

Australian Standard[®]

**Electroplated coatings of zinc on steel
fasteners with imperial threads**



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- Australian Institute of Metal Finishing
 - Australian Chamber of Commerce and Industry
 - Australian Industry Group
 - Department of Defence
 - Galvanizers Association of Australia
 - The Royal Australian Chemical Institute
 - Society of Automotive Engineers, Australia
-

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STANDARDS AUSTRALIA

RECONFIRMATION

OF

AS 4397—2007

Electroplated coatings of zinc on steel fasteners with imperial threads

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Technical Committee MT-009 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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NOTES

Australian Standard[®]

Electroplated coatings of zinc on steel fasteners with imperial threads

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PREFACE

This Standard was prepared by the Australian members of the Joint Standards Australia/Standards New Zealand Committee MT-009, Metal Finishing, to supersede AS 4397—1996, *Electroplated coatings of zinc on steel fasteners with imperial threads*. After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to specify requirements for zinc coatings on components with imperial threads for sectors of industry that have not converted to using metric threaded components.

The objective of this edition is to revise the zinc coating specifications and the means for complying with the Standard.

The terms ‘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.

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FOREWORD

The Standard specifies the electrodeposition of zinc on threaded steel components. The nature of threaded items presents a number of problems which necessitate special care in the specification, application and inspection of electrodeposited coatings. Factors to consider include the following:

- (a) The thickness of an electrodeposit on parallel screw threads must be sufficient to provide the required resistance to corrosion but be not so great as to prevent assembly. Specifications for the electroplating of threaded items, therefore, are required to have both a maximum and a minimum value for the coating thickness.
- (b) Because of the geometry of screw threads, the theoretical change in pitch diameter caused by a plated deposit is several times the coating thickness. This change in pitch diameter depends on flank angles. In practice, it is generally greater than the theoretical value because of the tendency for the coating to be thicker on the crests of the threads resulting in a change of thread flank angle.

Figure 1 diagrammatically shows a coating which has been plated on an external screw thread; t is the thickness of coating, and θ is the angle between flanks of the thread. A coating thickness t on the external thread results in an increase in pitch diameter of $2t \operatorname{cosec} \theta/2$, which for a thread of included angle of 60 degrees increases the pitch diameter by an amount equal to $4t$.

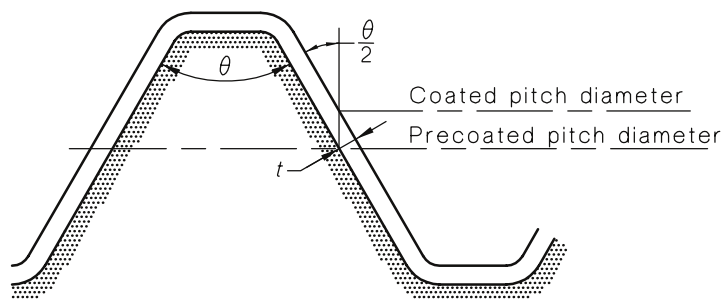
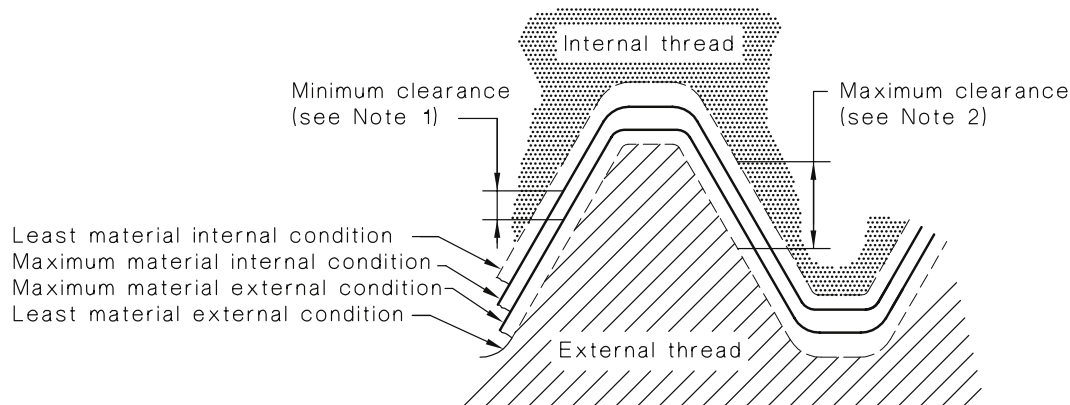


FIGURE 1 THEORETICAL CHANGE IN PITCH DIAMETER RESULTING FROM DEPOSIT OF THICKNESS (t)

- (c) With any form of electroplating, the coating tends to be preferentially deposited on projections and to be much thinner in any recess. For screws and bolts, the coating is thicker on the extremities and on the threaded ends of the items than on the centre of the bolt length. The longer the bolt in proportion to its diameter, the greater is this tendency. Fortunately, these extremities are the positions which are most significant in the ultimate service of the screw or bolt. Similarly for nuts, the thickness of coating on the threads is very much greater at the ends than on the interior threads. The greatest thickness will be on the outer surfaces which are most significant in service. In practice, thin coatings on the interior threads do not normally cause serious problems if sacrificial coatings are used, because they are normally in contact with the thicker coating on the external threads of the mating fastener. Furthermore, some slight variation in coating distribution occurs on the individual thread flanks, the tendency being for heavier deposition of coating at the crest of the thread than at the root. The effect of these variations is to increase the pitch diameter more than the theoretical value (see Item (b)). The clearance between an external and an internal thread is diagrammatically shown in Figure 2.

NOTE: The two types of electroplating processes in common use are vat plating and barrel plating. In vat plating, the items are individually suspended in the plating solutions either by wires or on jigs and are electrically connected to the cathode bar. In barrel plating, the items are contained in a suitable vessel which either contains the plating solution or is immersed in a tank of plating solution. In both cases, the barrel is rotated to ensure even mixing of the work, and electric current is fed from item to item in the barrel load so that all items receive a coating. It has been found that the variations in average thickness of coating received by different items in a barrel load follow a normal Gaussian distribution curve. This is the basis on which batch average thicknesses quoted in this Standard have been derived.



NOTES:

- 1 Minimum clearance allowed for assembly of standard unplated threads at maximum material condition.
- 2 Maximum clearance allowed for assembly of standard unplated threads at least material condition.

FIGURE 2 CLEARANCE BETWEEN EXTERNAL AND INTERNAL THREADS

STANDARDS AUSTRALIA

Australian Standard

Electroplated coatings of zinc on steel fasteners with imperial threads**1 SCOPE**

This Standard specifies the requirements for electroplated coatings of zinc, applied either by barrel plating or other techniques, on fasteners with imperial threads (UNC, UNF, BSW and BSF).

The Standard requires that coated threads be subject to 'GO' gauge acceptance criteria. It includes a method for the calculation of the degree of thread modification to accommodate thicker coatings.

NOTES:

- 1 Advice and recommendations on information to be supplied by the purchaser at the time of inquiry and order are contained in the purchasing guidelines set out in Appendix A.
- 2 This Standard may apply to threaded components other than fasteners, whether barrel or individually processed, subject to agreement between purchaser and supplier.
- 3 For a guide to complying to the Standard, refer to Appendix B.
- 4 A recommended sampling plan for electroplated zinc fasteners is contained in Appendix C.
- 5 For guidance on determining the surface area for imperial screws, bolts and nuts, refer to Appendix F.
- 6 For guidance on determining electroplating thickness for barrel plating refer to Appendix G.
- 7 For guidance on how to calculate plating thickness, refer to Appendix H.
- 8 For guidance on plating tolerances, refer to Appendix I.
- 9 For examples for calculating group average thickness variation, refer to Appendix J.
- 10 For examples for calculating external thread dimension to accommodate thicker coatings, refer to Appendix K.

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 of quality limit (AQL) for lot-by-lot inspection |
| 1722 | Pipe threads of Whitworth form |
| 1722.2 | Part 2: Fastening pipe threads |
| 1789 | Electroplated zinc (electrogalvanized) coatings on ferrous articles (batch process) |
| 2331 | Methods of test for metallic and related coatings |
| 2331.1.1 | Method 1.1: Local thickness tests—Micrographic examination of cross-sections |
| 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/NZS

- 2465 Unified hexagon bolts, screws and nuts (UNC and UNF threads)
- 2829 British Association (BA) screw threads and associated gauges and gauging practice
- 3501 Parallel screw threads of Whitworth form (BSW and BSF) and associated gauges and gauging practice
- 3635 Unified (ISO inch) screw threads associated gauges, and gauging practice

AS/NZS ISO

- 9001 Quality management system—Requirements
- 9004 Quality management system—Guidelines for performance improvements
- HB 18.28 Conformity by assessment—Guidance on a third-party certification system for products

ISO

- 12686 Metallic and other inorganic coatings—Automated controlled shot-peening of metallic articles prior to nickel, autocatalytic nickel or chromium plating, or as a final finish.

BS

- 811 Specification for cycle (BSC) threads (formerly known as CEI threads)
- 1981 Specification for unified machine screws and machine screw nuts

3 DEFINITIONS

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

3.1 Batch average thickness

The average thickness of the coating on all the items of an inspection batch as determined on a representative sample.

3.2 Inspection batch

A collection of items in the finished state from which a sample is randomly drawn and inspected to determine conformance with the acceptance criteria. It may differ from a collection of product items designated as a batch for other purposes, such as production, shipment and storage.

3.3 Local thickness

The coating thickness at the specified position.

3.4 Representative sample (for plating thickness)

Ten or more items selected at random from an inspection batch.

4 DIMENSIONAL REQUIREMENTS BEFORE PLATING

Threads of items supplied for plating shall comply with the relevant screw thread Standard, except where threads require modification to achieve the required fit.

5 COATING REQUIREMENTS**5.1 General**

The electroplated coating shall comply with the requirements for appearance, adhesion, ductility, and corrosion resistance, as specified in AS 1789.

5.2 Coating thickness

5.2.1 Batch average thickness

The batch average thickness determined on a representative sample shall comply with the limits specified in Table 1. However, if the batch average thickness exceeds the maximum specified in Table 1, fasteners shall be deemed to comply with the thickness requirements of this Standard if the threads are accepted by an appropriate GO gauge of basic size.

For control purposes, thickness may be determined by either the strip-and-weigh method or the hydrogen evolution method, as specified in AS 2331.2.1 and AS 2331.2.3 respectively. For referee purposes the strip-and-weigh method shall be used.

5.2.2 Local thickness

When the coating is tested for local thickness by the microsection method specified in AS 2331.1.1, the sampling procedure, measuring position and thickness requirement are the subject of agreement between the purchaser and the electroplater.

NOTE: The position where local thickness is to be determined is largely a matter of experience, but for guidance the measuring positions shown in Figure 3 should be considered. It is pointed out that where a bolt shank is only partly threaded, the minimum coating thickness has been found to be where the thread terminates.

TABLE 1
COATING THICKNESS REQUIREMENTS

Basic major diameter of screw thread	Batch average thickness	
	Min.	Max.
Up to and including 0.250	0.000 15	0.000 20
Over 0.250	0.000 20	0.000 25

NOTE: In order to determine the average thickness of a coating over the whole surface of a fastener, the total mass of the deposit and the total surface area should be known. Data to enable the calculation of the total surface area of fasteners and nuts having various types of imperial threads are given in Appendix F.

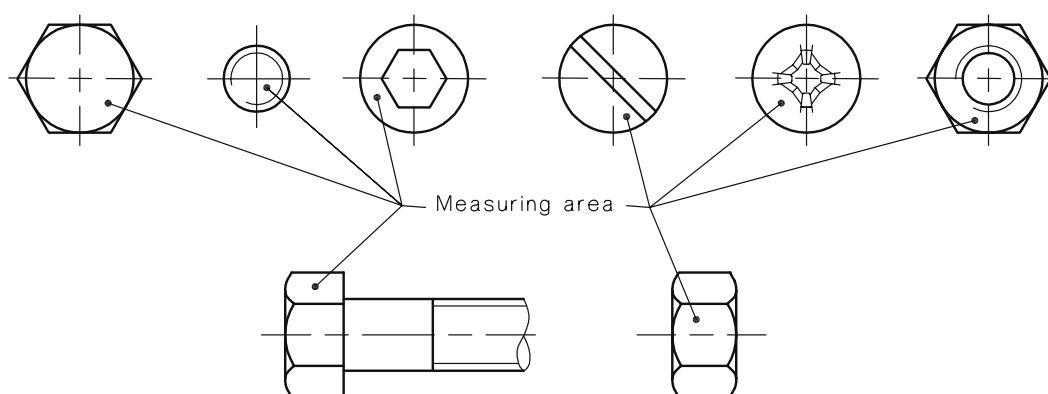


FIGURE 3 MEASURING POSITIONS FOR LOCAL THICKNESS

5.3 Gauging after coating

5.3.1 General

Gauging requirements for imperial threads shall be in accordance with AS 3635.

NOTE: Conformance to 'NOT GO' gauges after coating is not a requirement for acceptability to this Standard.

5.3.2 Acceptability

A batch of items after coating shall be accepted by a 'GO' gauge of basic size to an acceptable quality level of 2.5%.

NOTE: Special factors requiring consideration for the electroplating of screw threads are given in Appendix G.

6 APPLICABILITY OF COATING TO STANDARD THREADS

Where it is desired to protect threaded items from corrosion by the application of an electrodeposit without modification of the precoated thread dimensions, the electroplater should calculate the surface areas of fastener components. The average thickness of the deposit is then calculated from a knowledge of the total mass of the deposit on the fastener and its total surface area.

NOTE: Appendix F provides guidance on such calculations.

In order to calculate the maximum plating thickness that can be accommodated within the fit allowance for a particular thread, the following procedure should be followed:

- (a) From the appropriate thread Standards, determine the allowance for fit on a thread diameter. (This allowance may be listed directly or may have to be calculated from listed values of manufacturing tolerances, e.g. for certain threads covered by AS 3501 the allowance is 30% of the medium class effective diameter tolerance.)
- (b) Divide the value of the allowance for fit by the factor given in Table 2 for the particular thread form. This yields the maximum value of batch average plating thickness which can be classed as 'normal'.

NOTE: Examples of calculations of plating thicknesses are given in Appendix H and the results of such calculations for common thread types are shown in Appendix I. The effect of manufacturing tolerances on plating thickness calculations is shown in Appendix J.

TABLE 2
DEPOSIT THICKNESS FACTORS

Thread form	Factor	Thread form	Factor
BA* (AS 2829)	5	Unified (ISO in, AS 3635)	4
BSW* (AS 3501)	4.3	—	—
BSF* (AS 3501)	4.3	BSC (BS 811)	4
BSPF (AS 1722.2)	4.3	—	—

* These threads are now considered obsolete and their use is not recommended.

7 APPLICABILITY OF COATING TO MODIFIED THREADS

7.1 General

When a calculation (as in Clause 6) indicates that the desired plating thickness falls in the 'thicker' category, it will, in general, be necessary to modify the preplating dimensions of the threads.

7.2 External threads

The amount by which the diameter of an external thread is reduced in order to accommodate thicker plating depends on the plating thickness required and the thread form.

Table 3 shows values of plating allowance, designated A, B and C (corresponding with plating thicknesses of 0.0005 in, 0.0008 in and 0.0012 in), for common thread forms. Where fasteners having close-fit threads (e.g. AS 3635 Class 3A) require plating, the allowance should be calculated from the actual plating thickness required. However, plating thicknesses greater than 0.0005 in are not recommended for close-fit threads.

When determining preplating dimensions for a particular thread, the appropriate allowance should be subtracted from both maximum and minimum limits for major, minor and effective diameters.

NOTE: An example of the calculation of external thread dimensions is given in Appendix K.

7.3 Internal threads

The preferred method of dealing with thicker plating on internal threads may differ from that for external threads. Where it is requested by the purchaser that preplating dimensions be modified to allow for the thickness of plating, preplating thread dimensions shall be determined as for external threads (see Clause 7.2), except that the appropriate allowance given in Table 3 shall be added to the normal preplating dimensions.

TABLE 3
ALLOWANCES FOR THICKER PLATING

Thread form	Allowance, in		
	A (0.0005 in)	B (0.0008 in)	C (0.0012 in)
BA*	0.0025	0.004	0.006
BSW* and BSF*	0.0021	0.0034	0.0052
BSPF	0.0021	0.0034	0.0052
UNC and UNF	0.002	0.0032	0.0048
BSC	0.002	0.0032	0.0048

* These threads are now considered obsolete and their use is not recommended.

8 HEAT TREATMENT OF STEEL FOR RELIEF OF STRESS AND HYDROGEN EMBRITTLEMENT

8.1 Heat treatment before plating

Before coating the substrate, the substrate may require pre-treatment for iron and steel to prevent hydrogen embrittlement, see Appendix D.

8.2 Heat treatment after plating

For post treatment to prevent hydrogen embrittlement refer to Appendix E.

9 CHROMATE CONVERSION COATINGS

9.1 General

Electrodeposited coatings of zinc are usually chromate treated to produce a chromate conversion film which retards the formation of corrosion products that form on exposed surfaces in the atmosphere. The treatment improves corrosion resistance under conditions of high humidity or in the presence of certain vapours from organic substances.

In the event of coloured chromate treatments being specified on high tensile steel items, any hydrogen embrittlement relief heat treatment (see Clause 8) shall be carried out before the application of the conversion coating.

9.2 Types

The requirements for, and types of, chromate conversion coatings are given in AS 4397.