditions and impervious to aviation fuels, gasoline, and oil.

(10) **Retroreflectivity.** The material, when applied in accordance with manufacturer's guidelines, must demonstrate a uniform level of nighttime retroreflection when tested in accordance to ASTM E1710.

(11) **Packaging.** Packaging shall protect the material from environmental conditions until installation.

(12) Preformed thermoplastic airport pavement marking requirements.

(a) The markings must be a resilient thermoplastic product with uniformly distributed glass beads throughout the entire cross-sectional area. The markings must be resistant to the detrimental effects of aviation fuels, motor fuels and lubricants, hydraulic fluids, deicers, anti-icers, protective coatings, etc. Lines, legends, and symbols must be capable of being affixed to asphalt and/or Portland cement concrete pavements by the use of a large radiant heater. Colors shall be available as required.

(b) The markings must be capable of conforming to pavement contours, breaks, and faults through the action of airport traffic at normal pavement temperatures. The markings must be capable of fully conforming to grooved pavements, including pavement grooving per advisory circular (AC) 150/5320-12, current version. The markings shall have resealing characteristics, such that it is capable of fusing with itself and previously applied thermoplastics when heated with a heat source per manufacturer's recommendation.

(c) Multicolored markings must consist of interconnected individual pieces of preformed thermoplastic pavement marking material, which through a variety of colors and patterns, make up the desired design. The individual pieces in each large marking segment (typically more than 20 feet (6 m) long) must be factory assembled with a compatible material and interconnected so that in the field it is not necessary to assemble the individual pieces within a marking segment. Obtaining multicolored effect by overlaying materials of different colors is not acceptable due to resulting inconsistent marking thickness and inconsistent application temperature in the marking/substrate interface.

(d) The marking material must set up rapidly, permitting the access route to be re-opened to traffic after application.

(e) The marking material shall have an integral color throughout the thickness of the marking material.]

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Thermoplastic airport markings will be subject to an Engineering life-cycle cost analysis prior to inclusion in specifications.

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

Glass beads for red and pink paint shall meet the requirements for [Type I, Gradation A] [Type IV, Gradation A].

Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

The Engineer should insert all that will be used in the project. When more than one bead type is specified, the plans should indicate the bead type for each marking.

Federal Specification TT-B-1325D, Type I, gradation A shall be used when remarking on a frequent basis (at least every six months), and typically yield 300 mcd/m²/lux on white markings at installation and 175 mcd/m²/lux on yellow markings at installation.

Federal Specification TT-B-1325D, Type III. Initial readings typically yield 600 mcd/m²/lux on white markings and 300 mcd/m²/lux on yellow markings at installation and once in service, the reflectance values are approximately the same as Type I beads.

Federal Specification TT-B-1325D, Type IV, gradation A shall be used with TT-P-1952F, Type III paint. The glass beads are larger than either Type I or Type III, thus requiring more of the coating material to properly anchor. The Engineer should consult with the paint and bead manufacturer on the use of adhesion, flow promoting, and/or flotation additives.

Preformed thermoplastic pavement markings should yield at least 225 mcd/m²/lux on white markings at installation and at least 100 mcd/m²/lux on yellow markings at installation.

CONSTRUCTION METHODS

620-3.1 Weather limitations. Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer’s recommendations in accordance with paragraph 620-2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer’s recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings

shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time.

620-3.2 Equipment. Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

620-3.3 Preparation of surfaces. Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminants that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the RPR. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

a. Preparation of new pavement surfaces. The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the RPR to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.

b. Preparation of pavement to remove existing markings. Existing pavement markings shall be removed by rotary grinding, water blasting, or by other methods approved by the RPR minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to 'block out' the removal area to eliminate 'ghost' markings.

c. Preparation of pavement markings prior to remarking. Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the RPR. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the RPR prior to the initial application of markings.

Loose markings should always be removed prior to remarking, whether or not existing markings need to be removed is up to the Engineer and the Airport Operator. The type of removal method used depends upon whether you need to remove loose markings or all existing markings.

620-3.4 Layout of markings. The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans. [The locations of markings to receive silica sand shall be shown on the plans.]

Glass beads improve conspicuity and the friction characteristics of markings. At a minimum, the Engineer shall indicate the locations to receive glass beads per AC 150/5340-1, Standards for Airport Markings.

620-3.5 Application. A period of [___] days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the RPR.

Select timeframe between placement of surface course or seal coat and application of the paint based on type of surface course or seal coat in the project and environment at the project location. The typical timeframe is 30-days for volatiles and moisture vapor to dissipate.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±1/2 inch (12 mm)
greater than 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
greater than 60 feet (18.3 m)	±3 inch (76 mm)

The paint shall be mixed in accordance with the manufacturer’s instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

620-3.6 Application--preformed thermoplastic airport pavement markings.

[Preformed thermoplastic pavement markings not used.]

[To ensure minimum single-pass application time and optimum bond in the marking/substrate interface, the materials must be applied using a variable speed self-propelled mobile heater with an effective heating width of no less than 16 feet (5 m) and a free span between supporting wheels of no less than 18 feet (5.5 m). The heater must emit thermal

radiation to the marking material in such a manner that the difference in temperature of 2 inches (50 mm) wide linear segments in the direction of heater travel must be within 5% of the overall average temperature of the heated thermoplastic material as it exits the heater. The material must be able to be applied at ambient and pavement temperatures down to 35°F (2°C) without any preheating of the pavement to a specific temperature. The material must be able to be applied without the use of a thermometer. The pavement shall be clean, dry, and free of debris. A non-volatile organic content (non-VOC) sealer with a maximum applied viscosity of 250 centiPoise must be applied to the pavement shortly before the markings are applied. The supplier must enclose application instructions with each box/package.]

The Engineer will make the appropriate selection for thermoplastic markings.

620-3.7 Control strip. Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the RPR. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

620-3.8 Retro-reflectance. Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 reading shall be taken over a 6 square foot area with 3 readings taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m ² /lux		
	White	Yellow	Red
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35
All materials, remark when less than ¹	100	75	10

¹ Prior to remarking determine if removal of contaminants on markings will restore retro-reflectance

620-3.9 Protection and cleanup. After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the RPR. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

METHOD OF MEASUREMENT

620-4.1a The quantity of surface preparation shall be measured by [the number of square feet (square meters) for each type of surface preparation specified in paragraph 620-3.3] [lump sum].

620-4.1b The quantity of markings shall be paid for shall be measured [by the number of square feet (square meters) of painting] [by lump sum].

620-4.1c The quantity of reflective media shall be paid for by [the number of pounds (km)] [lump sum] of reflective media.

620-4.1d [The quantity of temporary markings to be paid for shall be [the number of square feet (square meters) of painting] [lump sum price] performed in accordance with the specifications and accepted by the RPR. Temporary marking includes surface preparation, application and complete removal of the temporary marking.] [Temporary markings not required.]

[**620-4.1e** The quantity of preformed markings to be paid for shall be [the number of square feet (square meters) of preformed markings] [lump sum]].

Separate pay items for surface preparation, marking, and reflective media is recommended, however on small jobs, lump sum pay items is acceptable.

BASIS OF PAYMENT

620-5.1 This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item complete in place and accepted by the RPR in accordance with these specifications.

620-5.1a Payment for surface preparation shall be made at the contract price for [the number of square feet (square meters) for each type of surface preparation specified in paragraph 620-3.3] [lump sum].

620-5.2b Payment for markings shall be made at the contract price for [the number of square feet (square meters) of painting and the number of pounds (km) of reflective media] [by the number of square feet (square meters) of painting] [by lump sum].

620-5.3c Payment for reflective media shall be made at the contract unit price for [the number of pounds (km) of reflective media] [lump sum].

620-5.4d Payment for temporary markings shall be made at the contract price for [the number of square feet (square meters) of painting] [lump sum price]. This price shall be full compensation for furnishing all materials and for all labor, equipment, tools, and incidentals necessary to complete the item. [Temporary markings are not required.]

[**620-5.5e** Payment for preformed markings shall be made at the contract price for [the number of square feet (square meters) of preformed markings] [lump sum price].]

Payment will be made under:

- | | |
|-----------------|---|
| Item P-620-5.1a | Surface Preparation [per square foot (square meter)]
[lump sum] |
| Item P-620-5.2b | Marking [per square foot (square meter)] [lump sum] |
| Item P-620-5.3c | Reflective Media [per pound (km)] [lump sum] |
| Item P-620-5.4d | Temporary runway and taxiway marking [per square foot]
[per square meter] [lump sum]. |
| [Item 620-5.5e | Preformed markings per [the number of square feet (square meters) of preformed markings]
[lump sum price].] |

REFERENCES

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

ASTM International (ASTM)

- | | |
|------------|---|
| ASTM D476 | Standard Classification for Dry Pigmentary Titanium Dioxide Products |
| ASTM D968 | Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive |
| ASTM D1652 | Standard Test Method for Epoxy Content of Epoxy Resins |
| ASTM D2074 | Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method |
| ASTM D2240 | Standard Test Method for Rubber Property - Durometer Hardness |
| ASTM D7585 | Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments |
| ASTM E303 | Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester |
| ASTM E1710 | Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer |
| ASTM E2302 | Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer |
| ASTM G154 | Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials |

Code of Federal Regulations (CFR)

40 CFR Part 60, Appendix A-7, Method 24

Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

29 CFR Part 1910.1200 Hazard Communication

Federal Specifications (FED SPEC)

FED SPEC TT-B-1325D Beads (Glass Spheres) Retro-Reflective

FED SPEC TT-P-1952F Paint, Traffic and Airfield Marking, Waterborne

FED STD 595 Colors used in Government Procurement

Commercial Item Description

A-A-2886B Paint, Traffic, Solvent Based

Advisory Circulars (AC)

AC 150/5340-1 Standards for Airport Markings

AC 150/5320-12 Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces

END OF ITEM P-620