INCH-POUND
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SUPERSEDING
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FEDERAL SPECIFICATION

BEADS (GLASS SPHERES) RETRO-REFLECTIVE

The General Services Administration has authorized the use of this federal specification by all federal agencies.

1. SCOPE AND CLASSIFICATION.

1.1 This specification covers three types of retro-reflective beads used to reflectorize traffic and airfield marking paints.

1.2 Classification.

1.2.1 Type I - Low Index of Refraction recycled glass (fire-polished process)
Gradation A (Coarse, Drop-on)
Gradation B (Fine, Premix)
Type II - Deleted
Type III - High Index of Refraction
Type IV - Low Index of Refraction direct melt glass (molten glass kiln process)
Gradation A (Large Coarse, Drop-on)
Gradation B (Medium Coarse, Drop-on)

2. APPLICABLE DOCUMENTS.

2.1 Government Publications. The issues of the following documents, in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

FEDERAL LANDS, HIGHWAY

T 520-93 – Determining the Roundness of Large Glass Beads

FEDERAL STANDARDS

Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data which may improve this document should be sent to: HQ AFCESA/CESC, 139 Barnes Drive, Suite 1, Tyndall AFB FL 32403-5319.

FSC 8010

Distribution Statement A Approved for public release. Distribution is unlimited.

FED-STD-141 - Paint, Varnish, Lacquer, and Related Materials; Methods of Inspection, Sampling and Testing

FED-STD-313 – Material Safety Data Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

(Single copies or this specification, and other federal specifications and commercial item descriptions required by activities outside the Federal Government for bidding purposes are available without charge from the General Services Administration, Federal Supply Service, Specification Section, Suite 8100, 470 L'Enfant Plaza, SW, Washington, DC, 20407)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on the date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards:

D 1155 - Standard Test Method for Roundness of Glass Spheres
D 1214 - Standard Test Method for Sieve Analysis of Glass Spheres

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, (610) 832-9500, www.astm.org.)

National Motor Freight Traffic Association, Inc. Agent:

National Motor Freight Classification

(Application for copies should be addressed to the ATA, Inc., Traffic Department, 2200 Mill Road, Alexandria, VA 22314, www.nmfta.org.)

National Railroad Freight Committee, Agent:

Uniform Freight Classification

(Application for copies should be addressed to G.F. Earl, Tariff Publishing Officer, Suite 1120, 222 South Riverside Plaza, Chicago, IL 60606-5945)

3. REQUIREMENTS.

3.1 Composition. The Type I beads shall be manufactured entirely from reclaimed scrap glass (soda lime cullet). No specific ingredients are required for the Type III beads. The Type IV beads shall be manufactured by a direct-melt process resulting in no visible carbon residue.

3.2 Physical properties.

3.2.1 Appearance. When tested as specified in 4.3.1, the beads shall be transparent, clean, dry, free-flowing, and free from bubbles and foreign matter.

3.2.2 Roundness. When tested as specified in 4.3.2, Type I and Type III beads shall contain not less than 80 percent by weight of true spheres. The Type IV beads shall contain not less than 85 percent by weight of true spheres.

3.2.3 Index of refraction. When tested as specified in 4.3.3, the index of refraction shall be as follows: For Type I and Type IV beads 1.50 to 1.55; for Type III beads 1.90 to 1.93.

3.2.4 Specific gravity. When tested as specified in 4.3.4, the specific gravity shall be as follows: For Type I and Type IV beads 2.30 to 2.50; for Type III beads 4.00 to 4.50.[1]

3.2.5 Gradation. When tested as specified in 4.3.5, the beads shall pass each sieve series, as specified in Table I.

Table I. Gradation, percent by weight, passing.

		Type I				Type III		Type IV			
U.S. Sieve #	Microns	A		B				A		B	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
12	1700	---	---	---	---	---	---	100	---	100	---
14	1400	---	---	---	---	---	---	95	100	---	---
16	1180	---	---	---	---	100	---	80	95	95	100
18	1000	---	---	---	---	---	---	10	40	---	---
20	850	100	---	---	---	95	100	0	5	35	70
30	600	80	100	---	---	55	75	---	---	0	5
40	425	---	---	---	---	15	35	---	---	---	---
50	300	18	35	---	---	0	5	---	---	---	---
70	212	---	---	100	---	---	---	---	---	---	---
80	180	---	---	85	100	---	---	---	---	---	---
100	150	0	10	---	---	---	---	---	---	---	---
140	106	---	---	15	55	---	---	---	---	---	---
200	75	0	2	---	---	---	---	---	---	---	---
230	63	---	---	0	10	---	---	---	---	---	---

[1] For field verification, the mass of Type I and Type IV beads should be 1570 grams per liter and Type III should be 2670 grams per liter.

3.2.6 Resistance to acid. When tested as specified in 4.3.6, the beads shall not develop any surface haze or dulling.

3.2.7 Resistance to calcium chloride. When tested as specified in 4.3.7, the beads shall not develop any surface haze or dulling.

3.2.8 Resistance to sodium sulfide. When tested as specified in 4.3.8, the sodium sulfide should not darken the beads.

3.2.9 Water resistance. When tested as specified in 4.3.9, the water shall not produce haze or dulling of the beads, and not more than 4.5 mL of 0.1 N hydrochloric acid shall be used in the titration.

3.3 Material Safety Data Sheet. A Material Safety Data Sheet (MSDS) shall be submitted in accordance with FED-STD-313 (see 6.2).

4. QUALITY ASSURANCE PROVISIONS.

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the government. The government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Quality conformance inspection.

4.2.1 Lot. A lot shall consist of all beads of one type offered for inspection at one time.

4.2.2 Inspection of preparation for delivery. An inspection shall be made to determine that the packing and marking comply with Section 5 of this specification. The sample unit shall be one filled shipping container for each ten ordered, randomly selected from the lot.

4.2.3 Sampling of the end item. Sampling shall be random in the ratio of 45 kg (100 lb) sample (in full bags) per 4,535 kg (10000 lb) shipped. Upon delivery, the material shall be reduced in a sample splitter to a size of approximately 1 kg (2.2 lb). The sample shall be submitted to the laboratory for testing.

4.2.4 Certificate of compliance. When Type I or Type IV beads are offered for inspection, the manufacturer shall certify that the beads conform to the requirements of 3.1.

4.3 Test procedure. The beads shall be tested in accordance with the methods specified in Table II and as otherwise specified herein to determine compliance with the requirements of section 3. Unless otherwise specified all tests shall be conducted at conditions specified in Section 9 of FED-STD-141. All test reports shall contain the individual values used in expressing the final results. Failure to pass any tests, or noncompliance with any requirement, shall be cause for rejection of the sample.

Table II. Tests and methods.

Characteristics	Requirement Paragraph	ASTM Method	Test Method Paragraph
Appearance	3.2.1	--	4.3.1
Roundness	3.2.2	D 1155	4.3.2
Index of refraction	3.2.3	--	4.3.3
Specific gravity	3.2.4	--	4.3.4
Gradation	3.2.5	D 1214	4.3.5
Resistance to acid	3.2.6	--	4.3.6
Resistance to calcium chloride	3.2.7	--	4.3.7
Resistance to sodium sulfide	3.2.8	--	4.3.8
Water resistance	3.2.9	--	4.3.9

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4.3.1 Appearance. Spread thinly 10 g of sample on white bond paper and examine visually for compliance with 3.2.1.

4.3.2 Roundness. The roundness of the Type I and Type III beads shall be determined in accordance with ASTM method D 1155. Use Procedure A for Type III beads and Procedure B for Type I beads. The roundness of the Type IV beads shall be determined in accordance with FLH Designation T 520-93. Evaluate for compliance with the requirements in 3.2.2.

4.3.3 Index of refraction. The index of refraction shall be determined by the immersion method. A microscope capable of a minimum of 100x magnification, equipped with a light source and certified immersion oils shall be used. Place crushed beads on a microscope slide and immerse in a refractive index immersion oil at standard conditions. (The immersion oil shall have a refractive index within 0.02 units of that of the beads to be tested.) Cover with a microscope slide and determine the refractive index of the beads to the nearest one-hundredth of a unit. Evaluate for compliance with the requirements of 3.2.3.

4.3.4 Specific gravity. Place 100 g of the beads in an oven at 105°C ± 2°C and dry to constant weight. Remove the beads and place in a desiccator until the sample is cool. Remove 60 g of beads from the desiccator and weigh the sample accurately. Pour the beads slowly into a 100 mL graduated cylinder containing 50 mL of reagent-grade xylene. Make certain that air is not entrapped among the beads. Calculate the specific gravity as follows:

Specific gravity = $\frac{M}{V-50}$

M = Mass of sample
V = total volume (xylene level after addition)

Evaluate for compliance with 3.2.4.

4.3.5 Gradation. Determine the gradation of the beads in accordance with ASTM method D 1214 for compliance with 3.2.5.

4.3.6 Resistance to acid. Place 10 g of the beads in a 100 mL beaker and cover with a 1N sulfuric acid. Let soak for 5 minutes. Rinse the beads 3 times with distilled water. Dry, then examine the beads under a microscope and compare with the untreated sample. Evaluate for compliance with 3.2.6.

4.3.7 Resistance to calcium chloride. Place 10 g of the beads in a 100 mL beaker and cover with a 1N calcium chloride solution. Let soak for 3 hours. Rinse the beads 3 times with distilled water. Dry, then examine the beads under a microscope and compare with the untreated sample. Evaluate for compliance with 3.2.7.

4.3.8 Resistance to sodium sulfide. Place 10 g of the beads in a glass stopper bottle and cover with a solution containing by weight 50% sodium sulfide, 48% distilled water, and 2% of an anionic wetting agent. Soak the beads for one hour and then rinse the beads 3 times with distilled water. Dry, then examine the beads under a microscope and compare with untreated sample. Evaluate for compliance with 3.2.8.

4.3.9 Water resistance. Place 10 g of the beads in a 20 x 80 mm extraction thimble. Place the thimble in a large (No. 3) Soxhlet extractor with a 125 mL boiling flask. Add 100 mL of distilled water, and reflux for two hours. Rinse the beads 3 times with distilled water. Remove the beads, dry, then examine the beads under a microscope and compare with untreated beads. Add five drops of one percent phenolphthalein indicator to the content of the boiling flask and titrate with 0.1N hydrochloric acid to the phenolphthalein indicator end point. Evaluate for compliance with 3.2.9.

5. PACKAGING.

5.1 Preservation. The glass beads shall be furnished in lots as specified by the purchaser and packaged in moisture-proof containers. Containers shall be in accordance with the supplier's normal commercial practice, provided that there will be no interaction chemically or physically with the contents so as to damage the containers or alter the strength, quality, or purity of the contents. Containers are to be guaranteed to furnish dry and undamaged beads. The container shall be securely closed to prevent accidental opening or loss of the glass beads, and sufficiently strong to prevent

accidental rupture during multiple shipments, handling and storage. The shipping containers shall also comply with the National Motor Freight Classification or Uniform Freight Classification requirements.

5.1.1 Packing. Beads shall be furnished in quantities specified. The preservation, packing and marking shall be as specified below (see 6.2).

5.1.2 Marking. Each package shall contain the following information: Name and address of manufacturer, shipping point, trademark or name, the wording; “Glass Beads, Retro-reflective”, the specification number, bead type, weight of the contents in kg and lb, the lot or batch number, information and warnings as may be required by federal and state laws, and the month and year of manufacture. Additional markings shall be as specified in the contract or order.

6. NOTES.

INFORMATION FOR GUIDANCE ONLY. (This section contains information of a general or explanatory nature that is helpful, but is not mandatory.)

6.1 Intended use.

Type I, Gradation A, coarse - low-index recycled glass beads for drop-on applications are intended for marking highways and all airfield markings.

Type I, Gradation B, fine - low-index glass beads for premixed paint are intended for marking highways, or for use in applying temporary airport or airfield markings.

Type III - high index glass beads for drop-on applications are intended for applications where increased retro-reflectivity is needed.

[NOTE: The increased retro-reflective values obtained from use of high index of refraction glass beads are only apparent to the observer in cases where the observer's line of sight is in close proximity to the path of the light source used to illuminate the markings. Studies by the USAF and the Federal Aviation Administration have shown that in cases where the light source is not in close proximity to the viewer's eye position, the added benefit from the use of the higher index of refraction beads is negligible.]

Type IV Gradation A – Large coarse, direct-melt, low-index glass beads for drop-on applications are intended for highways and all airfield markings.

Type IV Gradation B – Medium coarse, direct-melt, low-index glass beads for drop-on applications are intended for highways and all airfield markings.

See appropriate pavement marking guide for specific recommended uses and application rates.

6.2 Ordering Data. Purchasers should select the preferred options permitted herein and indicate the following information in procurement documents:

a. Title, number, and date of this specification.
b. Type and gradation required (see paragraphs 1.2.1 and 6.1).
c. Size and type of container required (see 5.1).
d. Palletization requirements.
e. Special Marking requirements.
f. Instructions and address for submission of MSDS (see 3.3).

6.3 Key Word Listing.

a. Paint
b. Reflective beads
c. Traffic
d. Airfield

MILITARY INTERESTS

Custodian
Air Force -- 99
Navy -- YD

Reviewing Activity
Air Force – 50

CIVIL AGENCY
COORDINATING ACTIVITIES:

FAA – AAS – 100

Preparing Activity
Air Force-84

Agent activity
Air Force-99

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NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.