

Design of articles that are to be coated —

Part 8: Recommendations for vitreous enamel coatings

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Committees responsible for this British Standard

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- Association of Manufacturers of Domestic Appliances
- British Bathroom Council
- Institute of Vitreous Enamellers
- UK Steel Association
- Vitreous Enamel Association

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Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Definitions	1
3 Vitreous enamelling	1
Appendix A Diagrams illustrating preferred and deprecated design features for articles to be vitreous enamelled	9
Appendix B Composition of cast iron	14
Figure 1 — Bends	9
Figure 2 — Corners	9
Figure 3 — Rolled edges	9
Figure 4 — Reinforced edges	10
Figure 5 — Flanges	10
Figure 6 — Cut-outs	10
Figure 7 — Embossing	11
Figure 8 — Reinforcement	11
Figure 9 — Lateral jointing	11
Figure 10 — Box sections	12
Figure 11 — Corners of castings	12
Figure 12 — Holes	12
Figure 13 — Sections	13
Figure 14 — Elongated sections	13
Figure 15 — Fluting	13
Table 1 — Recommended thicknesses of sheet steel for different combinations of width and area of flat parts to be vitreous enamelled	7
Publications referred to	Inside back cover

Foreword

This Part of BS 4479 has been prepared under the direction of the Surface Coatings (other than Paints) Standards Policy Committee and is based on a draft prepared by the Institute of Metal Finishing. The BSI Technical Committee acknowledges the contribution to this revision by the Institute¹⁾ and by the Committee for the Promotion of Electroplating. This part of BS 4479 is one of a series of parts which together form a revision of BS 4479:1969. On publication of all the parts, BS 4479:1969 will be withdrawn. This revision of BS 4479 comprises the following parts:

- *Part 1: General recommendations;*
- *Part 2: Recommendations for electroplated and autocatalytic coatings;*
- *Part 3: Recommendations for conversion coatings;*
- *Part 4: Recommendations for paint coatings and varnish coatings;*
- *Part 5: Recommendations for anodic oxidation coatings;*
- *Part 6: Recommendations for hot-dip metal coatings;*
- *Part 7: Recommendations for thermally sprayed coatings;*
- *Part 8: Recommendations for vitreous enamel coatings;*
- *Part 9: Recommendations for low pressure and vacuum deposited coatings.*

BS 4479 is directed towards helping to maximize the benefit obtained from coating processes. There is a wide variety of coating processes, developed and established industrially, intended to enhance or transform the surfaces of manufactured articles. However, time and money are often wasted because the design of many articles is unsuitable for the coating process to be applied. Coating is only one part of the manufacturing process and should not be ignored, or viewed in isolation, when considering the overall costs and quality.

This revision of BS 4479 has been undertaken to extend the range of coating processes covered. It is not intended to cover every conceivable design detail, type of article or service condition. Adherence to the general principles described will, however, greatly assist in the achievement of the desired results. In any case of doubt or difficulty specialist advice in the particular type of process being considered should be sought.

This part of BS 4479 is not a specification and should not be used as such. The recommendations are intended to provide guidance towards good practice.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

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Sidelining in this document indicates the most recent changes by amendment.

¹⁾ Institute of Metal Finishing.

1 Scope

This part of BS 4479 gives recommendations for the design of metal parts that are to be coated by vitreous enamelling using one of the four most commonly used methods whereby such coatings are applied, i.e.:

- a) spray coating techniques;
- b) dip coating techniques;
- c) powder coating techniques;
- d) electrophoretic coating techniques.

This part of BS 4479 outlines the salient features of each method of application and highlights the advantages and limitations of each method.

Recommendations are given for thicknesses of steel to be used for flat parts of varying width and area combinations, and information is given on the composition of cast iron suitable for vitreous enamelling.

NOTE 1 It is recommended that part 1 of BS 4479 be read in conjunction with this part. Part 1 includes a list of British Standards relating to processes covered by BS 4479 but not necessarily referred to in each part.

NOTE 2 The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this part of BS 4479, the following definitions apply.

2.1

vitreous enamel coating

a glazed surface finish produced by the application of a powdered inorganic glass, dry or suspended in water, to metal parts, and its subsequent fusion

2.2

manually sprayed vitreous enamel coating

a vitreous enamel coating applied using a compressed-air assisted, manually operated, pressure spray gun

2.3

electrostatically sprayed vitreous enamel coating

a vitreous enamel coating applied by means of low volume compressed-air assisted spray guns employing a high voltage potential between the components and the gun head

2.4

electrophoretic vitreous enamel coating

a vitreous enamel coating applied by immersing the component in a slurry and passing a low voltage electric current between the two

2.5

significant surface

the part of the article covered or to be covered by the coating and for which the coating is essential for serviceability and/or appearance

2.6

linishing

a process whereby flat surfaces are directionally ground by means of an abrasive bonded to an endless flexible belt

3 Vitreous enamelling

3.1 General

Vitreous enamel coatings are inorganic coatings applied to various metallic parts in order to provide a decorative effect and/or to protect the metal substrate.

Diagrams illustrating preferred and deprecated design features for articles to be vitreous enamelled are given in Appendix A.

3.2 Metal substrates

3.2.1 *Steel sheet*

The steel should have a specification agreed between the vitreous enameller and the steel supplier, having regard to the requirements of the particular enamelling process. In general, cold reduced steel provides a superior enamel substrate to hot rolled material, but is only available up to a thickness of 3.00 mm. Further benefit can be obtained by the use of grades having been specially processed to maximize suitability for an enamelling end-use see a) and b) below. It should also be noted that developments in enamelling technology now mean that under particular conditions, successful enamelling is regularly achieved using hot rolled steels or substrates which have not been specially processed for that end use. In these cases, the steel is supplied without the VE caption or accompanying enhanced properties, and responsibility for satisfactory enamelling results lies with the special expertise of the vitreous enameller.

- a) *Vitreous enamelling (VE) quality*. These are grades whose processing has been dedicated to producing an enamel substrate, and which exhibit increased resistance to enamelling defects. The grades were previously indicated by the suffix "VE" in BS 1449, but reference should now be made to BS EN 10209. Whenever steel is purchased to a special caption, test certificates should be obtained from the steel supplier, in order to provide verification of the special properties.

b) *Decarburized steels*. There are two routes to decarburizing steel, the traditional “open coil annealing” technique and the more recent vacuum degassing process. The vacuum degassed product is normally supplied as a titanium stabilized “interstitial free” steel, exhibiting superior formability and at least equivalent sag resistance to the “open coil annealed” product. Enamellers may find that this grade requires changes to the enamelling process in order to give equivalent enamelling results, especially in single coat white enamelling operations.

Buckling will occur if the relationship of size to thickness is overlooked (see Table 1).

3.2.2 Cast iron

The most suitable cast iron for vitreous enamelling is classified as “grey” (see Appendix B).

Casting techniques should aim for a high quality casting with no chilling, blow holes, washed sand, sharp edges, etc., and it is important to ensure high quality fettling. Further information on the design of articles manufactured from cast iron and to be vitreous enamelled is given in 3.9.

3.3 Pre-vitreous enamelling surface lubricants and rust inhibitors

3.3.1 Steel

It is desirable that the fabricated metal reaches the vitreous enamel processor in prime condition. So that this may be ensured, rust inhibitors and drawing compounds should be employed before, during and following fabrication. However, it is equally important that these coatings can be fully removed prior to the processing by standard vapour or alkaline detergent degreasers.

Before fusion vitreous enamel, except in the powder form, is water suspended and will not absorb any surface contamination. Combustion of organic residues in seams and corners during firing produces adverse chemical reactions in the glass steel/iron fusion. Folded or closed seams are particularly undesirable since cleaning is then almost impossible.

3.3.2 Cast iron

Cast iron is preheated and shotblasted prior to vitreous enamelling, thus removing all surface contaminants. However, it is desirable not to contaminate the furnaces and shotblast equipment with excess abrasives and other contaminants. Obvious recesses in the back of castings should be avoided (see Appendix B).

NOTE Castings will “grow” during the repeated annealing process of vitreous enamelling. Designers should allow approximately 2 mm per 300 mm of length to accommodate for this.

3.4 Spray coating techniques

3.4.1 Processes

The following processes are used:

- a) manual application (see 3.4.2);
- b) electrostatic application (see 3.4.3).

3.4.2 Manual spray coating technique

3.4.2.1 General

Spraying is the most widely used method of applying vitreous enamel finishes because of its speed of application and its adaptability to almost any condition, shape or size of article.

In addition to the conventional types of spray gun for inorganic finishes, there are several special adaptations of standard guns for particular applications and finishes allowing the design engineer additional scope in design. Extension spray heads, for example, are available for spraying the interior of small necked vessels, tubes, pipes, cylindrical objects, etc. These heads may give a disc spray, cone spray, or fan spray and may be directed at a 45° or 90° angle to the direction in which the gun is pointed.

3.4.2.2 Design considerations

Despite the ability to spray awkward shapes by various means as given in 3.4.1, it is still imperative that the design engineer avoids certain shapes if at all possible. The guiding principles given in a) to s) should be observed.

- a) The design should be such that all surfaces are fully accessible for surface preparation and permit complete and uniform application of the sprayed coating.
- b) Suitable areas, brackets, or holes should be made available for the purpose of supporting the component on jigs, etc., during processing and particularly during fusing. They should be sited as inconspicuously as possible to avoid visual aberration or subsequent contact with any corrosive media.
- c) Sharp edges should be avoided by giving corners a minimum radius of 2 mm and smoothing out edges as much as possible. Fins and ribs should be spaced as widely as possible and edges made round and smooth. Corners and edges of indentations should be rounded to a radius of at least a quarter of their depth. If blind holes are essential, they should be shallow with well rounded corners and edges.
- d) The designer should aim to reduce the number of protruding fasteners (bolts, pegs, pins) to a minimum. Welded joints are preferred as they aid shaping of optimal surfaces. Components made in one piece are best if practicable.