

STATE OF CALIFORNIA  
DEPARTMENT OF TRANSPORTATION  
ADMINISTRATION  
DIVISION OF PROCUREMENT AND CONTRACTS  
1727 30<sup>TH</sup> STREET, 4<sup>TH</sup> FLOOR  
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## SPECIFICATION FOR GLASS SPHERES (BEADS)

### 1.0 SCOPE

- 1.1 This specification covers glass spheres (beads) for use in providing nighttime retro-reflectance in painted traffic lines and other markings used in highway delineation. The supplied glass beads shall have a moisture-proof coating that promotes the free flow of beads in high humidity conditions.

### 2.0 SPECIFICATIONS AND STANDARDS

- 2.1 Specifications and standards referenced in this document in effect on the opening date of the Invitation for Bid form a part of this specification where referenced.

### 3.0 REQUIREMENTS

- 3.1 The glass beads shall meet the requirements listed below.

- 3.1.1 **General:** Glass spheres shall lend themselves readily to firm embedment in traffic paint when dropped on a freshly placed paint line. The embedment shall be of such nature so as to provide a highly retroreflective surface on the paint with reserve retroreflective capacity in the lower sections of the paint film. This retroreflection shall be evident to the operator of a motor vehicle at night when the headlights of the vehicle are directed at the marking. Glass beads shall not contain any hazardous materials at levels that would cause the beads to be classified as a hazardous waste under Title 22, Division 4, Section 66261.20 of the California Code of Regulations.
- 3.1.2 **Appearance:** A minimum of 85% of the beads by count shall be colorless, true spheres, free of dark spots, milkiness, air inclusions and surface scratches when viewed under 20X magnification. The beads shall be clean and free from foreign matter in accordance with high grade commercial practice.

Note: This specification cancels and supercedes; specification #8010-004 (March 24, 2009), specification #8010-004 (February 17, 2009), #8010-004 (December 15, 2008), #8010-004 (January 2006), #8010-004 (January 2004), 8010-004 (October, 1998) and specification #8010-21C-22 (March, 1992).

**3.1.3 Gradation:** The glass spheres shall conform to the following gradation requirements when tested according to California Test 202 (Appendix C):

<u>Sieve Opening</u>	<u>U.S. Stnd. Sieve #</u>	<u>% By Weight Passing</u>
600 μm	#30	100
250 μm	#60	40 - 70
180 μm	#80	15 - 35
106 μm	#140	0 - 0.5

**3.1.4 Refractive Index:** The beads shall have a minimum refractive index of 1.5 when tested by the oil immersion method (Becke Line Method or equal) at a temperature of  $25 \pm 5^{\circ}\text{C}$ . See ASTM C 1648-06.

**3.1.5 Specific Gravity:** The beads shall have a specific gravity between 2.40 and 2.60 at  $25^{\circ}\text{C}$ , when tested per ASTM D-153, Method A.

**3.1.6 Moisture Content:** Determine the moisture content by weighing a 25 g sample of the beads and placing the sample in a  $105^{\circ}\text{C}$  oven for 3 hrs. After 3 hrs, cool the sample in a desiccator, then re-weigh and calculate the % moisture content (% weight loss). The moisture content shall not exceed 0.01%.

**3.1.7 Chemical Stability:** Refluxing a 50 g sample of beads in a Soxhlet extraction apparatus for 8 hours with distilled water shall not produce more than a very slight reduction in luster or reflecting power of the beads.

**3.1.8 Arsenic, Antimony and Lead Content:** The glass spheres shall not contain more than 200 ppm (total) arsenic, 200 ppm (total) antimony nor more than 200 ppm (total) lead, when tested according to EPA Methods 3052 and 6010B. Other suitable x-ray fluorescence spectrometry analysis methods may be used to screen samples of glass spheres for arsenic, antimony and lead content.

**3.1.9 Flow:** Beads shall be free flowing. A 50 lb sample of beads, when emptied into a service box screen having sieve openings of 1.18 mm (U.S. Standard Sieve #16), shall pass completely through the screen without shaking or any excessive hand manipulation.

**3.1.10 Bulk Color:** Use a riffle splitter to obtain a 30-gram (plus or minus 3-gram) sub-sample of the glass bead sample. Place this sub-sample of beads in a flat-bottomed, 20-mL quartz fiber crucible (CEM Corporation P/N #303040). Tap the dish gently to level the beads in the crucible. Place this crucible (with beads) in a cold muffle furnace and heat the bead sample to  $800^{\circ}\text{C}$ . Allow the sample to remain at this temperature for 2 to 3 hours. Shut-off the muffle furnace and let the sample cool to room temperature before removing it from the furnace. The bead sample should now be melted into a fused, opaque mass of uniform color. Use a BYK-Gardner "Color Guide" spectrophotometer to measure the color of the fused

beads in CIE L\*a\*b\* color mode. Measure the color of the top surface of the fused bead sample. The spectrophotometer should be calibrated using 2-degree Observer and D65 Illuminant conditions and 45/0-degree geometry. Make 3 color measurements and obtain an average L\* value. The L\* value of the fused bead sample should be greater than or equal to 55.

**3.1.11 Moisture Resistance (Free Flow) Test:** The moisture resistance of the beads imparted by their moisture-proof coating shall be determined by the following procedure.

1. Obtain a pre-washed 10 by 17 inch, unbleached, 7 oz cotton canvas bag.
2. Turn the bag inside out to prevent water and beads from being entrapped within the seams.
3. Place a 907 g sample of beads into the cotton bag.
4. Immerse the bag containing the sample in a bucket of water at room temperature (21-22°C) for 30 seconds.
5. Remove the bag and sample from water and squeeze the excess water out of the bag by twisting the neck of the bag.
6. Using a rope and a ring stand, suspend the bag of beads above the table for 2 hours at room temperature. Do not allow the neck to loosen.
7. After the 2-hour period, mix the sample thoroughly by releasing the tension in the neck and shaking the bag, thus loosening the beads from bottom and sides.
8. Transfer the entire sample (at once) from the bag into a clean, dry, glass funnel (funnel dimensions: 6 inch top diameter, 4 ¾ inch deep cone, 6 inch long stem with ¼ inch I.D.).
9. If the beads bridge in the funnel while pouring the sample in, the funnel can be tapped lightly at the beginning to restart the flow, but not again once the flow has restarted.
10. After flow stops, the funnel must be essentially empty of glass spheres. If not, then the sample fails.

#### **4.0 QUALITY ASSURANCE PROVISIONS**

**4.1 Inspection and Sampling:** All lots of glass beads intended for shipment to California Department of Transportation (Department) Maintenance facilities must be sampled, tested and approved by the Transportation Laboratory before shipment. Manufacturers

shall take duplicate, representative 1-quart samples of each lot of glass beads destined for the Department and send these samples to the Transportation Laboratory for testing. The duplicate samples shall be packaged in separate 1-quart wide-mouth metal paint cans. The can lids shall be secured with clips to prevent spillage during shipment. The sample shall be labeled with the specification number, lot number, purchase order number (if known) and size of the lot (in pounds) represented by the samples. The samples shall be shipped to the Transportation Laboratory at the address shown below.

California Department of Transportation  
Transportation Laboratory, Chemical Testing Section  
5900 Folsom Blvd.  
Sacramento, CA 95819-4612  
attn.: Lisa Dobeck

A lot shall consist of a uniform blend of glass beads packaged on the same day. The lot size shall be more than 2200 pounds and less than 70,000 pounds of glass beads. Different lot numbers shall be used when more than 70,000 pounds of the same blend of glass beads are packaged on the same day. Each package (bulk, barrels or bags) shall be labeled with the specification number, manufacturer's lot number and date of manufacture (packaging date). See section 5.2 "Markings" for more labeling requirements.

Manufacturers must submit the following information along with the duplicate representative 1-quart samples of each lot sent to the Transportation Laboratory for testing;

1. State Specification number (#8010-004, dated December 22, 2009).
2. Type of moisture-proof coating used.
3. Lot number
4. Date of manufacture.
5. Amount of glass beads represented by lot.
6. Purchase Order and/or Contract number (if known)
7. Type of packaging (bulk, barrels or bags).
8. Sampling method (splitting, thieving, quartering, random bag, etc.).
9. Manufacturers lab results for the following tests (Gradation, Moisture Resistance Test, Appearance) when tested per Specification #8010-004.

The samples and above information shall be sent to the Transportation Laboratory at the address listed above.

- 4.2 Testing:** The material shall be tested per the requirements of this specification and the Invitation for Bid. The Department of Transportation reserves the right to retest any lot of glass beads after delivery. Data from such retesting shall prevail over all other tests and will be the basis of rejection. Material not meeting the specification shall be removed and replaced by the supplier at their expense, including all costs for handling,

retesting and shipping.

#### **4.3 Notification of Shipments:**

Once the Transportation Laboratory approves a lot of glass beads, the manufacturer will be notified that the lot is approved for shipment. When shipments of the approved lots of glass beads are made to Department Maintenance facilities, the manufacturer shall fax the following information to the Transportation Laboratory within 48 hours of shipment.

- \* State Specification number (#8010-004, dated December 22, 2009).
- \* A list of each delivery location and delivery date.
- \* Name and phone number of contact person(s) at the delivery location(s).
- \* Purchase Order number, contract number and date that order was received.
- \* Lot numbers and quantities of each lot of glass beads delivered.

This information shall be faxed to;

California Department of Transportation  
Transportation Laboratory, Chemical Testing Section  
5900 Folsom Blvd.  
Sacramento, CA 95819-4612  
attn.: Lisa Dobeck,  
Fax: (916) 227-7168.

#### **4.4 Certificate of Compliance:**

A Certificate of Compliance signed by the manufacturer shall accompany the samples. The Certificate of Compliance shall state that the lot of glass beads meets the required specification and shall contain the information listed in items 1 through 7 in the "Inspection and Sampling" section above.

### **5.0 PREPARATION FOR DELIVERY**

#### **5.1 Packaging:**

- (1) Bags: Glass spheres shall be packaged in pinch bottom style paper bags having glued top and bottom seams. Bags shall comply with the requirements of Federal Specification UU-S-48, Type VI, Style B, MB-3, Sack 13.

Each bag shall contain 50 lb of glass spheres and shall be plainly and conspicuously marked or branded on the side with the net weight of the glass spheres.

- (2) Fiber Drums: Drums shall conform to the Uniform National Freight Classification, Item 21840, Rule No. 291. These shall be designed for 550 lb of beads and have a 20 inch inside diameter and 32 ½ inch inside height. The drums

must pass a 1,000 pound sidewall test. The top cover shall be of steel with locking rim. A polyethylene liner shall be placed in the drum before filling. Four drums shall be placed on a pallet. Shrink-wrap shall be placed around the four drums.

(3) Totes: Shall meet the requirements of Agency Specification #8010-005.

Packaging shall conform to the applicable rules and sections of the current National Motor Freight Classification in use at the time of delivery. Deviation from packaging requirements shall require written consent of Department of Transportation, Office of Procurement and Contracts.

**5.2** Markings: All packages shall be labeled with the following information; manufacturer's name and address, State specification number (#8010-004, dated December 22, 2009), lot number and date of manufacture.

**5.3** Shipping: See the Invitation for Bid.

**5.3.1** Pallets: Bags shall be palletized on pallets furnished by the vendor. The pallets shall become the property of the State of California. The pallets shall meet all the requirements of State Specification 3990-XXX-01, Type II, Size 2. The outside of one stringer shall be stenciled, "Return to Department of Transportation Warehouse".

**5.3.2** Palletizing: 48 bags per pallet. The loaded pallets shall be plastic shrink-wrapped.

California Department of Transportation  
Specification #8010-004 (December 22, 2009)  
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