

Code of practice for

Cleaning and preparation of metal surfaces

Committees responsible for this British Standard

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- Agricultural Engineers' Association
- Association of Manufacturers of Domestic Electrical Appliances
- British Steel Industry
- British Steel plc
- Institute of Metal Finishing
- Institute of Vitreous Enamellers
- International Tin Research Institute
- Metal Finishing Association
- Metal Sink Manufacturers' Association
- Ministry of Defence
- Vitreous Enamel Development Council
- Welding Institute

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Foreword

This British Standard has been prepared under the direction of the Materials and Chemicals Sector Board. It supersedes CP 3012:1972 which is withdrawn.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

The standard is divided into sections. Section 2 gives recommended practice for cleaning a variety of metals and alloys prior to the application of comprehensive range of coatings (or when no subsequent coating is required). Full details of those methods recommended in section 2 are given in section 3. The designation of the methods conforms alphabetically to that given in DEF STAN 03-2/1 [1]. It is noteworthy, however, that this standard includes a number of processes not referred to in DEF STAN 03-2/1 as they are not generally used in the defence field and vice versa.

The cleaning and preparation of iron and steel prior to painting is already covered by BS 6150:1991, BS 5493:1977 and the various Parts of BS 7079.

It should be emphasized that the methods given for the treatment of metal are indicative of those most commonly used in practice. There are, in addition, numerous proprietary processes and other solution formulations available.

CAUTION. Some of the chemicals and processes referred to in this standard are hazardous to health. If the contractor is unfamiliar with the hazards which may be associated with any material or process, he should consult the supplier.

Nothing in this standard will relieve a contractor of his responsibilities with regard to the provision of protective clothing and the safety of his operations.

Attention is drawn to the appropriate government regulations including the Health and Safety at Work Act etc., 1974 [2] and COSHH Regulations 1988 [3] regarding protective clothing, breathing equipment, clean air and safety.

WARNING. In particular, great care should be taken in handling hydrofluoric acid. It is essential that the manufacturer's instructions be followed implicitly as burns due to contact with the acid may be apparent only after several hours.

NOTE Although it is not part of this Committee's purview, inevitably a number of processes covered by this code of practice are suitable for the preparation of metal surfaces prior to painting.

Attention is drawn to the replacement of the old nomenclature "*w/w*" by "*m/m*" in this standard.

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 to iv, pages 1 to 30, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1.1 Scope

This British Standard gives recommendations for processes for the cleaning of metal surfaces to remove any extraneous or undesirable materials or deposits at any stage of manufacture. Such cleaning processes are also suitable for cleaning prior to adhesive bonding (see also BS 5350-A1:1976), brazing and non-destructive testing. Appropriate stress relieving treatments are also included.

NOTE 1 While some of the methods given might be applicable to the preparation of surfaces before welding, the recommendations regarding stress relief in Annex A do not apply to parts which are to be welded.

NOTE 2 Specific advice should be sought from the purchaser about the treatment of individual products and materials including the need for stress relieving heat treatment, and particularly where the shape, quantity and size will influence the choice of procedures to be adopted.

NOTE 3 For practices applicable to high strength steel bolts special concern is given to minimizing or eliminating the risk of embrittlement. Relevant requirements are stated in BS 7371-1.

This British Standard also covers the processes which are necessary for preparing metals prior to the application of the following surface coatings:

- a) electrodeposited metal coatings;
- b) autocatalytic metal coatings (sometimes referred to as electroless);
- c) conversion coatings;
- d) anodic oxidation coatings;
- e) hot dipped coatings;
- f) sprayed metal coatings;
- g) diffusion coatings;
- h) vitreous and porcelain enamel coatings;
- i) ceramic coatings;
- j) vacuum deposited coatings;
- k) impacted metal coatings.

NOTE 4 This British Standard does not cover in detail the cleaning and preparation of metal surfaces prior to painting although some general recommendations are given where appropriate.

Section 3 of this standard describes methods for the following treatments:

- 1) degreasing;
- 2) descaling;
- 3) pickling;
- 4) etching;
- 5) derusting;
- 6) chemical smoothing;
- 7) chemical polishing;
- 8) electrobrightening;
- 9) electropolishing;
- 10) fluoride anodizing process for cleaning magnesium alloys.

1.2 References

1.2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

Section 2. General cleaning of metal surfaces

2.1 Information to be supplied to the processor

The following information should be given on the drawing or order, when appropriate:

- a) the specification and metallurgical condition of the material of the part;
- b) details of any particularly difficult surface condition or coating required to be removed;
- c) the minimum specified tensile strength (or hardness of the material of the part;
- d) instructions concerning any stress relieving heat treatment required before processing including the limits of temperature and time to be employed;
- e) when necessary, the cleaning method or methods given in this standard which are to be used, together with the condition of the basis metal after cleaning;
- f) the surface coating which is to be applied subsequently;
- g) instructions concerning any post-cleaning de-embrittlement which may be required.

2.2 General provisions

2.2.1 Avoidance of mercury

The mercury content of cleaning solutions (as mercury metal or mercury compounds) should not exceed 5 p.p.m. mercury by mass.

2.2.2 Rinsing

Rinsing is essential after each treatment in an aqueous solution, preferably in a multiple rinse sequence. Contamination and staining problems may be avoided or reduced by the use of demineralized water, especially for the final rinse. Parts should be given a final rinse in a pure solvent (before drying) to prevent deposition of soluble materials which may cause problems in subsequent treatments or service.

NOTE To avoid repetition, rinsing operations are not mentioned in the methods described in this standard, except where special sequences are required.

2.2.3 Drying

Parts to be given further treatment by a dry or non-aqueous process and parts which are not to be subjected to further processing, should be thoroughly dried.

If an air draught is used for this purpose it should be free from oil and other contaminants.

2.2.4 Cleaning treatments

Where necessary for efficient cleaning, more than one cleaning treatment should be given.

2.2.5 Condition of basis metal after cleaning

After final cleaning the following conditions should apply:

- a) the surface is free from foreign matter;
- b) the mechanical properties are not significantly impaired except in so far as they may be recovered by subsequent heat treatment;
- c) the dimensions and surface finish are suitable to achieve the desired coating finish.

2.2.6 Increased efficiency of cleaning

The efficiency of some of the cleaning methods may be increased by the application of ultrasonic or other physical methods, e.g. agitation, but care should be taken to avoid damage to delicate parts and assemblies.

2.2.7 Composite components

When composite components are to be processed, the treatments chosen should be suitable for each constituent material and combination of materials.

2.3 Cast irons

2.3.1 Selection of method of cleaning

It should be borne in mind that treatment of cast iron in acid solutions is liable to set up preferential etching around the graphite grains which may become detached, leaving holes which may entrap treatment solution and give rise to subsequent staining or corrosion.

NOTE Cast irons containing flake graphite are particularly liable to give this effect.

2.3.2 Cleaning prior to electroplating

The parts should be cleaned in accordance with one or more of the methods given in 3.1 to 3.11 as appropriate (methods A to L).

2.3.3 Cleaning prior to autocatalytic nickel plating

The following procedure should be carried out:

- a) cleaning in accordance with one or both of the methods given in 3.1 and 3.6 as appropriate (methods A and F);
- b) acid dip in 50 % (V/V) hydrochloric acid or other suitable acid of density 1.16 g/ml.

NOTE A warm rinse may be found desirable immediately before autocatalytic nickel plating to preheat large components but care has to be taken to ensure that the parts do not dry off before being immersed in the autocatalytic nickel solution.

2.3.4 Cleaning prior to phosphating and the application of other conversion coatings

Clean in accordance with one or more of the methods given in 3.1 to 3.11 as appropriate (methods A to L).

NOTE If inhibited solutions are used for acid pickling, see 3.6 (method F), or for derusting, see 3.9 (method J), it may be necessary to remove adsorbed inhibitor before rinsing and phosphating or the application of other conversion coatings.

2.3.5 Cleaning and preparation for hot tinning¹⁾

NOTE The special methods described in 2.3.5.1 to 2.3.5.3 have been developed for preparing cast irons for hot tinning since cast irons may possess hard siliceous casting skins and their surfaces are often rich in graphite which interferes with the tinning processes.

2.3.5.1 (ITRI) Direct chloride process

The procedure for this process should be carried out as follows.

a) Prepare the parts mechanically by grinding, machining, or coarse abrasive blast cleaning in accordance with 3.4.1 (method D.1). Cutting oils or coolants should not be used during machining. When abrasive blast cleaning is used, metallic shot or grit is preferred.

b) Degrease in accordance with 3.1.1 (method A.1);

c) Grit-blast with fine angular chilled iron grit which will pass a BS 410:1986 test sieve of 212 μm nominal aperture size, or fine abrasive liquid blast clean using alumina, unless the mechanical preparation given in item a) consists of fine grinding.

d) Immerse in an aqueous flux solution of the following composition:

zinc chloride	400 g/l
ammonium chloride	25 g/l
hydrochloric acid of density 1.16 g/ml	100 ml (maximum)

e) Tin the parts using an ebullient flux cover on the first tinning bath, consisting of zinc chloride 73 % (V/V), sodium chloride 18 % (V/V) and ammonium chloride 9 % (V/V). The initial thickness of the flux cover should be about 10 mm but before use it should be thoroughly activated by copious spraying with water, which will make it froth and the thickness may rise to 50 mm to 75 mm.

The pre-fluxed castings should be lowered slowly through the ebullient flux cover into the tin.

2.3.5.2 Proprietary fused salt processes

The proprietary processes available which prepare cast iron for tinning by oxidizing graphite exposed at the surface should normally be used electrolytically.

2.3.5.3 Electroplating with a readily tinnable metal

NOTE 1 The difficulty of tinning over a graphite-contaminated surface may be avoided by electroplating the cast iron with a readily tinnable metal such as iron, copper or nickel, iron plating being preferred.

Iron plating should be carried out as follows.

a) Tumble the parts with a suitable fine abrasive in accordance with 3.4.4 (method D.4) or shot blast with fine abrasive in accordance with 3.4.2 (method D.2).

b) Degrease in an organic solvent vapour in accordance with 3.1.1 (method A.1).

c) Pickle for approximately 2 min in hydrochloric acid in accordance with 3.6 (method F.2).

d) Electroplate with iron until the casting is completely covered.

NOTE 2 A suitable electrolyte consists of a solution of 300 g/l ferrous ammonium sulfate operated at room temperature at a current density of 1 A/dm² to 1.5 A/dm².

e) After rinsing, flux and tin the plated castings immediately.

2.3.6 Cleaning and preparation for hot dip galvanizing

Preparation should be by one of the following procedures.

a) Welding slag, iron scale and moulding sand should be removed mechanically (e.g. by abrasive blast-cleaning, see 3.4.1). After blast-cleaning, an acid dip (dilute hydrochloric acid) is advantageous to remove residual iron dust from the surface prior to fluxing where necessary.

b) A hydrofluoric acid solution (e.g. 30 % (m/m) hydrogen fluoride (HF) diluted to 2 % to 10 % (V/V aqueous solution) is an alternative. Vigorous rinsing and brushing to remove any gelatinous products should follow prior to acid pickling (see 2.4.8) and fluxing where necessary.

WARNING. Rigorous safeguards are needed for operators using hydrofluoric acid.

2.3.7 Cleaning prior to metal spraying (for protection against corrosion and high temperature oxidation)¹⁾

The surface should be degreased in accordance with 3.1 to 3.3 (methods A to C), as appropriate and then roughened by compressed air or centrifugal blasting with a suitable abrasive grit in accordance with 3.4.1 (method D.1). Immediately before spraying it should be free from grease, scale, rust, moisture or other foreign matter. It should be comparable in roughness with a reference surface produced in accordance with Appendix A of BS 2569-2:1965 and should provide an adequate key for the subsequent sprayed metal coating, or meet the requirements of BS 7079-C2:1989, coarse grade.

¹⁾ the information given in this clause has been abstracted from the booklet *Practical hot-tinning* [4] by C.J. Thwaites (published by the International Tin Research Institute) which should be consulted for further information.

2.3.8 Cleaning prior to the application of diffusion coatings

The surface should be cleaned in accordance with one or more of the methods given in 3.1 to 3.11, as appropriate (methods A to L).

2.3.9 Cleaning and preparation for vitreous enamelling

The surface of the casting should be cleaned by blasting in accordance with 3.4.1 (method D.1) using chilled angular grit to remove the chilled surface of the casting and leave an angular finish.

NOTE 1 The correct grade of blasting media will depend upon the degree of cleaning required, but generally a mixture of grade G14 and G15 conforming to BS 2451:1963 is found to be satisfactory.

Unless the castings can be used fresh from the foundry, a burn-off process should be used before the blast-cleaning. This should be carried out at around 700 °C to 750 °C for an appropriate time depending upon the thickness and weight of the casting. Burn-off processes can also sometimes be used to refine the metallurgical structure.

NOTE 2 An annealing ground coat may be used in certain cases so that only one fusing will be necessary in place of two. This will depend upon the quality of the casting.

Castings which have stood for some time should be given heat treatment and blast-cleaning before use.

2.4 Non-corrosion-resisting steels

2.4.1 Selection of method of cleaning

The choice of cleaning methods for medium and high strength steels should be restricted by the recommendations given in 2.4.3 in order to reduce risk of embrittlement by hydrogen absorption during cathodic or acid treatments.

2.4.2 Stress-relieving heat treatment

The appropriate stress-relieving heat treatment given in Annex A should be used.

2.4.3 Cleaning methods²⁾

2.4.3.1 Steels of tensile strength less than 1 000 MPa

The steels should be cleaned in accordance with one or more of the methods as given in 3.1 to 3.11 as appropriate (methods A to L).

2.4.3.2 Steels of tensile strength in the range of 1 000 MPa to 1 400 MPa

No form of cathodic cleaning treatment of these steels should be carried out. The parts should be cleaned in accordance with one or more of the methods given in 3.1, 3.2, 3.4, 3.8 and 3.10 (methods A, B, D, H and K).

NOTE Methods D.2 and K.1 are preferred.

2.4.3.3 Steels of tensile strength in the range of 1 400 MPa to 1 800 MPa

The steels should be cleaned by one or more of the following methods:

- a) degreasing in an organic solvent in accordance with 3.1.1 or 3.1.2 (method A.1 or A.2);
- b) degreasing in an aqueous alkaline solution in accordance with 3.2.2 (method B.1), with applied anodic direct current if desired. Neither cathodic nor alternating current treatments should be used;
- c) alkaline derusting in accordance with 3.10.2 (method K.1);
- d) abrasive cleaning in accordance with 3.4 (method D). This method, especially grit blasting in accordance with 3.4.1 (method D.1), leaves the surface readily corrodible, and further processing should be given without any delay;
- e) anodic etching in a sulfuric acid solution in accordance with 3.8 (method H), subject to close control. Additionally, parts should be connected and the current switched on before the parts are immersed in the solution, and after treatment the parts should be withdrawn rapidly before the current is finally switched off, and washed immediately. The sulfuric acid should at no time contain more than 11 p.p.m. by volume of oxidizable material calculated as sulfur dioxide, determined in accordance with Annex B;
- f) acid pickling in an inhibited acid solution in accordance with 3.6 (method F.1) followed, if desired and subject to agreement, by a dip in plain acid in accordance with 3.7 (method G) and then by baking prior to further treatment, at not less than 190 °C for not less than 4 h.
- g) electrolytic derusting using an alkaline electrolyte and anodic current.

2.4.3.4 Steels of tensile strength greater than 1 800 MPa

Steels should be cleaned by one or more of the following treatments:

- a) degreasing in an organic solvent in accordance with 3.1.1 or 3.1.2 (method A.1 or A.2);
- b) alkaline treatments, in accordance with items b), c), and g) of 2.4.3.3;
- c) abrasive cleaning in accordance with item d) of 2.4.3.3.

²⁾ The information in this clause has been abstracted from the booklet *Practical hot-tinning* [4] by C.J. Thwaites (published by the International Tin Research Institute) which should be consulted for further information.

2.4.4 Cleaning prior to electroplating

The parts should be cleaned in accordance with one or more of the methods given in 2.4.3 appropriate to the tensile strength of the steel but may require activation by immersion in a weak acid for up to 60 s.

NOTE If inhibited solutions are used for acid pickling, see 3.6 (Method F), or for derusting, see 3.9 (method J), it may be necessary to remove adsorbed inhibitor from the surface by acid dipping, see 3.6 (method F without inhibitors) or by suitable alkaline solution, see 3.2 (method B) before chemical smoothing, see 3.11, (method L), and/or electroplating.

2.4.5 Preparation for autocatalytic nickel plating

2.4.5.1 Steels of tensile strength less than 1 000 MPa

The following procedure should be carried out:

- clean in accordance with one or more of the methods given in 3.1 to 3.6 (methods A to F), as appropriate;
- acid dipping in 50 % (V/V) hydrochloric acid or other suitable acid of density 1.16 g/ml;
- autocatalytic nickel plating.

NOTE 1 An alkaline periodic reverse current cleaner (10 s each way finishing anodically) can be used as an alternative to the activating treatment for stage b). Cathodic treatments alone may cause hydrogen embrittlement and prolonged anodic treatments are undesirable because of the risk of passivating the surface.

NOTE 2 A warm rinse may be found desirable immediately before stage c) to preheat large components but care should be taken to ensure that the parts do not dry off before being immersed in the autocatalytic nickel solution.

2.4.5.2 Steels of tensile strength in the range of 1 000 MPa to 1 400 MPa

The following procedure should be carried out.

- cleaning in accordance with one or more of the methods given in 3.1 to 3.6 (methods A to F), as appropriate;
- anodically etching in accordance with 3.8 (method H), for 1 min to 3 min;
- rinsing very thoroughly to remove all viscous sulfate solution from the surface;
- autocatalytic nickel plating.

2.4.6 Cleaning prior to phosphating and the application of other conversion coatings

One or more of the methods given in 2.4.3 appropriate to the phosphating or other process and to the tensile strength of the steel should be used. Before phosphating, a conditioner or grain refiner may be used.

2.4.7 Cleaning and preparation for hot tinning³⁾

2.4.7.1 Normal mild steels

The parts should be cleaned in accordance with 3.1.1 (method A.1) or 3.2.2 (method B.1), followed by either method F.1 or method F.2 given in 3.6.

2.4.7.2 "Difficult" mild steels

NOTE 1 Certain batches of mild steel sheet and strip are more difficult to tin than others, coatings tending to de-wet even when the usual methods of cleaning and pickling are thoroughly carried out. Such steels are called "difficult" steels. They possess a non-reactive surface skin formed by the polymerization of certain rolling lubricants present on the surface during low temperature bright annealing, or during such operations as pressing and spinning.

"Difficult" steels should be prepared for tinning by one of the following methods, as appropriate to the particular component:

- abrasive cleaning in accordance with 3.4.1 or 3.4.2 (method D.1 or D.2);
- heat treatment within the temperature range 700 °C to 850 °C for sufficient time for the component to reach the operating temperature of the furnace. The temperature employed should be the lowest which will effectively oxidize the surface contaminant and should be determined by carrying out trials on test pieces from the same batch of material. Any loose scale should be brushed off the component, see 3.4.5 (method D.5), which is then treated in accordance with 2.4.7.1;
- etching in nitric acid. If there is any visible rust or scale on the article it should be treated in accordance with 2.4.7.1. It should then be immersed in an approximately 10 % (V/V) solution of nitric acid of density 1.42 g/ml at a temperature of approximately 25 °C. An immersion time of 1 min to 3 min is normally sufficient. The article should be rinsed, dipped for approximately 1 min in dilute hydrochloric acid in accordance with 3.6 (method F.2), and rinsed again.

NOTE 2 It is then ready for fluxing and tinning.

- etching in nitric-sulfuric acid mixture. The article should be immersed in a solution containing approximately 4 % (m/m) of nitric acid of density 1.5 g/ml and 20 % (m/m) of sulfuric acid of density 1.84 g/ml at 25 °C to 40 °C for about 4 min to 6 min. The removal of any rust or scale should be carried out in accordance with method F.1 or F.2 given in 3.6 before or after the etching in the nitric-sulfuric acid mixture.

³⁾ The information given in this clause has been abstracted from the booklet *Practical hot-tinning* [4] by C.J. Thwaites (published by the International Tin Research Institute which should be consulted for further information).

2.4.8 Cleaning and preparation for hot dip galvanizing⁴⁾

2.4.8.1 Steel (other than castings)

Preparation should be by the following general procedures.

- a) Degreasing, if required, is generally in a hot alkaline solution, the strength of the alkali being related to the amount of grease to be removed.
- b) Abrasive blast-cleaning may be used to remove millscale and other mechanical methods (e.g. chipping) may be used to remove slag from the unclean welds. Paint may also be removed mechanically or by chemical paint strippers. Pickling etc. follows.
- c) Pickling is generally in cold hydrochloric acid at room temperature (18 °C or above), typically made initially by diluting commercial 27.5 % (m/m) acid with an equal volume of water. Hot sulfuric acid may alternatively be used (e.g. 10 % to 14 % (m/m) sulfuric acid at 60 °C to 65 °C). Pickling inhibitors to reduce attack on the basis metal are often added.
- d) A flux coating of dry iron chloride salts (from hydrochloric acid pickling), zinc ammonium chloride or proprietary flux is then normally applied before immersion in the molten zinc.

2.4.8.2 Steel castings

Preparation should be carried out using one of the following procedures.

- a) *Abrasive blast-cleaning with chilled iron or steel grit* in accordance with 3.4.1 (method D.1) to remove moulding sand and iron scale. After blasting, methods F.1 or F.2 given in 3.6 may be used and where necessary a flux coating should be applied.
- b) *Hydrofluoric acid* [30 % (m/m)] diluted to 2 % (V/V) to 10 % (V/V) aqueous solution may be used, followed by hosing with water to remove any gelatinous products. After hosing, method F.2 given in 3.6 is used and if necessary a flux coating should be applied.

WARNING. Rigorous safeguards are needed for operators using hydrofluoric acid.

2.4.9 Cleaning for metal spraying (for protection against corrosion and high temperature oxidation)⁵⁾

The surface should be degreased in accordance with 3.1 to 3.3 (methods A to C) where necessary and as appropriate and then roughened by compressed air or centrifugal blasting with a suitable abrasive grit in accordance with 3.4.1 (method D.1).

NOTE 1 After preparation the surface should be sprayed without undue delay.

Immediately before spraying the surface should be free from grease, scale, rust, moisture, or other foreign matter. It should be comparable in roughness with a reference surface produced in accordance with appendix A of BS 2569-2:1965 and should provide an adequate key for the subsequent sprayed metal coating.

NOTE 2 Depending on the geometry of the component, normal methods of preparation may not prove satisfactory due to the risk of distortion. Material thinner than 3 mm cannot always be satisfactorily prepared for metal spraying; the metal sprayer should be consulted.

2.4.10 Cleaning prior to the application of diffusion coatings

The surface should be cleaned in accordance with one or more of the methods given in 2.4.3, according to the tensile strength of the steel.

2.4.11 Cleaning and preparation for vitreous enamelling

2.4.11.1 Conventional enamelling

The surface should be cleaned and prepared as follows.

- a) Subject the surface to vapour degreasing in accordance with 3.1.1 (method A.1) or abrasive blasting in accordance with 3.4 (method D), where appropriate.

NOTE 1 Vapour degreasing is optional but may be preferred for components with welded seams.

- b) Clean in an alkaline solution in accordance with 3.2 (method B), with or without prior vapour degreasing. Rinse in hot and cold water.
- c) Acid pickle in accordance with 3.6 (method F.1 or F.2). Wetting agents and inhibitors should be avoided.
- d) Rinse.

⁴⁾ The information given in this clause has been abstracted from *General galvanizing practice* [5] (published by the Galvanizers' Association), which should be consulted for further information.

⁵⁾ For further information see BS 2569-2:1965 and BS EN 22063:1994.