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**SECTION 32 17 23**  
**PAVEMENT MARKINGS**

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. Section Includes:

1. Pavement Markings
  - a. Thermoplastic, hot-applied, spray (HAS) pavement markings
  - b. Thermoplastic, hot-applied, extruded (HAE) pavement markings
  - c. Preformed polymer tape
  - d. Preformed heat-activated thermoplastic tape
  - e. Preformed Contrast Markings
2. Raised markers
3. Work zone markings
4. Removal of pavement markings and markers

B. Deviations from this City of Fort Worth Standard Specification

1. None.

C. Related Specification Sections include, but are not necessarily limited to:

1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
2. Division 1 – General Requirements

**1.2 PRICE AND PAYMENT PROCEDURES**

A. Measurement and Payment

1. Pavement Markings
  - a. Measurement
    - 1) Measurement for this Item shall be per linear foot of material placed.
  - b. Payment
    - 1) The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” shall be paid for at the unit price bid per linear foot of “Pvmt Marking” installed for:
      - a) Various Widths
      - b) Various Types
      - c) Various Materials
      - d) Various Colors
  - c. The price bid shall include:
    - 1) Installation of Pavement Marking
    - 2) Glass beads, when required
    - 3) Surface preparation
    - 4) Clean-up
    - 5) Testing (when required)
2. Legends
  - a. Measurement
    - 1) Measurement for this Item shall be per each Legend installed.

- 1 b. Payment
- 2 1) The work performed and materials furnished in accordance with this Item
- 3 shall be paid for at the unit price bid per each “Legend” installed for:
- 4 a) Various types
- 5 b) Various applications
- 6 c. The price bid shall include:
- 7 1) Installation of Pavement Marking
- 8 2) Glass beads, when required
- 9 3) Surface preparation
- 10 4) Clean-up
- 11 5) Testing
- 12 3. Preformed Thermoplastic – Contrast Markings
- 13 a. Measurement
- 14 1) Measurement for this Item shall be per linear foot of material placed or per
- 15 each for legend items
- 16 b. Payment
- 17 1) The work performed and materials furnished in accordance with this Item
- 18 shall be paid for at the unit price bid per linear foot or per each for legends for
- 19 “Preformed Thermoplastic – Contract Markings” installed for:
- 20 a) Various Widths
- 21 b) Various Types
- 22 c) Various Applications
- 23 c. The price bid shall include:
- 24 1) Installation of Contrast Markings, including solid black and solid white or
- 25 yellow material as preformed
- 26 2) Railroad Legend shall include X and RR legend markings and three 24”
- 27 stop bars
- 28 3) Surface preparation
- 29 4) Clean-up
- 30 5) Testing
- 31 4. Raised Markers
- 32 a. Measurement
- 33 1) Measurement for this Item shall be per each Raised Marker installed.
- 34 b. Payment
- 35 1) The work performed and materials furnished in accordance with this Item
- 36 shall be paid for at the unit price bid per each “Raised Marker” installed for:
- 37 a) Various types
- 38 c. The price bid shall include:
- 39 1) Installation of Raised Markers
- 40 2) Surface preparation
- 41 3) Clean-up
- 42 4) Testing
- 43 5. Work Zone Tab Markers
- 44 a. Measurement
- 45 1) Measurement for this Item shall be per each Tab Marker installed.
- 46 b. Payment
- 47 1) The work performed and materials furnished in accordance with this Item
- 48 shall be paid for at the unit price bid per each “Tab Marker” installed for:
- 49 a) Various types

- 1 c. The price bid shall include:
- 2 1) Installation of Tab Work Zone Markers
- 3 6. Fire Lane Markings
- 4 a. Measurement
- 5 1) Measurement for this Item shall be per the linear foot.
- 6 b. Payment
- 7 1) The work performed and materials furnished in accordance with this Item
- 8 and measured as provided under “Measurement” shall be paid for at the unit
- 9 price bid per linear foot of “Fire Lane Marking” installed.
- 10 c. The price bid shall include:
- 11 1) Surface preparation
- 12 2) Clean-up
- 13 3) Testing
- 14 7. Pavement Marking Removal
- 15 a. Measurement
- 16 1) Measure for this Item shall be per linear foot.
- 17 b. Payment
- 18 1) The work performed and materials furnished in accordance with this Item
- 19 and measured as provided under “Measurement” shall be paid for at the unit
- 20 price bid per linear foot of “Remove Pvmt Marking” performed for:
- 21 a) Various widths
- 22 c. The price bid shall include:
- 23 1) Removal of Pavement Markings
- 24 2) Clean-up
- 25 8. Raised Marker Removal
- 26 a. Measurement
- 27 1) Measurement for this Item shall be per each Pavement Marker removed.
- 28 b. Payment
- 29 1) The work performed and materials furnished in accordance with this Item
- 30 shall be paid for at the unit price bid per each “Remove Raised Marker”
- 31 performed.
- 32 c. The price bid shall include:
- 33 1) Removal of each Marker
- 34 2) Disposal of removed materials
- 35 3) Clean-up
- 36 9. Legend Removal
- 37 a. Measurement
- 38 1) Measure for this Item shall be per each Legend removed.
- 39 b. Payment
- 40 1) The work performed and materials furnished in accordance with this Item
- 41 and measured as provided under “Measurement” shall be paid for at the unit
- 42 price bid per linear foot of “Remove Legend” performed for:
- 43 a) Various types
- 44 b) Various applications
- 45 c. The price bid shall include:
- 46 1) Removal of Pavement Markings
- 47 2) Clean-up

1 **1.3 REFERENCES**

2 A.Reference Standards

- 3 1. Reference standards cited in this Specification refer to the current reference  
4 standard published at the time of the latest revision date logged at the end of this  
5 Specification, unless a date is specifically cited.
- 6 2. Texas Manual on Uniform Traffic Control Devices (MUTCD), 2011 Edition  
7 a. Part 3, Markings
- 8 3. American Association of State Highway and Transportation Officials (AASHTO)  
9 a. Standard Specification for Glass Beads Used in Pavement Markings, M 247-09
- 10 4. Federal Highway Administration (FHWA)  
11 a. 23 CFR Part 655, FHWA Docket No. FHWA-2009-0139
- 12 5. Texas Department of Transportation (TxDOT)  
13 a. DMS-4200, Pavement Markers (Reflectorized)  
14 b. DMS-4300, Traffic Buttons  
15 c. DMS-8220, Hot Applied Thermoplastic  
16 d. DMS-8240, Permanent Prefabricated Pavement Markings  
17 e. DMS-8241, Removable Prefabricated Pavement Markings  
18 f. DMS-8242, Temporary Flexible-Reflective Road Marker Tabs

19 **1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]**

20 **1.5 SUBMITTALS**

21 A.Submittals shall be in accordance with Section 01 33 00.

22 B.All submittals shall be approved by the City prior to delivery and/or fabrication for  
23 specials.

24 **1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]**

25 **1.7 CLOSEOUT SUBMITTALS [NOT USED]**

26 **1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]**

27 **1.9 QUALITY ASSURANCE [NOT USED]**

28 **1.10 DELIVERY, STORAGE, AND HANDLING**

29 A.Storage and Handling Requirements

- 30 1. The Contractor shall secure and maintain a location to store the material in  
31 accordance with Section 01 50 00.

32 **1.11 FIELD [SITE] CONDITIONS [NOT USED]**

33 **1.12 WARRANTY [NOT USED]**

34 **PART 2 - PRODUCTS**

35 **2.1 OWNER-SUPPLIED PRODUCTS**

36 A.New Products

- 37 1. Refer to Drawings to determine if there are owner-supplied products for the Project.

1 **2.2 MATERIALS**

2 **A.Manufacturers**

- 3 1. Only the manufacturers as listed in the City’s Standard Products List will be  
4 considered as shown in Section 01 60 00.  
5 a. The manufacturer must comply with this Specification and related Sections.  
6 2. Any product that is not listed on the Standard Products List is considered a  
7 substitution and shall be submitted in accordance with Section 01 25 00.

8 **B.Materials**

9 1. Pavement Markings

- 10 a. Thermoplastic, hot applied, spray  
11 1) Refer to Drawings and City Standard Detail Drawings for width of  
12 longitudinal lines.  
13 2) Product shall be especially compounded for traffic markings.  
14 3) When placed on the roadway, the markings shall not be slippery when wet,  
15 lift from pavement under normal weather conditions nor exhibit a tacky  
16 exposed surface.  
17 4) Cold ductility of the material shall permit normal road surface expansion  
18 and contraction without chipping or cracking.  
19 5) The markings shall retain their original color, dimensions and placement  
20 under normal traffic conditions at road surface temperatures of 158 degrees  
21 Fahrenheit and below.  
22 6) Markings shall have uniform cross-section, clean edges, square ends and no  
23 evidence of tracking.  
24 7) The density and quality of the material shall be uniform throughout the  
25 markings.  
26 8) The thickness shall be uniform throughout the length and width of the  
27 markings.  
28 9) The markings shall be 95 percent free of holes and voids, and free of  
29 blisters for a minimum of 60 days after application.  
30 10) The material shall not deteriorate by contact with sodium chloride, calcium  
31 chloride or other chemicals used to prevent roadway ice or because of the oil  
32 content of pavement markings or from oil droppings or other effects of traffic.  
33 11) The material shall not prohibit adhesion of other thermoplastic markings if,  
34 at some future time, new markings are placed over existing material.  
35 a) New material shall bond itself to the old line in such a manner that no  
36 splitting or separation takes place.  
37 12) The markings placed on the roadway shall be completely retroreflective  
38 both internally and externally with traffic beads and shall exhibit uniform  
39 retro-directive reflectance.  
40 13) Traffic beads  
41 a) Manufactured from glass  
42 b) Spherical in shape  
43 c) Essentially free of sharp angular particles  
44 d) Essentially free of particles showing cloudiness, surface scoring or  
45 surface scratching  
46 e) Water white in color  
47 f) Applied at a uniform rate

- 1 g) Meet or exceed Specifications shown in AASHTO Standard  
2 Specification for Glass Beads Used in Pavement Markings, AASHTO  
3 Designation: M 247-09.
- 4 b. Thermoplastic, hot applied, extruded  
5 1) Product shall be especially compounded for traffic markings  
6 2) When placed on the roadway, the markings shall not be slippery when wet,  
7 lift from pavement under normal weather conditions nor exhibit a tacky  
8 exposed surface.  
9 3) Cold ductility of the material shall permit normal road surface expansion  
10 and contraction without chipping or cracking.  
11 4) The markings shall retain their original color, dimensions and placement  
12 under normal traffic conditions at road surface temperatures of 158 degrees  
13 Fahrenheit and below.  
14 5) Markings shall have uniform cross-section, clean edges, square ends and no  
15 evidence of tracking.  
16 6) The density and quality of the material shall be uniform throughout the  
17 markings.  
18 7) The thickness shall be uniform throughout the length and width of the  
19 markings.  
20 8) The markings shall be 95 percent free of holes and voids, and free of  
21 blisters for a minimum of 60 days after application.  
22 9) The minimum thickness of the marking, as measured above the plane  
23 formed by the pavement surface, shall not be less than 1/8 inch in the center  
24 of the marking and 3/32 inch at a distance of 1/2 inch from the edge.  
25 10) Maximum thickness shall be 3/16 inch.  
26 11) The material shall not deteriorate by contact with sodium chloride, calcium  
27 chloride or other chemicals used to prevent roadway ice or because of the oil  
28 content of pavement markings or from oil droppings or other effects of traffic.  
29 12) The material shall not prohibit adhesion of other thermoplastic markings if,  
30 at some future time, new markings are placed over existing material. New  
31 material shall bond itself to the old line in such a manner that no splitting or  
32 separation takes place.  
33 13) The markings placed on the roadway shall be completely retroreflective  
34 both internally and externally with traffic beads and shall exhibit uniform  
35 retro-directive reflectance.  
36 14) Traffic beads  
37 a) Manufactured from glass  
38 b) Spherical in shape  
39 c) Essentially free of sharp angular particles  
40 d) Essentially free of particles showing cloudiness, surface scoring or  
41 surface scratching  
42 e) Water white in color  
43 f) Applied at a uniform rate  
44 g) Meet or exceed Specifications shown in AASHTO Standard  
45 Specification for Glass Beads Used in Pavement Markings, AASHTO  
46 Designation: M 247-09.
- 47 c. Preformed Polymer Tape  
48 1) Material shall meet or exceed the Specifications for SWARCO Director 35,  
49 3M High Performance Tape Series 3801 ES, or approved equal.
- 50 d. Preformed Heat-Activated Thermoplastic Tape

- 1) Material shall meet or exceed the Specifications for HOT Tape Brand 0.125 mil preformed thermoplastic or approved equal.
2. Raised Markers
  - a. Markers shall meet the requirements of the Texas Manual on Uniform Traffic Control Devices.
  - b. Non-reflective markers shall be Type Y (yellow body) and Type W (white body) round ceramic markers and shall meet or exceed the TxDOT Specification DMS-4300.
  - c. The reflective markers shall be plastic, meet or exceed the TxDOT Specification DMS-4200 for high-volume retroreflective raised markers and be available in the following types:
    - 1) Type I-C, white body, 1 face reflects white
    - 2) Type II-A-A, yellow body, 2 faces reflect amber
    - 3) Type II-C-R, white body, 1 face reflects white, the other red
3. Work Zone Markings
  - a. Tabs
    - 1) Temporary flexible-reflective roadway marker tabs shall meet requirements of TxDOT DMS-8242, "Temporary Flexible-Reflective Road Marker Tabs."
    - 2) Removable markings shall not be used to simulate edge lines.
    - 3) No segment of roadway open to traffic shall remain without permanent pavement markings for a period greater than 14 calendar days.
  - b. Raised Markers
    - 1) All raised pavement markers shall meet the requirements of DMS-4200.
  - c. Striping
    - 1) Work Zone striping shall meet or exceed the TxDOT Specification DMS-8200.

**2.3 ACCESSORIES [NOT USED]**

**2.4 SOURCE QUALITY CONTROL**

**A. Performance**

1. Minimum maintained retroreflectivity levels for longitudinal markings shall meet the requirements detailed in the table below for a minimum of 30 calendar days.

	Posted Speed (mph)		
	≤ 30	35 – 50	≥ 55
2-lane roads with centerline markings only (1)	n/a	100	250
All other roads (2)	n/a	50	100

(1) Measured at standard 30-m geometry in units of mcd/m<sup>2</sup>/lux.

(2) Exceptions:

A. When raised reflective pavement markings (RRPMs) supplement or substitute for a longitudinal line, minimum pavement marking retroreflectivity levels are not applicable as long as the RRPMs are maintained so that at least 3 are visible from any position along that line during nighttime conditions.

B. When continuous roadway lighting assures that the markings are visible, minimum pavement marking retroreflectivity levels are not applicable.

1 **PART 3 - EXECUTION**

2 **3.1 EXAMINATION [NOT USED]**

3 **3.2 PREPARATION**

4 **A.Pavement Conditions**

- 5 1. Roadway surfaces shall be free of dirt, grease, loose and/or flaking existing  
6 markings and other forms of contamination.
- 7 2. New Portland cement concrete surfaces shall be cleaned sufficiently to remove the  
8 curing membrane.
- 9 3. Pavement to which material is to be applied shall be completely dry.
- 10 4. Pavement shall be considered dry, if, on a sunny day after observation for 15  
11 minutes, no condensation develops on the underside of a 1 square foot piece of  
12 clear plastic that has been placed on the pavement and weighted on the edges.
- 13 5. Equipment and methods used for surface preparation shall not damage the  
14 pavement or present a hazard to motorists or pedestrians.

15 **3.3 INSTALLATION**

16 **A.General**

- 17 1. The materials shall be applied according to the manufacturer's recommendations.
- 18 2. Markings and markers shall be applied within temperature limits recommended by  
19 the material manufacturer, and shall be applied on clean, dry pavement having a  
20 surface temperature above 50 degrees Fahrenheit.
- 21 3. Markings that are not properly applied due to faulty application methods or being  
22 placed in the wrong position or alignment shall be removed and replaced by the  
23 Contractor at the Contractor's expense. If the mistake is such that it would be  
24 confusing or hazardous to motorists, it shall be remedied the same day of  
25 notification. Notification will be made by phone and confirmed by fax. Other  
26 mistakes shall be remedied within 5 days of written notification.
- 27 4. When markings are applied on roadways open to traffic, care will be taken to  
28 ensure that proper safety precautions are followed, including the use of signs,  
29 cones, barricades, flaggers, etc.
- 30 5. Freshly applied markings shall be protected from traffic damage and disfigurement.
- 31 6. Temperature of the material must be equal to the temperature of the road surface  
32 before allowing traffic to travel on it.

33 **B.Pavement Markings**

- 34 1. Thermoplastic, hot applied, spray
  - 35 a. This method shall be used to install and replace long lines – centerlines, lane  
36 lines, edge lines, turn lanes, and dots.
  - 37 b. Markings shall be applied at a 110-mil thickness.
  - 38 c. Markings shall be applied at a 90-mil thickness when placed over existing  
39 markings.
  - 40 d. A sealer shall be used if concrete or asphalt is older than three (3) years.
  - 41 e. Typical setting time shall be between 4 minutes and 10 minutes depending upon  
42 the roadway surface temperature and the humidity factor.



- 1 f. Retroreflective raised markers shall be used to supplement the centerlines, lane  
2 lines, and turn lanes. Refer to City Standard Detail Drawings for placement.
- 3 g. Minimum retroreflectivity of markings shall meet or exceed values shown in  
4 subparagraph 2.4.A.1 of this Specification.
- 5 2. Thermoplastic, hot applied, extruded  
6 a. This method shall be used to install and replace crosswalks and stop-lines.  
7 b. Markings shall be applied at a 125-mil thickness.  
8 c. Minimum retroreflectivity of markings shall meet or exceed values shown in  
9 this Specification.
- 10 3. Preformed Polymer Tape  
11 a. This method shall be used to install and replace crosswalks, stop-lines, and  
12 legends.  
13 b. The applied marking shall adhere to the pavement surface with no slippage or  
14 lifting and have square ends, straight lines and clean edges.  
15 c. Minimum retroreflectivity of markings shall meet or exceed values shown in  
16 this Specification.
- 17 4. Preformed Heat-Activated Thermoplastic Tape  
18 a. This method shall be used to install and replace crosswalks, stop-lines, and  
19 legends.  
20 b. The applied marking shall adhere to the pavement surface with no slippage or  
21 lifting and have square ends, straight lines and clean edges.  
22 c. Minimum retroreflectivity of markings shall meet or exceed values shown in  
23 this Specification.

#### 24 C. Raised Markers

- 25 1. All permanent raised pavement markers on Portland Cement roadways shall be  
26 installed with epoxy adhesive. Bituminous adhesive is not acceptable.
- 27 2. All permanent raised pavement markers on new asphalt roadways may be installed  
28 with epoxy or bituminous adhesive.
- 29 3. A chalk line, chain or equivalent shall be used during layout to ensure that  
30 individual markers are properly aligned. All markers shall be placed uniformly  
31 along the line to achieve a smooth continuous appearance.

#### 32 D. Work Zone Markings

- 33 1. Work shall be performed with as little disruption to traffic as possible.
- 34 2. Install longitudinal markings on pavement surfaces before opening to traffic.
- 35 3. Maintain lane alignment traffic control devices and operations until markings are  
36 installed.
- 37 4. Install markings in proper alignment in accordance with the Texas MUTCD and as  
38 shown on the Drawings.
- 39 5. Place standard longitudinal lines no sooner than 3 calendar days after the placement  
40 of a surface treatment, unless otherwise shown on the Drawings.
- 41 6. Place markings in proper alignment with the location of the final pavement  
42 markings.
- 43 7. Do not use raised pavement markers for words, symbols, shapes, or diagonal or  
44 transverse lines.

- 1 8. All markings shall be visible from a distance of 300 feet in daylight conditions and  
2 from a distance of at least 160 feet in nighttime conditions, illuminated by low-  
3 beam automobile headlight.
- 4 9. The daytime and nighttime reflected color of the markings must be distinctly white  
5 or yellow.
- 6 10. The markings must exhibit uniform retroreflective characteristics.
- 7 11. Epoxy adhesives shall not be used to work zone markings.

### 8 **3.4 REMOVALS**

- 9 1. Pavement Marking and Marker Removal
- 10 a. The industry's best practice shall be used to remove existing pavement markings  
11 and markers.
- 12 b. If the roadway is being damaged during the marker removal, Work shall be  
13 halted until consultation with the City.
- 14 c. Removals shall be done in such a manner that color and texture contrast of the  
15 pavement surface will be held to a minimum.
- 16 d. Repair damage to asphaltic surfaces, such as spalling, shelling, etc., greater than  
17  $\frac{1}{4}$  inch in depth resulting from the removal of pavement markings and markers.  
18 Driveway patch asphalt emulsion may be broom applied to reseal damage to  
19 asphaltic surfaces.
- 20 e. Dispose of markers in accordance with federal, state, and local regulations.
- 21 f. Use any of the following methods unless otherwise shown on the Drawings.
- 22 1) Surface Treatment Method
- 23 a) Apply surface treatment at rates shown on the Drawings or as directed.  
24 Place a surface treatment a minimum of 2 feet wide to cover the existing  
25 marking.
- 26 b) Place a surface treatment, thin overlay, or microsurfacing a minimum  
27 of 1 lane in width in areas where directional changes of traffic are  
28 involved or in other areas as directed by the City.
- 29 2) Burn Method
- 30 a) Use an approved burning method.
- 31 b) For thermoplastic pavement markings or prefabricated pavement  
32 markings, heat may be applied to remove the bulk of the marking material  
33 prior to blast cleaning.
- 34 c) When using heat, avoid spalling pavement surfaces.
- 35 d) Sweeping or light blast cleaning may be used to remove minor residue.
- 36 3) Blasting Method
- 37 a) Use a blasting method such as water blasting, abrasive blasting, water  
38 abrasive blasting, shot blasting, slurry blasting, water-injected abrasive  
39 blasting, or brush blasting as approved.
- 40 b) Remove pavement markings on concrete surfaces by a blasting method  
41 only.
- 42 4) Mechanical Method
- 43 a) Use any mechanical method except grinding.
- 44 b) Flail milling is acceptable in the removal of markings on asphalt and  
45 concrete surfaces.
- 46 2. If a location is to be paved over, no additional compensation will be allowed for  
47 marking or marker removal.

1 **3.5 REPAIR / RESTORATION [NOT USED]**

2 **3.6 RE-INSTALLATION [NOT USED]**

3 **3.7 FIELD QUALITY CONTROL**

4 A.All lines must have clean edges, square ends, and be uniform cross-section.

5 B.The density and quality of markings shall be uniform throughout their thickness.

6 C.The applied markings shall have no more than 5 percent, by area, of holes or voids and  
7 shall be free of blisters.

8 **3.8 SYSTEM STARTUP [NOT USED]**

9 **3.9 ADJUSTING [NOT USED]**

10 **3.10 CLEANING**

11 A.Contractor shall clean up and remove all loose material resulting from construction  
12 operations.

13 **3.11 CLOSEOUT ACTIVITIES [NOT USED]**

14 **3.12 PROTECTION [NOT USED]**

15 **3.13 MAINTENANCE [NOT USED]**

16 **3.14 ATTACHMENTS [NOT USED]**

17 **END OF SECTION**

18

Revision Log		
DATE	NAME	SUMMARY OF CHANGE
11/22/13	S. Arnold	Removed paint type marking, updated references, added sealer language
6/10/22	M Owen	1.1 A and 1.2 A – Revised to address preformed “contrast” pavement markings

19