AS/NZS 4680:2006

AS/NZS 4680:2006

Australian/New Zealand Standard™

Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

STANDARDS Australia

STANDARDS NEW ZEALAND PAEREWA AOTEAROA

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee MT-009, Metal Finishing. It was approved on behalf of the Council of Standards Australia on 3 August 2006 and on behalf of the Council of Standards New Zealand on 11 August 2006.
This Standard was published on 30 August 2006.

The following are represented on Committee MT-009:

Australasian Institute of Metal Finishing
Australian Aluminium Council
Australian Chamber of Commerce and Industry
Australian Industry Group
Australian Paint Manufacturers' Federation
Bureau of Steel Manufacturers of Australia
Department of Defence
Galvanizers Association of Australia
Institute of Materials Engineering Australasia
Pacific Coilcoaters
Society of Automotive Engineers
The Royal Australian Chemical Institute

Keeping Standards up-to-date

Standards are living documents which reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued. Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments which may have been published since the Standard was purchased.

Detailed information about joint Australian/New Zealand Standards can be found by visiting the Standards Web Shop at www.standards.com.au or Standards New Zealand web site at www.standards.co.nz and looking up the relevant Standard in the on-line catalogue.

Alternatively, both organizations publish an annual printed Catalogue with full details of all current Standards. For more frequent listings or notification of revisions, amendments and withdrawals, Standards Australia and Standards New Zealand offer a number of update options. For information about these services, users should contact their respective national Standards organization.

We also welcome suggestions for improvement in our Standards, and especially encourage readers to notify us immediately of any apparent inaccuracies or ambiguities. Please address your comments to the Chief Executive of either Standards Australia or Standards New Zealand at the address shown on the back cover.

This Standard was issued in draft form for comment as DR 05584.

Australian/New Zealand Standard™

Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

Originated as part of AS K53.1—1934.
Previous edition AS/NZS 4680:1999.
Second edition 2006.

COPYRIGHT

© Standards Australia/Standards New Zealand

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher.

Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 7697 3

PREFACE

This Standard was prepared by the Joint Standards Australian/Standards New Zealand Committee MT-009, Metal Finishing, to supersede AS/NZS 4680:1999, *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.*

The objective of this Standard is to specify the requirements for hot-dip galvanized (zinc) coatings applied to general fabricated ferrous products.

The objective of this revision is to revise the hot-dip galvanized coating specifications.

Although International Standard ISO 1461 covers the hot-dip galvanizing process for general fabricated ferrous articles, Committee MT-009 considered that the present document is more appropriate to Australian industry conditions and is more user friendly.

The term 'normative' and 'informative' have been used in this Standard to define the application of the appendix to which they apply. A 'normative' appendix is an integral part of a Standard, whereas an 'informative' appendix is only for information and guidance.

CONTENTS

Page

1 SCOPE 4
2 REFERENCED DOCUMENTS 4
3 DEFINITIONS 5
4 DESIGN REQUIREMENTS 6
5 BASIS METAL 6
6 GALVANIZING PROCESS 6
7 APPEARANCE AND FREEDOM FROM DEFECTS 7
8 REPAIR AFTER GALVANIZING 7
9 COATING MASS AND THICKNESS 9
10 ADHERENCE OF COATING 9

APPENDICES
A PURCHASING GUIDELINES 11
B MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD 12
C RECOMMENDED PROCEDURES FOR THE DESIGN AND PREPARATION OF ARTICLES FOR GALVANIZING 14
D PROPERTIES OF THE STEEL TO BE COATED, WHICH CAN AFFECT OR BE AFFECTED BY HOT-DIP GALVANIZING 17
E DUPLEX ADDED PROTECTION FOR GALVANIZING PLACE BELOW GROUND 19
F TRANSPORT AND STORAGE OF GALVANIZED ARTICLES 20
G DETERMINATION OF COATING MASS AND LOCAL THICKNESS 21
H GENERAL INFORMATION ON FACTORS THAT AFFECT THE CORROSION OF GALVANIZED STEEL 23
I INFORMATION ON THE USE OF SWEEP (BRUSH) BLAST CLEANING OF GALVANIZED STEEL PRIOR TO PAINTING 26

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

1 SCOPE

This Standard specifies requirements and tests for hot-dip zinc coatings on fabricated ferrous articles including structural steel, steel reinforcements, steel sheet fabrications, assembled steel products, tubular fabrications, fabricated wire work, steel forgings, steel stampings, ferrous castings, nails and other small components.

This Standard applies to both centrifuged and non-centrifuged articles.

This Standard does not apply to products such as wire and welded wire fabric (see AS/NZS 4534), sheet (see AS 1397) or open sections (see AS/NZS 4791) and tube hot-dip galvanized in continuous, semi-continuous or specialized plants (see AS/NZS 4792).

NOTES:

1 Advice and recommendations on information to be supplied by the purchaser to the hot-dip galvanizer at the time of enquiry or order are contained in the purchasing guidelines set out in Appendix A.

2 Means for demonstrating compliance with this Standard are given in Appendix B.

3 After-treatment of hot-dip galvanized articles is not covered by this Standard. Such treatment (if any) should be specified separately by the purchaser.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1199 Sampling procedures for inspection by attributes
1199.0 Part 0: Introduction to the ISO 2859 attribute sampling system
1199.1 Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection

1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)

1397 Steel sheet and strip—Hot dipped zinc-coated or aluminium/zinc-coated

1627 Metal finishing—Preparation and pretreatment of surfaces
1627.4 Part 4: Abrasive blast cleaning of steel

1815 Metallic materials—Rockwell hardness test (series)

1816 Metallic materials—Brinell hardness test (series)

1817 Metallic materials—Vickers hardness test (series)

2331 Methods of test for metallic and related coatings
2331.1.3 Method 1.3: Local thickness tests —Magnetic method
2331.1.4 Method 1.4: Local thickness tests—Magnetic induction and eddy current methods
2331.2.1 Method 2.1: Tests for average coating mass per unit area or for thickness—Dissolution methods—Strip and weigh, and analytical
2331.2.3 Method 2.3: Tests for average coating mass per unit area or for thickness—Hydrogen evolution method for zinc coatings

AS
2331.3.1 Method 3.1: Corrosion and related property tests—Neutral salt spray test (NSS) test

3894 Site testing of protective coatings
3894.3 Method 3: Determination of dry film thickness

AS/NZS
2243 Safety in laboratories
2243.1 Part 1: Planning and operational aspects
2243.2 Part 2: Chemical aspects

2312 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings

3750 Paints for steel structures
3750.9 Part 9: Organic zinc-rich primer
3750.15 Part 15: Inorganic zinc silicate paint

4534 Zinc and zinc/aluminium-alloy coatings on steel wire

4791 Hot-dip galvanized (zinc) coatings on ferrous open sections, applied by an in-line process

4792 Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process

AS/NZS ISO
9001 Quality management systems—Requirements

9004 Quality management systems—Guidelines for performance improvements

HB 18.28 Conformity assessment—Guidance on a third party certification system for products

ISO
2063 Thermal spraying—Metallic and other inorganic coatings—Zinc, aluminium and their alloys

3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

3.1 Coating mass

The total mass of hot-dip galvanized coating per unit surface area of steel base, *on a single surface*, expressed in grams per square metre.

3.2 Coating mass, average

The mean value of local coating masses measured using test pieces representing either one large article or all items of an inspection batch.

3.3 Coating mass, local

The coating mass at a reference area, expressed in grams per square metre.

3.4 Coating thickness

The total thickness of hot-dip galvanized coating, *on a single surface,* expressed in micrometres.

3.5 Coating thickness, average

The mean value of local thicknesses measured either on one large article or on all items of an inspection batch, expressed in micrometres.

COPYRIGHT

3.6 Coating thickness, local

The coating thickness at a reference area, expressed in micrometres.

3.7 Galvanizer

A person, persons or organization responsible for the coating of the article with molten zinc.

3.8 Hot-dip galvanized coating

A coating consisting of zinc-iron alloys covered by zinc, obtained by the hot-dip galvanizing process.

NOTE: The term 'hot-dip galvanized coating' is subsequently referred to as the 'coating'.

3.9 Hot-dip galvanizing

A process comprising pretreatment, and molten zinc baths in which steel products are dipped so as to form adherent zinc and zinc-iron alloy coatings.

3.10 Reference area

The area within which a specific number of single measurements is required to be made.

3.11 Significant surface

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

4 DESIGN REQUIREMENTS

The article should be designed to suit the galvanizing process. It shall contain the necessary holes or sheared corners for filling, venting or draining, and shall be designed to minimize the possibility of dimensional change and embrittlement occurring during the galvanizing process.

NOTES:

1 Recommended procedures for the design, selection, composition and preparation of materials prior to galvanizing are listed in Appendix C. Guidelines to minimize the possibility of dimensional change resulting from the galvanizing process are also given in Appendix C.

2 Guidelines to minimize the possibility of embrittlement are given in Appendix D.

5 BASIS METAL

The mechanical properties of some steel types can be adversely affected by the coating process; these steels may require special treatment.

NOTES:

1 The mechanical properties of the structural steels most commonly galvanized are not affected by the galvanizing process.

2 Information on the effects of chemical composition, surface condition, mass of the article to be galvanized, the galvanizing conditions, and the appearance, thickness, texture and physical/mechanical properties of the galvanized coating, is given in Appendix D.

6 GALVANIZING PROCESS

6.1 Pretreatment

The articles to be galvanized shall be cleaned and fluxed to a condition that will allow the galvanizing reaction to take place.

COPYRIGHT

6.2 Bath composition

The molten metal in the working area of the galvanizing bath shall contain not less than 98% by mass of zinc. The bath may contain certain deliberately added elements to achieve special properties (see Appendix D, Paragraph D3).

6.3 Threaded components

If threaded components are galvanized in batches, surplus zinc shall be removed from threads by a process such as centrifuging or brushing. If threaded components are attached to fabricated articles, the extent of removal of excess zinc from the threads is subject to agreement between the purchaser and the galvanizer.

7 APPEARANCE AND FREEDOM FROM DEFECTS

The galvanized coating shall be continuous and as smooth and evenly distributed as possible and shall be free of defects that may affect the stated use of the article. The coating shall be free from blisters, i.e. raised areas separated from the solid metal, roughness, sharp points and flux residues. Lumps and zinc ash are not permitted where they may affect the intended end use of the galvanized product. Any wet storage staining which is formed at the galvanizer's plant shall be removed prior to the material leaving the plant, unless prior arrangements have been made. The underlying coating thickness after this removal treatment shall exceed the specified minimum value.

NOTES:

1 When renovating damaged coatings or uncoated areas the method should be one of those specified in Appendix E.

2 Advice on the transport and storage of galvanized articles is given in Appendix F.

3 Where a superior surface finish is required or the presence, size or frequency of any defects in the coating is considered to be of concern, appropriate arrangements should be made between the purchaser and the galvanizer. This may be achieved by the provision of acceptable type samples or methods of test.

4 Articles galvanized after fabrication have a thicker, less smooth coating when compared with continuously galvanized products such as sheet or wire.

5 If the galvanized product is to be subsequently painted or powder coated, the galvanizer should be advised at the time of order, as extra work may be required to ensure that the agreed finish is obtained.

6 Steels of certain compositions or articles slowly cooled after galvanizing may cause the finish of the coated object to become partly or wholly grey in colour. Provided that such a coating has adequate adhesion, the grey finish is not detrimental, although it may cause premature staining to occur in service.

7 Wet storage stain (white or dark corrosion products primarily of basic zinc oxide, formed during storage in humid conditions after hot-dip galvanizing) which occurs after the product leaves the galvanizer's factory is not a cause for rejection.

8 Stains resulting from acid salts weeping from overlapping surfaces cannot be avoided and should not be cause for rejection.

8 REPAIR AFTER GALVANIZING

8.1 Extent of repairable damaged or uncoated areas

For objects galvanized after fabrication, the sum total of the damaged or uncoated areas shall not exceed 0.5% of the total surface area or 250 cm^2, whichever is the lesser, and no individual damaged or uncoated area shall exceed 40 cm^2. Uncoated areas greater than 40 cm^2 which have been caused by unavoidable air locks or prior contamination of the steel surface shall be repaired. Repairs shall be carried out in accordance with Clause 8.2.

COPYRIGHT

8.2 Repair requirements

Surfaces that remain uncoated during the galvanizing process as outlined above and require repair, shall be repaired by the application of one of the following coatings:

(a) Organic zinc rich epoxy paint complying with AS/NZS 3750.9. This is to be applied to the repair areas in two coats. Each coat shall have a minimum dry film thickness of 50 µm.

(b) Inorganic zinc silicate paint complying to AS/NZS 3750.15. This shall have a minimum dry film thickness of 100 µm.

NOTE: For subsequent powder coating, these two coating repair systems should be capable of passing 1000 hour neutral salt spray performance when tested in accordance with AS 2331.3.1 and should be stable under powder coating curing conditions.

(c) Zinc metal spray to ISO 2063 or AS/NZS 2312.

(d) Zinc alloy solder stick.

All of the above treatments shall be applied as per manufacturers' requirements and shall include any necessary pre-treatment to ensure good adhesion to the substrate.

The coating thickness on the renovated area shall be a minimum of 30 µm more than the local coating thickness requirements in Tables 1 and 2 for the relevant hot dip galvanized coating unless the purchaser advises the galvanizer otherwise e.g., when the galvanized surface is to be over coated and the thickness for renovated areas is to be the same as for the hot dip galvanized coating.

The selected coating on the renovated areas shall be capable of giving sacrificial protection to the steel to which it is applied.

If a further coating has been specified by the purchaser for aesthetic or further protective purposes, the purchaser and applicator of such coatings shall assure themselves that they are compatible with the repair methods and materials used in the repair of uncoated areas.

8.3 Repair after site handling and installation

The same procedures and quality of repair products shall apply as for galvanizing process works.

Given the less specific facilities available on site, particular care is required with surface preparation and ensuring the most suitable method needed with the minimum 100 µm dry film thickness described.

8.4 Site repair

Galvanizing rectification described in Clause 8.2 as part of a plant process, shall also apply to site work for the repair of damage from steel handling impact, erection damage or site welding.

NOTES:

1 Optimum power tool cleaning to approach abrasive blasting preparation is a necessity to achieve the quality and film thickness required. The compromise not available in the case of thermal zinc spray work which should be blast cleaned.

2 Site facilities lack workshop application access, protection from weather or the close proximity to work surface for normal quality control. Consideration of the above factors in choosing the method, including sufficient time and priority to ensure preparation to achieve adequate coating thickness.

Close supervision shall be required to compensate for the absence on workshop controls.

COPYRIGHT

9 COATING MASS AND THICKNESS

9.1 Coating mass

The coating mass shall be determined on significant surfaces in accordance with Appendix G, Paragraph G2, G3 or G4 and shall comply with the relevant requirements of Tables 1 and 2. In case of dispute, the test method selected shall be agreeable to both the purchaser and the galvanizer.

If an article includes a number of different thicknesses of steel, each thickness range shall be regarded as a separate article and the relevant values in Table 1 or 2, as appropriate, shall apply.

The coating mass may also be derived by conversion from coating thickness measurements carried out in accordance with the requirements of Clause 9.2. The results shall comply with the requirements of Table 1 or 2.

NOTE: General information on factors that affect the corrosion of galvanized steel is given in Appendix H.

9.2 Coating thickness

When determined in accordance with Appendix G, Paragraph G5, the coating thickness on significant surfaces shall be not less than the values given in Table 1 or Table 2. If an article includes a number of different thicknesses of steel, each thickness range shall be belonging to as a separate article and the relevant values in Table 1 or 2, as appropriate, shall apply.

Where large articles, e.g. structural steel fabrications, are tested by the magnetic method, the local coating thickness shall be the average of 10 determinations performed randomly over an area of 20 cm^2 (the reference area). The average thickness shall be the mean of the values taken from three separate test areas (i.e. the mean of 30 determinations).

Unless otherwise specified, thickness measurements shall be carried out at positions not less than 10 mm away from edges, flame cut surfaces and corners.

10 ADHERENCE OF COATING

The coating shall be sufficiently adherent to withstand normal handling without peeling or flaking. The coating adherence shall also comply with any additional requirements of the customer's specification nominated at the time of enquiry or order.

NOTE: Adhesion between zinc and the basis metal generally does not need to be tested, as adequate bonding is a characteristic of the galvanizing process. The coated work should be able to withstand handling consistent with the nature and thickness of the coating, and normal usage, without peeling or flaking. In general, thick coatings require more careful handling than thin coatings. Bending or forming after hot-dip galvanizing is not considered to be normal handling.

COPYRIGHT

TABLE 1

REQUIREMENTS FOR COATING THICKNESS AND MASS FOR ARTICLES THAT ARE NOT CENTRIFUGED

Article thickness mm	Local coating thickness minimum µm	Average coating thickness minimum µm	Average coating mass minimum g/m²
≤1.5	35	45	320
>1.5 ≤3	45	55	390
>3 ≤6	55	70	500
>6	70	85	600

NOTE: 1 g/m² coating mass ≡ 0.14 µm coating thickness.

TABLE 2

REQUIREMENTS FOR COATING THICKNESS AND MASS FOR ARTICLES THAT ARE CENTRIFUGED

Thickness of articles (all components including castings) mm	Local coating thickness minimum µm	Average coating thickness minimum µm	Average coating mass minimum g/m²
<8	25	35	250
≥8	40	55	390

NOTES:

1 For requirements for threaded fasteners refer to AS 1214.

2 1 g/m² coating mass ≡ 0.14 µm coating thickness.

COPYRIGHT

APPENDIX A

PURCHASING GUIDELINES

(Informative)

A1 GENERAL

This Standard is intended to include the technical provisions for relevant products, but does not purport to comprise all the necessary provisions of a contract. This Appendix contains recommendations on the information to be supplied by the purchaser at the time of enquiry or order.

A2 INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser should supply the following information at the time of enquiry or order:

(a) Reference to this Standard, i.e. AS/NZS 4680.

(b) The nature, chemical composition and mechanical properties of the product to be galvanized, and its end use (a drawing and sample are useful).

(c) Any mechanical work required, such as drilling (see Clause 4 and the note to Paragraph C6.1).

(d) Any special requirements for frequency of testing.

(e) Whether a passivation coating is required.

(f) Whether removal of surplus zinc on threads is required (see Clause 6.3).

(g) Whether an additional test for uniformity or adherence of the coating is required.

(h) Details of test requirements should be included.

(i) Whether a test report covering coating mass or thickness is required.

(j) Requirements for independent testing, if applicable.

(k) Whether it is the intention of the purchaser to inspect the coated product prior to delivery.

(l) Location of significant surfaces.

(m) Any special or supplementary requirement of the coating, e.g. for a special finish such as powder coating, or requirements for pretreatment or post-treatment.

NOTE: Information on the use of sweep or brush blast cleaning of galvanized steel is given in Appendix I.

(n) Any special coating thickness requirements.

(o) Instructions for renovation of damaged or uncoated areas (see Appendix E).

(p) Relevant quality Standard, if applicable.

COPYRIGHT

APPENDIX B

MEANS FOR DEMONSTRATING COMPLIANCE WITH THIS STANDARD

(Informative)

B1 SCOPE

This Appendix sets out the following different means by which compliance with this Standard can be demonstrated by the manufacturer or supplier:

(a) Evaluation by means of statistical sampling.

(b) The use of a product certification scheme.

(c) Assurance using the acceptability of the supplier's quality system.

(d) Other such means proposed by the manufacturer or supplier and acceptable to the customer.

B2 STATISTICAL SAMPLING

Statistical sampling is a procedure which enables decisions to be made about the quality of batches of items after inspecting or testing only a portion of those items. This procedure will only be valid if the sampling plan has been determined on a statistical basis and the following requirements are met:

(a) The sample needs to be drawn randomly from a population of product of known history. The history needs to enable verification that the product was made from known materials at essentially the same time, by essentially the same processes and under essentially the same system of control.

(b) For each different situation, a suitable sampling plan needs to be defined. A sampling plan for one manufacturer of given capability and product throughput may not be relevant to another manufacturer producing the same items.

In order for statistical sampling to be meaningful to the customer, the manufacturer or supplier needs to demonstrate how the above conditions have been satisfied. Sampling and the establishment of a sampling plan should be carried out in accordance with AS 1199.1, guidance to which is given in AS 1199.0.

B3 PRODUCT CERTIFICATION

The purpose of product certification is to provide independent assurance of the claim by the manufacturer that products comply with the stated Standard.

The certification scheme should meet the criteria described in HB 18.28 in that, as well as full type testing from independently sampled production and subsequent verification of conformance, it requires the manufacturer to maintain effective quality planning to control production.

The certification scheme serves to indicate that the products consistently conform to the requirements of the Standard.

COPYRIGHT

B4 SUPPLIER'S QUALITY SYSTEM

Where the manufacturer or supplier can demonstrate an audited and registered quality management system complying with the requirements of the appropriate or stipulated Australian or international Standard for a supplier's quality system or systems, this may provide the necessary confidence that the specified requirements will be met. The quality assurance requirements need to be agreed between the customer and supplier and should include a quality or inspection and test plan to ensure product conformity.

Information on establishing a quality management system is set out in AS/NZS ISO 9001 and AS/NZS ISO 9004.

B5 OTHER MEANS OF ASSESSMENT

If the above methods are considered inappropriate, determination of compliance with the requirements of this Standard may be assessed from the results of testing coupled with the manufacturer's guarantee of product conformance.

Irrespective of acceptable quality levels (AQLs) or test frequencies, the responsibility remains with the manufacturer or supplier to supply products that conform with the full requirements of the Standard.

COPYRIGHT

APPENDIX C

RECOMMENDED PROCEDURES FOR THE DESIGN AND PREPARATION OF ARTICLES FOR GALVANIZING

(Informative)

C1 SCOPE

This Appendix contains advice for the designer and fabricator on factors which may affect the galvanizing process.

C2 SIZE AND SHAPE

Before design and fabrication, the dimensional limitations of size and shape imposed by the galvanizing facilities should be determined.

NOTE: Information on facilities of galvanizers in Australia is available from the Galvanizers Association of Australia, 124 Exhibition Street, Melbourne, 3000.

C3 DIMENSIONAL STABILITY

Fabricated steel assemblies are liable to dimensional change at the galvanizing temperature due to stresses induced during manufacture and subsequent fabricating operations. Additional stresses may arise from bad design, e.g. the use of parts of unequal thickness, or parts having non-symmetrical sections. Where appropriate, the likelihood of buckling may be reduced by the use of suitable jigs and jigging procedures. However, designers should observe the following guidelines in order to minimize the occurrence of dimensional change during galvanizing:

(a) Avoid designs that require double-end dipping into the galvanizing bath. It is preferable to build assemblies and sub-assemblies in suitable units so that they can be immersed quickly and fully in a single dip.

(b) Use symmetrical sections in preference to angles and channels.

(c) Use sections of nearly equal thickness at joints.

(d) Bend members to the largest acceptable radii.

(e) Accurately preform parts to avoid the need for force or restraint during joining.

(f) Continuously weld joints, if possible, using balanced welding techniques to reduce uneven thermal stresses. It should be noted that acid seepage may occur in staggered-weld fabrications.

(g) Design castings to comply with the guidelines given in Paragraph C11.

C4 OVERLAPPING OR CONTACTING SURFACES

All oil, grease, paint or oxides should be removed from contacting surfaces before assembly. Wherever possible, gaps between surfaces, which are sufficiently close to prevent penetration of zinc during galvanizing yet allow the ingress of liquor during pickling, should be avoided. Wherever such gaps cannot be avoided, they should be sealed by a pinhole-free continuous weld and the area of overlap vented by one hole of approximately 6 mm diameter for every 100 cm^2 of overlap area.

COPYRIGHT

C5 WELDING

Any recognized welding procedure may be used. It is important that the supplier remove all welding slags and spatter prior to delivery to the galvanizer.

NOTE: Some weld metals can have a higher silicon content than the adjacent metal; this can cause distinct changes in appearance and thickness of the galvanized coating at welds.

C6 VENTING AND DRAINING

C6.1 General

Structures that incorporate enclosed sections should have provision for adequate venting and draining (or filling) during galvanizing. At galvanizing temperatures, any moisture present in closed sections is rapidly converted to superheated steam capable of generating explosive forces if venting to the atmosphere is not provided.

The purchaser should confer with the galvanizer during the design and fabrication stages to ensure that venting and draining (or filling) requirements are met. In this way, the galvanizer's experience can often assist the purchaser to design a product that can be galvanized safely and that will have a satisfactory galvanized coating.

NOTE: The location of vent holes, and if required, any method of draining and resealing should be agreed with the purchaser before galvanizing commences.

C6.2 Hollow sections

In the case of welded hollow section assemblies, it is preferable to use full open-mitre joints. If this is not possible, vent and drain (or fill) holes should be drilled in accordance with the following:

(a) For hollow sections such as pipe columns with base plates and caps, and handrails, hole diameters should be at least 25% of the section diameter or diagonal dimensions, and be a minimum of 10 mm. As an exception, for light fabrications, e.g. packracks, the hole diameters may be 6 mm minimum.

(b) Tanks and closed vessels should have one vent and one drain (or fill) hole of 50 mm diameter minimum for each 0.5 m^3 of enclosed volume, at appropriate locations. Baffles should be corner cut to a minimum of 75 mm.

NOTE: Examples of correct design are given in AS/NZS 2312 and in booklets available from the Galvanizers Association of Australia.

C7 ASSEMBLIES

Where steels of widely differing surface conditions are combined in a single assembly, the entire assembly should be abrasive-blast cleaned to produce a uniform finish before galvanizing.

The supplier should not deliver to the galvanizer items that have been assembled and require break-up prior to galvanizing.

C8 MOVABLE PARTS

The designer and fabricator should allow a minimum of 1 mm radial clearance on parts requiring free movement after galvanizing; these parts should be disassembled before supplying to the galvanizer.

C9 LABELS AND MARKINGS

For temporary identification, the supplier should use either water-soluble marking paints or detachable metal labels. For permanent identification, markings should be heavily punched or embossed by the supplier.

COPYRIGHT

C10 HANDLING

Items delivered to the galvanizer should be designed to provide for any special handling requirements.

C11 CASTINGS

To produce high quality galvanized coatings on castings, it is essential that the castings be sound, stress-free and have a good surface finish. To produce such castings, the following practices are recommended:

(a) Wherever possible, castings should be designed with uniform section thickness.

(b) Large fillet radii and large pattern numbers should be used; deep recesses and sharp corners should be avoided.

(c) Large grey iron castings should be stress relieved by the supplier. Heat-treated castings should be abrasive-blast cleaned by the supplier.

COPYRIGHT

APPENDIX D

PROPERTIES OF THE STEEL TO BE COATED, WHICH CAN AFFECT OR BE AFFECTED BY HOT-DIP GALVANIZING

(Informative)

D1 BASIS METAL

D1.1 Composition

Whereas most ferrous metals can be satisfactorily hot-dip galvanized, unalloyed carbon steel, low-alloy steel and grey and malleable cast iron are particularly suitable. Where there is uncertainty about other types of ferrous metals, adequate information, or samples, should be provided by the purchaser for the galvanizer to decide whether they can be satisfactorily galvanized. Sulfur-containing free-cutting steels are normally unsuitable and certain other reactive elements in the steel can affect hot-dip galvanizing; for example, silicon and phosphorus at certain composition levels can give uneven, bright and/or dull dark grey coatings that may be brittle and thick.

D1.2 Surface condition

The steel surface has an influence on the thickness and appearance of the zinc coating and should be clean before dipping into the molten zinc. Pickling in acid is the recommended method of cleaning the surface; however, care should be taken to avoid over-pickling. Surface contaminants that cannot be removed by pickling, e.g. carbonaceous films such as oils, grease, paint, and welding slag, should be removed by other methods prior to pickling. The responsibility for the removal of such impurities is subject to agreement between the galvanizer and the purchaser. Castings should be as free as possible from surface porosity and shrinkage holes and should be cleaned either by abrasive blasting to AS 1627.4 Class Sa 2½, electrolytic pickling or by other suitable methods.

D1.3 The influence of the steel surface on the hot-dip galvanized coating thickness

The roughness of the steel surface has an influence on the thickness and the structure of the coating. Surface unevenness of the basis metal generally remains visible after galvanizing.

A rough steel surface, as obtained by abrasive blasting or coarse grinding prior to pickling, will result in a thicker coating than a surface that is produced by pickling alone.

NOTE: An improvement in the accuracy of the magnetic method for determining the zinc coating thickness of a rough surface can be obtained by applying the instrument to the uncoated surface and setting the zero adjustment, immediately prior to hot-dip galvanizing.

Flame cutting changes the steel composition and structure in the heat-affected zone, with the consequence that the coating thickness in this area may not meet the requirements of Tables 1 and 2. In order to obtain the required coating thickness, flame cut surfaces should be ground off by the fabricator.

COPYRIGHT

D1.4 Stresses in the basis metal

Some stresses in the basis metal will be relieved during the hot-dip galvanizing process, which may cause the coated article to deform.

Whether a steel article that has been cold worked could become embrittled during galvanizing is dependent on the type of steel and the degree of cold work that it has received. Hot-dip galvanizing is a form of heat treatment and may accelerate the onset of strain age embrittlement for susceptible grades of steel. To avoid this risk, it is advisable to use a steel that is not susceptible to strain age embrittlement. If a steel article is thought to be susceptible, and if it is not possible to avoid the use of severe cold working, stress relieve the article by heat treatment before pickling and hot-dip galvanizing.

NOTE: The susceptibility of a steel to strain age embrittlement is principally caused by the nitrogen content of the steel which, in turn, is largely dependent on the steelmaking process. The problem is largely overcome by the use of modern steelmaking practices. Aluminium-killed steels are the least susceptible to strain age embrittlement.

Steels may be tempered by the heat of the hot-dip galvanizing bath and, as a result, may lose some of any increase in strength that has resulted from heat treatment or coldworking processes.

Heat-treated or severely cold-worked high tensile steels may contain tensile stresses of such a magnitude that pickling and hot-dip galvanizing may cause the steel to crack in the galvanizing bath. The risk of cracking may be reduced by stress relieving before the pickling and hot-dip galvanizing processes; however, specialist advice should be sought when galvanizing such steels.

Structural steels are not normally subject to hydrogen embrittlement, which may occur as a result of the absorption of hydrogen during pickling, because the hydrogen is discharged during the galvanizing process. If a steel is harder than approximately 34 HRC, 340 HV or 325 HB (see AS 1815, AS 1817 and AS 1816 (series) respectively) it is more susceptible to hydrogen embrittlement, and care is necessary to minimize hydrogen absorption during surface preparation.

The designer should make use of the knowledge resulting from previous experience with respect to the thermal and mechanical treatments given to grades of steel that have been successfully hot-dip galvanized.

D2 LARGE OBJECTS OR THICK STEELS

The longer handling times needed in the galvanizing bath for large articles and the metallurgical properties of heavy sections of steel due to normal manufacturing methods, may cause thick coatings to form.

D3 HOT-DIP GALVANIZING PRACTICE

Very small additions of alloying elements may be made to the galvanizing bath as part of the processing technique of galvanizers to reduce the adverse effects of silicon and phosphorus (see Paragraph D1.1), or to modify the surface appearance of the galvanized coating. Such additions do not affect the general quality or long-term corrosion resistance of the galvanized coating or the mechanical properties of the galvanized product.

COPYRIGHT

APPENDIX E

DUPLEX ADDED PROTECTION FOR GALVANIZING PLACE BELOW GROUND

(Informative)

E1 SCOPE

This Appendix describes typical paint coating for galvanized steel used for underground service where additional protection is required to address wet or chemically contaminated soil conditions.

The areas may involve steel elements submerged in soil together with the first 20 cm of columns or posts in permanent contact with the ground.

E2 PAINTING PROCEDURES

E2.1 General

Before commencing the procedure the soil conditions should be assessed to assist with the paint supplier's choice of specification.

Where the conditions are principally only of above ground surface wetness, duplex coating underground may not be warranted provided back fill is of the same composition as for the surrounding ground layers and shaped to a ground configuration surrounding the column or post, ground penetration.

NOTE: In such cases, treatment as described may be adequately applied to the footings of vertical elements in contact with the ground on a 20 cm above and below ground basis.

E2.2 Preparation

The galvanized areas that are to be painted should be either sweep or brush abrasive blasted, refer to Appendix I or by degreasing and abrading will wet or dry sandpaper to obtain a key for painting.

E2.3 Painting system

The painting system that should be considered are a 2-pack epoxy zinc phosphate primer to 50 µm and 2-pack epoxy top coat(s) to 250 µm.

NOTE: The paint system should be applied to the manufacturer's instructions.

COPYRIGHT

APPENDIX F

TRANSPORT AND STORAGE OF GALVANIZED ARTICLES

(Informative)

Attention should be paid to the conditions of transport, shipment and storage of galvanized articles to avoid the possibility of wet-storage stain. A corrosion product known as 'white rust', can occur on freshly galvanized articles that are transported or stored under damp and/or badly ventilated conditions. The attack is frequently superficial despite the bulkiness of the corrosion product and may be unattractive, but is not usually detrimental to the other properties of the coating.

If it is desired to retain the initial bright appearance of the galvanized coating, dry storage conditions are necessary. Post-treatments, such as chromating applied immediately after galvanizing, can prevent or reduce the formation of 'white rust'.

The packed product should be kept under clean, dry and ventilated conditions. Galvanized articles should never be stored in contact with cardboard or paper products, cinders, clinkers, unseasoned or treated timber or harmful chemicals.

The storage of galvanized articles under covers which restrict ventilation (e.g. tarpaulins) is not recommended.

If the galvanized coating is subjected to excessively rough treatment during transit or erection, damage to small areas may be renovated by the procedures described in Appendix E.

COPYRIGHT

APPENDIX G

DETERMINATION OF COATING MASS AND LOCAL THICKNESS

(Normative)

G1 GENERAL

This Appendix sets out four alternative procedures for determining the mass of the zinc coating on galvanized articles, as follows:

(a) Gravimetric method (see Paragraph G2).

(b) Volumetric method (see Paragraph G3).

(c) Mass-on-mass method (see Paragraph G4).

(d) Magnetic, magnetic induction and eddy current methods (see Paragraph G5).

NOTES:

1 The methods in Item (d) determine local thickness, which can be converted to a value of the coating mass.

2 The test procedures do not necessarily include all the precautions required to satisfy health and safety aspects. In particular, care should be taken to ensure that the test procedures in Paragraphs G2 and G3 are executed only by people who have received suitable training. Guidance in the handling and use of hazardous chemicals is given in AS/NZS 2243.1 and AS/NZS 2243.2.

G2 GRAVIMETRIC METHOD

G2.1 Method

The method used shall be the strip and weigh (dissolution of coating) method in accordance with Method A of AS 2331.2.1, with the following exceptions:

(a) The test piece(s) are weighed to within an accuracy of 1% of the presumed coating mass.

(b) Where necessary, the area *(A)* of the stripped surface is determined to within an accuracy of 1%.

G2.2 Calculation of coating mass

The coating mass shall be calculated using the following equation:

$$m_A = \frac{m_1 - m_2}{A} \times 10^6 \qquad \text{. . . G1}$$

where

m_A = coating mass of stripped area A, in grams per square metre

m_1 = mass of specimen before stripping, in grams

m_2 = mass of specimen after stripping, in grams

A = stripped surface area, in square millimetres

NOTE: For a surface area of 2000 mm^2, Equation G1 can be expressed as:

$$m_A = (m_1 - m_2) \times 500$$

COPYRIGHT

G3 VOLUMETRIC METHOD

G3.1 Method

The method used shall be the hydrogen evolution method for zinc coatings, given in AS 2331.2.3.

G3.2 Calculation of coating mass

The coating mass shall be calculated using the following equation:

$$m_A = \frac{V}{A} \times 2718 \qquad \ldots \text{G2}$$

Where

m_A = coating mass, in grams per square metre

V = volume of hydrogen evolved, in millilitres

A = stripped surface area, in square millimetres

NOTE: The above equation is based on the measurement of the hydrogen volume at 1013 hPa and 20°C.

G4 MASS-ON-MASS METHOD

The coating mass, in grams per square metre, shall be determined by weighing the articles before and after galvanizing and dividing the difference by the area of the surface before galvanizing.

The mass before galvanizing shall be determined after pickling and drying, and the mass after galvanizing when the article has cooled to ambient temperature.

G5 MAGNETIC, MAGNETIC INDUCTION AND EDDY CURRENT METHODS FOR LOCAL THICKNESS

G5.1 General

The method used shall be in accordance with either AS 2331.1.3, AS 2331.1.4 or AS 3894.3.

G5.2 Calculation of coating mass

If required, the coating mass can be calculated by multiplying the thickness, in micrometres, by 7.15.

G6 TEST REPORT

A test report shall include the following information:

(a) Name of testing authority.

(b) Report number and date of issue.

(c) Batch number and details of the material under test.

(d) Test method used.

(e) Location and details of test samples and test specimens.

(f) Results of the test, and a statement of compliance or otherwise with the requirements of this Standard.

(g) Results of any retests carried out.

(h) Reference to this test method, i.e. AS/NZS 4680, Appendix G.

COPYRIGHT

APPENDIX H

GENERAL INFORMATION ON FACTORS THAT AFFECT THE CORROSION OF GALVANIZED STEEL

(Informative)

H1 SCOPE

This Appendix provides general information on factors that affect the corrosion rate of galvanized steel. A classification of atmospheric environments encountered in Australia and New Zealand is given in AS/NZS 2312.

H2 EXTERNAL ATMOSPHERIC CORROSIVITY FACTORS

There are a large number of factors that influence external atmospheric corrosivity, but the four most important ones are—

(a) time of wetness;

(b) atmospheric chloride content;

(c) atmospheric sulfur dioxide content; and

(d) atmospheric hydrogen sulfide content.

Time of wetness is the length of time during which the metal surface is covered by a film of water which renders atmospheric corrosion possible. It is influenced by factors such as metal mass, orientation and pollution, and can be quantified to sufficient accuracy in terms of the number of hours per year that the relative humidity is above 80% for temperatures above 0°C.

Airborne salinity, sulfur dioxide and hydrogen sulfide are powerful stimulants for atmospheric corrosion and their deposition rate in non-sheltered situations is directly proportional to their concentration in the atmosphere. Airborne salt has a major influence on corrosion rates. In Australasia sulfur dioxide and hydrogen sulfide have been found to play only a minor role in corrosion and can be neglected except when occurring near recognized point sources, such as certain fossil fuel-burning industries (sulfur dioxide) and geothermal areas (hydrogen sulfide).

Rainfall also influences corrosion rates and has the effect of either stimulating or reducing corrosion, depending on the environment. In polluted or coastal atmospheres, the washing effect of rain reduces corrosion, while at less polluted sites or those well away from the ocean the situation is reversed and the corrosive action of rain is more important.

Temperature influences corrosion rate but can have contradictory effects; increasing temperature accelerates the rate of the corrosion reactions, but, on the other hand, leads to more rapid evaporation, thus shortening the time of wetness and decreasing the corrosion rate.

H3 LOCAL ENVIRONMENT EFFECTS

In addition to the macroclimatic effects described in Paragraph H2, local environmental effects, microclimatic effects and the circumstances of use of the coated article, may present an influence and, therefore, should be taken into account if the duration of the corrosion protection sought is to be realized.

For example, a coating employed in a macroclimatic atmosphere, classified as mildly corrosive, may have its useful life significantly shortened if due consideration has not been taken of fumes from a nearby effluent-treatment plant.

COPYRIGHT

Factors that can significantly affect the corrosion rate of coated steel are as follows:

(a) *Protection from rain*

The corrosion rate in applications exposed to airborne salts and other contaminants, but sheltered from rain, can be many times that which would result in exposed situations. This applies particularly to localities affected by sea-mist and fertilizer drift.

(b) *Prolonged dampness*

Corrosion will be promoted at locations where the coating remains damp for extended periods of time, such as where it is protected from the warming effects of the sun, where it is in contact with wet vegetation, where it is subject to moisture retention or condensation, or where a supplementary covering such as noise-deadening material allows prolonged retention of moisture.

(c) *Galvanic corrosion*

Galvanic corrosion of the coating can occur where it is in direct electrical or metallic contact with a dissimilar, more noble (cathodic) metal in the presence of an electrolyte.

(d) *Burial in soils*

It should not be assumed that galvanized steel buried in soils in regions classified as mild or moderate will be immune to corrosion, because the soil may contain salts and its moisture content may be reasonably high, thus providing a good electrolyte. For example, the clay pans in the vicinity of Birdsville in the arid, far south-west of Queensland are very corrosive.

(e) *Organic and chemical attack*

Galvanized steel should not be employed or stored in contact with cardboard or paper products, damp concrete or other damp surfaces, cinders, clinkers, unseasoned timber or damp timber that has been treated with copper-based preservatives, or harmful chemicals or vapours.

(f) *Use in concrete*

Although an immediate reaction occurs between zinc and the highly alkaline constituents of freshly laid concrete (or mortar), this quickly diminishes because of the formation of a passivating layer of calcium hydroxyzincate on the embedded galvanized coating. The subsequent slow carbonation of the concrete assists the process. During carbonation, the pH of the concrete falls below its initial value of about 12.5. The overall result is that the galvanized steel will last much longer than its bare counterpart, particularly where deterioration of the concrete permits ingress of moisture contaminated with salt or other ionic pollutants.

(g) *pH effect*

Since zinc is an amphoteric metal, it is rapidly attacked at pH values below 6 and above 12.5. The relatively slow rate of attack between these pH values is due to the formation of a protective film of basic zinc carbonate on the coating surface.

(h) *Barrier film removal*

Galvanized steel relies for its durability on thin barrier films of oxides and/or carbonates formed on the surface during the early stages of service.

Any agent, such as a chemical contaminant or abrasive, which tends to modify or remove the protective films, will seriously reduce the useful life of the coating.

COPYRIGHT

(i) *Wind erosion*

The expected life of a coating, based purely on climatic considerations, will be seriously reduced by the abrasive effects of windborne particles. This is a particular problem in arid regions.

(j) *Effect of temperature*

Temperature may have a marked effect on the behaviour of zinc coatings subjected to immersion in aerated water. At temperatures above 60°C to 65°C, zinc may become cathodic to iron, with the result that any bare steel, such as at damaged areas or resulting from uncoated fittings, corrodes preferentially.

H4 SEA WATER IMMERSION

The life of a zinc coating in sea water depends on a large number of factors, such as whether the coating is partly or wholly immersed, the velocity of water flow, the time of wetness (for intermittent immersion), salinity, wave or sand action, water temperature and the presence of any contaminants. The depth at which the coating is immersed and the degree of water turbulence are important because the corrosion rate increases with aeration.

NOTE: Further research is currently being undertaken which influence the information in this clause.

COPYRIGHT

APPENDIX I

INFORMATION ON THE USE OF SWEEP (BRUSH) BLAST CLEANING OF GALVANIZED STEEL PRIOR TO PAINTING

(Informative)

I1 GENERAL

Abrasive sweep (brush) blast cleaning is a method used for the preparation of a galvanized coating prior to the application of an organic (paint) coating. The purpose of this procedure is to remove the oxide film from the zinc surface.

NOTE: It is important that this procedure be performed carefully to ensure that no more than 10 µm of zinc is removed.

Organic paint coatings should be applied as soon as possible after galvanizing or abrasive blasting.

I2 PROCEDURE

The following procedure should be observed when sweep blast cleaning is carried out to ensure that a good surface is produced for painting, without severely damaging the existing galvanized coating:

(a) Use fine non-metallic abrasives of a size which will pass through a test sieve of nominal aperture size 150 µm to 180 µm (80 to 100 mesh), e.g. ilmenite or garnet.

(b) Use a venturi nozzle which has an orifice diameter of 10 mm to 13 mm.

(c) Set the blast pressure at 275 kPa (40 p.s.i.) maximum.

(d) Keep the venturi nozzle at a distance of 350 mm to 400 mm from the surface of the workpiece and at an angle no greater than 45° to the surface.

COPYRIGHT

NOTES

NOTES

Standards Australia

Standards Australia is an independent company, limited by guarantee, which prepares and publishes most of the voluntary technical and commercial standards used in Australia. These standards are developed through an open process of consultation and consensus, in which all interested parties are invited to participate. Through a Memorandum of Understanding with the Commonwealth government, Standards Australia is recognized as Australia's peak national standards body.

Standards New Zealand

The first national Standards organization was created in New Zealand in 1932. The Standards Council of New Zealand is the national authority responsible for the production of Standards. Standards New Zealand is the trading arm of the Standards Council established under the Standards Act 1988.

Australian/New Zealand Standards

Under a Memorandum of Understanding between Standards Australia and Standards New Zealand, Australian/New Zealand Standards are prepared by committees of experts from industry, governments, consumers and other sectors. The requirements or recommendations contained in published Standards are a consensus of the views of representative interests and also take account of comments received from other sources. They reflect the latest scientific and industry experience. Australian/New Zealand Standards are kept under continuous review after publication and are updated regularly to take account of changing technology.

International Involvement

Standards Australia and Standards New Zealand are responsible for ensuring that the Australian and New Zealand viewpoints are considered in the formulation of international Standards and that the latest international experience is incorporated in national and Joint Standards. This role is vital in assisting local industry to compete in international markets. Both organizations are the national members of ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission).

Visit our web sites

www.standards.org.au
www.standards.co.nz
www.standards.com.au

STANDARDS Australia

GPO Box 476 Sydney NSW 2001
Administration
Phone (02) 8206 6000
Fax (02) 8206 6001
Email mail@standards.com.au
Customer Service
Phone 1300 65 46 46
Fax 1300 65 49 49
Email sales@standards.com.au
Internet www.standards.org.au

STANDARDS NEW ZEALAND PAEREWA AOTEAROA

Level 10 Radio New Zealand House
155 The Terrace Wellington 6001
(Private Bag 2439 Wellington 6020)
Phone (04) 498 5990
Fax (04) 498 5994
Customer Services (04) 498 5991
Information Service (04) 498 5992
Email snz@standards.co.nz
Internet www.standards.co.nz

ISBN 0 7337 7697 3

Printed in Australia