

QUALITY STANDARD FOR

TRIFUSION[®]

GLASS COATINGS

FOR USE IN

INDUSTRIAL LIQUID STORAGE TANKS

1. SCOPE

This Standard specifies the quality requirements for the TRIFUSION[®] process for glass coating by vitreous enamelling of panels intended for use in the construction of liquid storage tanks for industrial use.

This Standard applies to the enamelling elements of the TRIFUSION[®] process, however, the quality criteria in Section 5.2 should apply to the tank as built. The TRIFUSION[®] glass coating has been developed with reference to International Standard specifications for glass coatings on bolted steel panels for use in industrial liquid storage tanks such as BS 7793 : Part 2⁽¹⁾, DEZ 4.13⁽²⁾ and SE 6.18/94⁽³⁾.

2. DEFINITIONS

For the purposes of this Standard, the following definitions shall apply.

Glass coating: Any coating, commonly also referred to as vitreous enamel, based on silica glass applied to steel sheets by the TRIFUSION[®] process at temperatures sufficient to cause melting and chemical bonding to the steel so as to form a composite glass/steel panel.

Supplier: Any company supplying Permastore with any materials for use in the TRIFUSION[®] process.

Defect: Any void, break, crack, thin spot, blister, foreign inclusion or contamination of the glass coating.

Resprays: Any panel subjected to an additional application of glass coating following initial inspection.

Discontinuity: Any defect which allows an electric current to pass through the glass coating when testing using the specified instrument operated in accordance with Section 5.2.2.1 of this Standard.

3. GENERAL

The inspection procedures specified in this Standard and the TRIFUSION[®] enamelling process shall be carried out under a quality system accredited to ISO 9001⁽⁴⁾.

4. RAW MATERIALS

4.1 The steel used shall have a specification as agreed between Permastore and the steel supplier having due regard to the requirements of the enamelling process.

4.2 All other raw materials used in the production of the glass coated panels shall be inspected on receipt at Permastore's premises to ensure that they meet Permastore's specifications.

4.3 Where Permastore is not able to inspect raw material against any aspect of Permastore's specification or the specification according to Clause 5.1.1 (for example, chemical composition of steels, flow bead tests of glass etc.), Permastore shall require the supplier to carry out such inspections at the suppliers premises and provide Permastore with authorised copies of certificates for such inspections and record conformity of the raw materials in accordance with the Quality Specification, and make certified copies of those records available.

5. QUALITY

5.1 Glass Coating

Glass coated test samples shall be regularly tested to ensure that the properties of the glass coating meet the requirements of this Standard and Permastore's specification.

5.1.1 Quality Specification

Tests shall be carried out to ensure that the glass coating on the inside panel surface meets the chemical resistance and physical properties specifications set out in Table 1.

TABLE 1 – CHEMICAL RESISTANCE AND PHYSICAL PROPERTIES

	TEST STANDARD	QUALITY SPECIFICATION	MINIMUM TEST FREQUENCY
CHEMICAL RESISTANCE (Inside Surface)			
Citric acid at room temperature	ISO 2722 ⁽⁵⁾	Class AA	Monthly
Boiling citric acid	ISO 2742 ⁽⁶⁾	Maximum weight loss 1.5g/m ² after 2½h	Annually
Boiling distilled water and water vapour: Liquid phase - Vapour phase -	ISO 2744 ⁽⁷⁾	Maximum weight loss 5g/m ² after 48 hours 7.5/m ² after 48 h	Annually
Sodium hydroxide solution at 80°C	ISO 2745 ⁽⁸⁾	Maximum weight loss 2.0g/ m ² /24 h	Annually
Sulphuric acid	BS EN ISO 8290 ⁽⁹⁾	Class 1	Monthly
Hydrochloric acid at room temperature	BS EN ISO 8290 ⁽⁹⁾	Class 2	Annually
Condensing hydrochloric acid vapour: Liquid phase - Vapour phase -	ISO 2743 ⁽¹⁰⁾	Maximum weight loss 6.0g/m ² after 24 h 7.5g/m ² after 24 h	Annually
Hot detergent solution	ISO 4533 ⁽¹¹⁾	Maximum weight loss 5.0g/m ² in 24 h	Annually
PHYSICAL PROPERTIES (Inside Surface)			
Impact	ISO 4532 ⁽¹²⁾ , 20N force.	Maximum cracking 2mm after 24 h	Monthly
Adhesion	BS EN 10209 : Annex D ⁽¹³⁾	Class 2	Monthly
Abrasion	BS 1344 : Part 4 ⁽¹⁴⁾	Maximum weight loss 0.08g cumulative after 30 minutes	Annually
Resistance to heat	ISO 4530 ⁽¹⁵⁾	300°C	Annually
Resistance to thermal shock	ISO 2747 ⁽¹⁶⁾	300°C	Annually
Scratch hardness	EN 101 ⁽¹⁷⁾	Better than Mohs 5	Monthly

5.2 Finished Panels

Finished panels shall be inspected following the enamelling process, prior to packing and despatch from Permastore's premises. Permastore shall carry out inspections on both the inside and the outside surfaces. In cases where both the inside and the outside surfaces of the panel are in contact with the stored liquid both surfaces shall be treated as inside surfaces for the purposes of this Standard.

5.2.1 Inspection of the Outside Surface

The outside surface of all panels shall be inspected visually under good daylight or equivalent lighting for defects in the glass coating. Any panel having visible defects larger than 1mm shall be rejected. Any panel having more than a total of three visible defects per m² of panel area shall be rejected. All visible defects on the outside surface of accepted panels shall be repaired using a repair material approved by Permastore for this purpose and applied according to the repair material manufacturers instructions.

5.2.2 Inspection of the Inside Surface Using a High Voltage Tester

The inside panel surface shall be inspected using a high voltage tester approved by Permastore for this purpose and used in accordance with Clause 5.2.2.1. Inspection shall be carried out using a sampling procedure complying with ISO 2859 : Part 1⁽¹⁸⁾. Any panel having any discontinuities shall be rejected.

5.2.2.1 The tester shall be calibrated using a calibration instrument having an accuracy of $\pm 1\%$, such that the voltage at the test probe is 1100 volts. The tester shall have a valid calibration record.

5.2.3 Inspection of the Glass Thickness

The thickness of the glass shall be measured using an approved instrument suitable for a measurement range of 0-500 μ m which is regularly checked against a calibration standard. Inspection shall be carried out using a sampling procedure complying with ISO 2859 : Part 1⁽¹⁸⁾.

The average thickness of the glass on any panel shall be maintained in the range from 280 μ m to 380 μ m. To accommodate an allowable frequency for resprays the upper

limit of the thickness band can increase by up to 80 μ m providing this is limited to less than 12% of production panels. Panels having an average glass thickness outside these limits shall be rejected.

5.2.4 Inspection of Glass Colour

The outside panel surface shall be inspected using a colour comparator instrument and the colour checked against standard limits set by Permastore. Inspection shall be carried out using a sampling procedure complying with ISO 2859 : Part 1⁽¹⁸⁾. Panels of a colour outside these limits shall be rejected.

6. HANDLING AND PACKING

Prior to storage or packing, all panel edges shall be protected, and all panels shall be packed using a suitable membrane between the panels.

7. GUIDANCE NOTES FOR INSTALLATION AND USE

7.1 Care in Handling

Recommendations for the correct methods of handling outside the enamelling premises are given in the *Permastore Builders Guide*.

7.2 Inspection at the Construction Site

During tank installation, the use of an approved low voltage wet swab tester on the inside panel surface is recommended. Permastore can advise on the use of the low voltage wet swab test equipment. Guidance is also given in the *Permastore Builders Guide*.

7.3 Change of Use

Owners and users of industrial liquid storage tanks should be aware that changes in the use or structure of a tank can result in dramatic changes to the operating environment and affect the coating and design limitations of the tank. Permastore will offer advice on request.

TRIFUSION

8. REFERENCES

1. **BS 7793**
Vitreous Enamel Coatings for Use on Bolted Steel Panels. Part 2 : 1996 : Specification for Coatings on Bolted Steel Panels for Use in Industrial Liquid Storage Tanks.
2. **Deutsches Email Zentrum**
Quality Requirements and Test Regulations for Vitreous / Porcelain Enamels : 1994 : Part A : Section 4.13 : Waste Water Tanks of Steel, Edition 9/96.
3. **Stichting Email : Norm**
SE 6.18/94
Kwaliteitseisen voor Geëmailleerde Industriële Tank met "Email-Keur"
4. **ISO 9001 : 2000**
Quality Systems - Specification for Design/Development, Production, Installation and Servicing. (≅BS EN ISO 9001 : 2000)
5. **ISO 2722 : 1973**
Vitreous and Porcelain Enamels - Determination of Resistance to Citric Acid at Room Temperature. (≅BS 1344 : Part 2 : 1975).
6. **ISO 2742 : 1983**
Vitreous and Porcelain Enamels - Determination of Resistance to Boiling Citric Acid. (≅BS 1334 : Part 8 : 1984).
7. **ISO 2744 : 1998**
Vitreous and Porcelain Enamels - Determination of Resistance to Boiling Water and Water Vapour. (≅BS 1344 : Part 9 : 1998).
8. **ISO 2745 : 1998**
Vitreous and Porcelain Enamels - Determination of Resistance to Hot Sodium Hydroxide. (≅BS 1344 : Part 17 : 1998).
9. **BS EN ISO 8290 : 1998**
Vitreous and Porcelain Enamels - Determination of Resistance to Sulphuric Acid at Room Temperature. (≅BS 1344 : Part 3 : 1998).
10. **ISO 2743 : 1986**
Vitreous and Porcelain Enamels - Determination of Resistance to Condensing Hydrochloric Acid Vapour. (≅BS 1344 : Part 10 : 1987).
11. **ISO 4533 : 1983**
Vitreous and Porcelain Enamels - Determination of Resistance to Hot Detergent Solutions Used for Washing Textiles. (≅BS 1344 : Part 5 : 1984).
12. **ISO 4532 : 1991**
Determination of Resistance of Enamelled Articles to Impact : Pistol Test. (≅BS 1344 : Part 21 : 1993).
13. **BS EN 10209 : 1996**
Annex D : Cold Rolled Low Carbon Steel Flat Products for Vitreous Enamelling - Technical Delivery Conditions.
14. **BS 1344 : 1968**
Method of Testing Vitreous Enamel Finishes : Part 4 : 1968 - Resistance to Abrasion.
15. **ISO 4530 : 1983**
Vitreous and Porcelain Enamelled Manufactured Articles - Determination of Resistance to Heat. (≅BS 1344 : Part 7 : 1984).
16. **ISO 2747 : 1998**
Vitreous and Porcelain Enamels - Enamelled Cooking Utensils : Determination of Resistance to Thermal Shock. (≅BS 1344 : Part 16 : 1998).
17. **EN 101 : 1991**
Method for Determination of Scratch Hardness of Surface According to Mohs. (≅BS 6431 : Part 13 : 1996)
18. **ISO 2859 : 1999**
Sampling Procedures for Inspection by Attribute : Part 1 : 1999 - Sampling Plans Indexed by Acceptable Quality Levels for Lot-by-Lot Inspection. (≅BS 6001 : Part 1 : 1999).